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July-December 2015

NEW AGE PROTECTED CULTIVATION

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NEW AGE PROTECTED CULTIVATION
(A magazine devoted for the advancement of protected cultivation technology)
July – December 2015
Published bi-annually, Vol. 1 No. 2

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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 latest JPG photographs and five lines of brief about senior author. Hard copies are not required.

From the Editor's Desk

Specialty agriculture is gaining popularity to yield desired high productivity of crops and economic return. Protected cultivation is one of the specialty agriculture where high input (land, water, seeds and chemicals) use efficiency on account of better protection against abiotic and biotic stress is obtained besides off season production. It is estimated that small area approximately fifty thousand hectares is under protected cultivation in India. Protected cultivation though has variety of agriculture application (poultry, mushroom, orchids etc) but mainly it is being considered for the production of horticulture crops like vegetables and ornamental foliage and flowers. Rapid urbanization, an indicator of progress and prosperity, is a favorable factor for development of protected cultivation. Urban areas are well suited for protected cultivation of fresh fruits, flowers and vegetables. Urban horticulture can be in the form of home gardens, terrace garden, container gardens, plant nurseries, multistorey greenhouses etc. With advancement of technology it has been possible to grow plants without soil with alternate substrates like coco peat, sphagnum moss, coir dust, bio char, coir peat, perlite, vermiculite, sand, gravel, wood fiber, Rockwool, sheep wool, brick shards etc not only horizontally but vertically also. The substrates are fertigated frequently or as per requirement of crops. The system is called hydroponics which is an age old practice but uncommon in India. Same hydroponic system can be used without using substrate where roots of plants are periodically sprayed with nutrient solutions (aeroponics). Such soilless farming can be done at any space available in the houses/flats and multi- storey greenhouses. This issue of magazine covers article on such farming besides cultivation under naturally ventilated polyhouses, net and shade houses, rain shelters, low plastic tunnels/covers, plastic mulch, micro irrigation etc

Protected cultivation of vegetables like tomato, capsicum and parthenocarpic cucumbers under different protected structures particularly in naturally open ventilated polyhouse has been proved more remunerative than open field cultivation. So is the case with the production of cut flowers like rose, lilium, chrysanthemum, carnation and anthurium. Production of strawberry under plastic mulch and hydroponically has been a rewarding experiment with its adoption by progressive growers throughout the country. Another milestone under protected cultivation of off and on season multiplication/raising seedling plugs in soilless media of different horticultural crops has been acknowledged by Indian nurserymen for mass multiplication.

This issue covers articles detailing assistance by National Horticulture Board for protected cultivation, rain shelter vegetable cultivation besides news on global development on protected cultivation. Efforts have been made to cover topics of interest on protected cultivation for the benefit of all stakeholders.

Chief Editor

LED LIGHTING UP DUTCH HORTICULTURE SECTOR

Step into any of the greenhouses in the Netherlands and one is unlikely to miss out on the arrays of tiny blue and red coloured light emitting diodes (LEDs) amidst the tomato or capsicum plants or cucumber vines.

Horticulturists across Netherlands, the second-largest exporter of agri-products after the US, are experimenting with the use of the multi-coloured LEDs for a potential enhancement of yield, improvement in quality and taste of the produce and also reduce their greenhouse energy costs.

Cutting down costs

Add to this, a section of large growers have also started tapping geo-thermal energy, heat generated at great depths, to warm their greenhouses. Geo-thermal energy and LEDs are the latest buzzwords in the Dutch horticulture sector, where growers are trying to reduce their energy costs while making their operations more sustainable. The LEDs are far more energy efficient and consume less energy compared to traditional fluorescent growing lights.

As operational costs rise amidst shrinking profit margins, the energy-intensive Dutch horticulture industry is increasingly looking at alternatives that are sustainable and could possibly help them reduce costs. Netherlands has now close to 10,000 hectares under greenhouses against a peak of 11,000 hectares a couple of years ago. Besides shrinking profits, reduced interest among younger generation in horticulture has led to consolidation of holdings.

Russian ban

Also, the one-year ban imposed by

Russia in August last year on food imports from the Western countries in retaliation against sanctions imposed on its defence, oil and financial sectors over its support for rebels in East Ukraine has hit vegetable growers hard in Netherlands, affecting their margins. Russia was among the biggest importers of fruits and vegetables from the European Union.

"We have been experimenting with the LED lightings for the past one year," said Ted Duijvestijn, owner Duijvestijn Tomaten, considered the most innovative producer of tomatoes in a sustainable way. Duijvestijn Tomaten won the award for Best Tomato Grower Worldwide 2015 at the Fruit Logistica in Berlin recently. In a corner of the Duijvestijn greenhouse spread across 13.5 acres at Pijnacker near The Hague, arrays of various coloured LEDs have been installed amidst several rows of tomato plants.

Yields improve

"We have been told that LEDs help improve the quality of tomatoes. We are trying to figure it out ourselves," said Duijvestin, who grows 9 million kg of tomatoes annually. Eva van Rijsingen, consultant researcher at HAS University of Applied Sciences, said it was possible to influence the yields and improve parameters such as taste and quality of horticultural produce by using various coloured LEDs to grow the plants and fine-tuning their wavelengths.

Rijsingen, who leads Brightbox, a collaborative research initiative in hi-tech horticulture between the HAS University of Applied Sciences, Philips Horticulture LED Solutions and the Dutch province of Limburg, said results of the research on usage of LEDs in greenhouses were expected to be published later this year.

Geo-thermal systems

Duijvestijn is also among the 13-odd large horticulture farms that are using the geo-thermal energy to heat up their greenhouses for the past couple of years. As part of the process, hot water of around 70 degrees centigrade is extracted from great depth of around 2,000 metres and is brought to the surface, where it is pumped through heat exchangers.

In these exchangers, the heat of the hot water is absorbed by a second stream of water. This hot water (second stream) is used to heat up the greenhouses. After passing through the heat exchanger, the water (extracted from the ground) would have turns cooler by around 10 degrees, which is then pumped back into the stratum.

The deployment of geothermal heat plant that entails drilling through stratum at great depths and installation of heat exchangers is highly capital-intensive and the Dutch Government has supported the growers through various incentives such as tax breaks and soft loans.

"It cost about €15 million for setting up the geo-thermal energy system. We expect to recover the costs over a period of 5-7 years," said Pieter Wijnen, owner, Wijnen Square Crops, that grows mainly capscicum and cucumbers and exports to countries such as China and Japan.

ALGAE THE FRESH AND LOCALLY GROWN GREENHOUSE CROP OF THE FUTURE?

Algae have the potential to become a cash crop that can provide commercial greenhouse and controlled environment growers with a stable income stream, year round. According to Robert Henrikson, a pioneer in large scale commercial algae production, Spirulina algae is a crop that commercial growers could consider adding to their greenhouse or vertical farm. "I believe greenhouse growers will be the next to incorporate algae microfarms, seeking to diversify into new products with greater income potential."

Vertical farming is a good initiative, looks exiting and supplies locally grown product direct to the market. Yet, it is a costly way of growing and may not always create the revenues to cover the cost of going vertical. Adding a spirulina cultivation inside a small portion of an existing urban farm or commercial greenhouse farm can change this and

add higher income to become more successful.

A SUCCESS STORY OF CENTRE OF EXCELLENCE FOR VEGETABLES AT GHARAUNDA (KARNAL) AND ITS IMPACT ON PROMOTION OF PROTECTED CULTIVATION

– Dr Arjun Singh Saini
Director General, Department of Horticulture, Panchkula, Haryana

Dr. Arjun Singh Saini is currentlyDirector GeneralHorticulture Department, Govt of Haryana. He has done his doctorate in horticulture from CCS Haryana Agricultural University, Hisar in 1993. After his brief stint in private sector, he has joined Govt. sector in horticulture department of Haryana since 2004. He has been credited with number of new initiatives in the horticulture department. Major ones are projects under Indo-Israel work plan which is implementing 5 major projects on fruits, vegetables, flowers and bee-keeping. He has travelled widely both India and abroad and has undergone intensive training in horticulture production technologies. He is also credited with formation of farmers' groups/association in the Haryana State as a new initiatives and so far formed 13 farmer producer companies.

1. Background

In Haryana total area under horticultural crops is 4.37 lacs hectare in the year 2012-13 out of which the area under vegetables is 3.60 lacs hectare which is around 83% of the total area under horticulture. Vegetables in Haryana were traditionally grown and with little technological inputs, therefore, new technologies are to be brought to increase production and productivity. A Centre of Excellence for Vegetables was established and inaugurated on 17th January, 2011. This Centre was established under Indo-Israel work plan, under Indo-Israel bilateral agreement with the following objectives:

- Intensive crop cultivation farm by demonstrating latest technologies
- High quality vegetables production systems for domestic and export market
- To achieve potential productivity per unit area
- LEAD THE FARMERS with technology

2. Initiatives

A) Technology Demonstration at the Centre

Number of initiatives have been taken at this center since its establishment. The technologies introduced and demonstrated at this Centre since 2011 are as under:

1. Vegetable nursery/seedling production in soilless media under Hi-tech greenhouse.
2. Demonstration of different varieties of different vegetables and viz. tomato, capsicum, cucumber, chilies, brinjal etc. under different structures namely polyhouse, net house, walk-in-tunnels and low tunnels.
3. Open field cultivation with plastic mulching and micro irrigation system.
4. Post-harvest management technologies.

Centre of Excellence for Vegetable (IIP) at Gharaunda, Karnal

CEV Gharaunda outside view

Vegetable Seedling Production & vegetable production at CEV

Training at CEV (IIP)

B) Front Line Demonstration Centre

1. Fourteen Front Line Demonstration Centre (FLDC) were established at farmer's field in 14 different districts of the state for transfer of technologies developed at Centre to grass root level.

3. Milestone achieved at the Centre and facilities provided to the farmers

a) The Centre has achieved the potential productivity of 302 MT per ha in tomato, 211 MT in capsicum and 151 MT in cucumber.

b) Providing hybrid vegetable seedlings that can be grown under polyhouses for the last three years (2011 to 2013) 115.98 lacs seedlings have been sold to the farmers on subsidized rates.

c) Since 2011, 85 hybrids of tomatoes (45 cherry and 40 regular hybrids), 30 hybrids of capsicum (7 colours), 20 hybrids of cucumber along with brinjal, green chilies, summer cabbage, muskmelon in winter were demonstrated and tested at the center. Most successful hybrids were recommended to the farmers.

d) Regular trainings are conducted to the growers, extension workers and corporate managers. Every week farmers training on practical aspects conducted for 2 days.

e) High Level Officers and Experts from Israel, Holland, U.S., Afghanistan, Rwanda and Nepal have visited this center during last one year.

f) To mark the occasion, 1st Vegetable Expo was organized during 17th – 19th January, 2012, 2nd Expo on 17th February, 2013 and 3rd Expo on 16th February, 2014. In these Expo every year more than 15000 farmers have participated. Seminar was conducted and private sector companies were invited to show case their products.

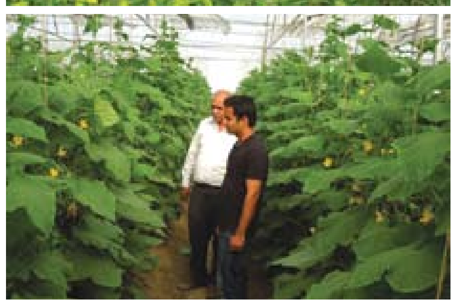
4. Impact

After the inauguration of the center in January, 2011 a lot of farmers from the state has visited the center and seen the technologies demonstrated there. The status of protected cultivation was insignificant before the setting up of the center in Haryana state. After seeing the technologies at the center, the farmers got confidence and started adoption of technologies at their farms.

1) Impact on area under protected cultivation:Up to 2010, an area of 42.5 hectare was under protected cultivation which increased to 63.46 hectare upto 2011-12, 217.71 hectare upto 2012-13 and 398.01 hectare upto 2013-14.The adoption rate of these technologies is very high and the main focus of state is towards the vertical and protected cultivation to increase the quality and per unit productivity. For the next five years it is proposed to cover 2500 hectare under protected cultivation with capital investment of Rs. 2500 crore.

2) Impact on productivity and income of farmers: On an average yield increment in crops grown under protected structures than that of open field is 4 to 5 times in case of tomato, 3 to 4 times in capsicum and cucumber. NABARD has made bankable projects on protected cultivation and income was worked out which is Rs. 17.20 lacs per hectare in case of tomato,Rs. 20 lacs per hectare in case of cucumber, Rs. 19.30 lacs per hectare in case of rose flowers and Rs. 14.90 lacs in case of gerbera flower.

Production of vegetable and flowers at Farmer's Field



NATIONAL HORTICULTURE BOARD FOR THE HOLISTIC DEVELOPMENT OF PROTECTED HORTICULTURE IN INDIA

– A. K Singh

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Ministry of Agriculture and Cooperation
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Dr Singh obtained his Ph. D from IARI; Post Doctorate from Japan and USA. He is an awardee of Mombusho fellowship of Japan and DBT Associateship, Gold medal from HSI and DAHS.He had been Head, Division of Fruits & Horticultural Technology, IARI for more than 7 years. He has worked on plant tissue culture, genetic improvement of vegetable and fruit crops particularly mango. He has organized and coordinated several national and International conferences/seminars on Horticulture and Biotechnology. He has published more than 117 papers in journals of national and international repute, edited four books and several technical bulletins and manuals. Dr Singh guided large number of Ph D and M Sc students at IARI. He was Member, National Core Committee (BSMA), ICAR, to modify the M Sc and Ph D courses of Horticulture of Agricultural Universities. He is fellow of Horticultural Society of India, Hill Horticulture Development Society and National Academy of Biological Sciences. He is Chairman of PPV&FRA's, Committee on DUS test guidelines for mango and member of Institute Committee members of 8 ICAR Institutes in the past. He is currently President (Elect), Delhi-Agri-Horti Society and Managing Director, National Horticulture Board, Ministry of Agriculture and Cooperation, Government of India.

Cucumber cultivation in NHB supported structure in Karnataka

Greenhouse technology, in the field of horticulture, is likely to play an important role to increase production (quantity and quality) to meet ever increasing food and nutritional requirements. In the past, unfavorable conditions led to the development of protected structures. Later, natural conditions were modified and control devices evolved according the need of the crop to harness the increased quality yield. Under present situation the demand for fruits, vegetables and other crops is rising, quality parameters are changing with noticeable shift in the nature of climate. Greenhouse technology has potential to increase the efficiency of input needed for crop production. It may be used to surmount disadvantages in the growing qualities of a piece of land e.g. limited growing season or inadequate light levels or marginal environments. In addition, greenhouse technology can also be used to raise healthy seedlings early in the seasons also off -season making cultivation more profitable.

National Horticulture Board (NHB), Ministry of Agriculture, Government of India, deems greenhouse technology potential in producing high quality of a range of horticultural products to raise the farmer's income and improve their availability for extended period. NHB, through various schemes, extend support growing and processing of horticultural crops (fruits, vegetables, ornamental, plantation crops, spices etc.) in the country. It provides subsidy from 35 to 50 per cent of project cost to the tune of Rs 72.5 lakh.The scheme wise details are given hereunder:

Scheme: Development of Commercial Horticulture through Production and Post -Harvest Management of Horticulture Crops

Credit linked projects relating to establishment of commercial production units in open field as well as under protected conditions and projects on post-harvest management and primary processing of products are eligible for assistance under this scheme as per cost norms. However, release of subsidy need not be credit linked in North Eastern States and for the institutions like public sector units, panchayats, cooperatives, registered societies/trust and public limited companies provided they can meet remaining share of the project cost out of their own resources. Such projects will have to be appraised by appraising agency approved by NHB.

DESCRIPTION OF COMPONENTS AND PATTERN OF ASSISTANCE

1.1 Commercial horticulture development in open field conditions on project mode

NHB will take up integrated commercial horticulture development projects in open field conditions on project mode, including components viz planting material,plantation,irrigation,ferti-gation, mechanization, precision farming,good agricultural practices (GAP) etc. for projects covering area over 2.00 ha. (5 acres). Integration of production unit with on farm post- harvest management (PHM) components and primary processing unit shall also be allowed in project mode. Cost of raising new plantation will vary from crop to crop, which will be taken into consideration while providing assistance to the beneficiary. Integrated production unit on mushroom and tissue culture shall also be eligible for assistance under this component. The components like farm machinery and PHM infrastructure, irrigation and micro irrigation etc. shall be eligible under the scheme for assistance in existing/new orchards/projects to increase productivity.

Pattern of assistance

Credit linked back-ended subsidy @ 40% of the total project cost limited to Rs 30.00 lakh per project in general areas and @ 50% of project cost limited to Rs. 37.50 lakh in NE Region, hilly and scheduled areas.

1.2 Commercial horticulture development in protected cover on project mode

The Board will also take up commercial horticulture development projects under protected cover on project mode including components viz planting material, plantation, irrigation, ferti-gation, mechanization, etc for projects having area over 2500 sq meter. Activities like construction of green houses, shade net house, plastic mulching, and plastic tunnel, anti-bird/hail nets etc would be promoted. Provision has been made for selecting a variety of construction material for green houses and shade nets houses. Preference will be given to using locally available material to minimize cost of construction of such structures. However, for availing subsidy, all material / technology should conform to prescribed standards.

Protected cultivation of Gerbera: assisted by NHB

Pattern of assistance

Credit linked back-ended subsidy @ 50% of the total project cost limited to Rs 56.00 lakh per project as per admissible cost norms for green houses, shade net house, plastic tunnel, anti-bird /hail nets and cost of planting material etc.

1.3 Integrated post- harvest management projects

The board will take up integrated post-harvest management projects relating to pack house, ripening chamber, refer van, retail outlets, pre- cooling unit, primary processing etc . NHB will also take up projects in component mode and for standalone projects of PHM components.

Pattern of assistance

Credit linked back-ended subsidy @ 35% of the total project cost limited to Rs 50.75 lakh per project in general area and @ 50 % of project cost limited to Rs. 72.50 lakh per project in NE , hilly and scheduled areas.

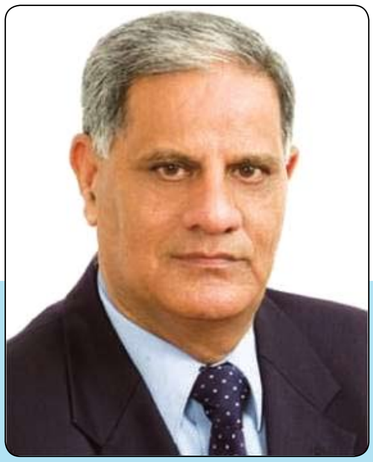
1.4 General conditions

1. Credit component as means of finance of the project should be term loan from banking or non -banking financial institutions. For credit linked projects under NHB, eligible subsidy amount to be capped at par with term loan sanctioned by the lending banks/ financial institution.
2. Normative cost of various components shall be prescribed by NHB.
3. Benefit of exclusive components of cold storage scheme shall also be available to the promoters over and above the assistance that will be provided under commercial horticulture scheme to set up integrated projects for production and PHM components.
4. Projects relating to setting up of new units shall be technically and financially appraised to ensure and enable entrepreneur to incorporate latest available technology.
5. Assistance can also be availed for a combination of PHM infrastructure components by a beneficiary, within the prescribed norms of individual items.

Note: visit www.nhb.gov.in for further detail

SIMPLE HYDROPONICS FOR SAFE AND HEALTHY VEGETABLE GROWING

— M.L. Chadha
Former Director, AVRDC-The World Vegetable Centre, Taiwan



Hydroponics is the growing of plants in systems isolated from the soil, and fed with the total water and nutrients required. Systems can be either recirculating or non-recirculating and do not necessarily use a growing medium. Another, perhaps better term is soilless culture.Many people use hydroponics as a hobby. Hobby systems can be great fun as well as being educational and rewarding, and the enjoyment and satisfaction of growing your own produce can be easily achieved through hydroponics. However, to go from a hobby scale to commercial production is a major step as there are substantially different requirements for the two. A commercial enterprise must not only produce reliably, but must give an acceptable financial return as well. When using a hydroponic technique, additional skills are needed to manage the system. And, of course, once you've produced the crop you have to be able to sell it for a reasonable price.

In this article we will discuss Simple Non-circulating Hydroponic technique for producing vegetables at home garden level.Hydroponics (from the Greek words hydro meaningwater and ponos meaning labor) is a method of growing plants using mineral nutrient solutions without soil.

Advantages of hydroponics

Anything can be grown and there is no back-breaking work: no tilling, raking or hoeing. There are no weeds to pull, no

Dr. M.L. Chadha, a renowned international scientist with over 40 years of experience in the discipline of Horticulture and Vegetable Sciences. He has served as founder Director of AVRDC-The World Vegetable Centre- Regional Centre for South Asia during the period 2006 to 2011. Earlier, he was the Director of AVRDC, Regional Centre for Africa for almost a decade (1997-2006). He has been coordinating and networking AVRDC vegetable research at the international level for over 20 years, in about thirty eight countries of South, East West Africa and South Asia.

Dr. Chadha has the distinction of receiving a number of national and international awards like ISHS, Medal and certificate, Scientific Achievement Award in Bangladesh, AVRDC-Gold Medal, the Rafi Ahmed Kidwai Memorial Award. Dr. Chadha has to his credit more than 200 publications. He has been fellow of NAAS, the Founder Fellow, Life Member and Vice President, The Horticulture Society of India.

Recently, he has completed his assignment as Consultant, World Bank and also served Haryana Kisan Ayog for two years during 2011-13. Presently, he is Chairman, Madan Chadha Safe Healthy Vegetable Foundation with its headquarters at Hisar, Haryana.

poisonous pesticides to spray, no miles or cutworms eat the roots, and most insects leave the clean and healthy plants alone. Hydroponics is ideal for the hobbyist home-owner or apartment dweller who doesn't have the time or space for full-time soil gardening. A hydroponic system distributes nutrients evenly to each plant; their roots don't have to push through heavy, chunky soil to compete for nutrients.Hydroponic plants grow faster, ripen earlier and give up to ten times the yield of soil-grown plants. These clean and pampered plants produce fruits and vegetables of great nutritive value and superior flavor.

Requirements of a successful hydroponic system

Avoid big changes in nutrient concentration in the nutrient solution because this may damage the roots and reduce the nutrient uptake.Maintain the solution pH in the range of 5-7.5 because this range will affect the availability and uptake of nutrients.Maintain an adequate solution temperature because as the temperature goes up, the respiration of the plant increases, causing a higher demand of oxygen. Provide a continuous supply of oxygen, as adequate oxygen is the key to the hydroponic system.

Basic material needed for setting up a hydroponic system

The first is a container for the nutrient solution. Almost any kind and any shape of the container can be used.The best could be a Styrofoam which holds the temperature of the nutrient solution nicely.A container made of wood or bricks lined with plastic can also be used. Plastic sheet for inner lining of the box should be at least 0.15 mm thick to avoid leakage.

Depth should be at least 20 cm to provide enough space for the oxygen absorbing roots.

Next needed is the covering material for the box. This is generally a netting material with a spacing of about 3 mm × 2.5 mm. This covering will protect the plants from insect damage and also keeps rainwater from entering the nutrient solution.Also needed are some pots or a net bag made from the same net material used for the covering.Some net for the bottom of the pots

The most important aspect of the technology is the nutrient solution. The solution is made up of many basic chemicals which provide the macro as well as micro nutrients.Also needed is some seedling medium like smoked rice hull. This is the rice hull that has undergone a smoking process.Ordinary rice hull is not effective as a seedling medium. Soil is not recommended either. If smoked rice hull is not available, vermiculite or similar types of seedling medium can be used.Lastly, needed are the good quality seeds.For any particular crop find out its environmental limitations. What varieties are available and what are their advantages and disadvantages? When should it be planted to harvest?

Setting up a hydroponic system

- To begin the box for planting, fill it first about ¾ full of the nutrient solution.
- Then prepare the pots for planting. Place a piece of netting on the bottom of the pots.
- This helps prevent the seedling medium from coming down and separating the root system.
- It also helps in the uptake of oxygen and the absorption of the nutrient solution.
- Net tray rather than pots can be used to plant large root plants such as onions or radishes.
- The pots about three fourth full of seedling medium. Then place the pots into the perforated lid of the box
- Check to make sure that the pots are placed so that the solution is 2-3 cm above the bottom of each pot.
- Sow the seeds and cover lightly with more smoked rice hull
- Remember to cover the box with the netting to prevent insect invasion. When it is raining, cover it with plastic to keep out the rainwater.
- Leave the plants to grow with little care.
- As the plants grow the roots develop in the box. The roots which are exposed to the air are called the O roots and the roots which are submerged are called the WN roots. The success of the hydroponic system is dependent on the rapid growth and quantity of these O roots.
- Before too long you can harvest your vegetables, and you'll enjoy them because they are healthy, and

Constitutent of the nutrient solution

Element	Chemical formula	Concentration (ppm)	Amount (g/l solution)
N	$Ca(NO_3)_2.4H_2O$;	70.0	0.59
P	K_2HPO_4	15.0	0.09
K	KNO_3;	30.0	0.22
	K_2HPO_4	83.8	-
Ca	$Ca(NO_3)_2.4H_2O$;	100.0	-
	$CaCl_2.2H_2O$	50.0	0.18
Mg	$MgSO_4.7H_2O$	48.6	0.49

disease, insect, and chemical free.

Basic requirements for a hydroponic system

a. Light: is essential to carry on photosynthesis, without which the cultivation of vegetables is not possible, irrespective of the nutrients you provide.

b. Oxygen -Nutrient Ratio:Oxygen maintains a healthy root system and allows the plant to absorb nutrients. In a hydroponic system, the water is a medium through which nutrients and oxygen are fed to the roots.

c. Nutrient Strength: Nutrients must be solely designed for hydroponics. An ideal hydroponic system has minimal bacteria, if any. Hydroponic systems require solubility as the nutrient delivery system is based upon that factor.

d. Growth Mediums:In hydroponics, the growing medium, not soil, holds moisture and anchors roots. Composed of inert mineral matter, it won't decompose or harbor potential soil-born problems. All the plant's nutritional requirements are filled by the nutrient mixes you add to your garden reservoir.

e. pH - Alkalinity And Acidity: pH is the level of acidity or alkalinity of the nutrient solution. Most nutrients in common tap water will be within the range of 6 to 6.5 pH, which is suitable for hydroponics systems.

f. Temperature: Requirements for plants in a hydroponics system are the same as out of a hydroponic system.

g. Air: Plants require carbon dioxide, it is what they breathe. Poor ventilation will kill plants as surely as a lack of sunlight or water will. Proper aeration for the roots is important.

h. Water Quality:In most situations tap water is just fine for hydroponics systems, over extended periods of time you may get some mineral build-up, but this is not a major cause for concern. Excessive salinity or high zinc content could be harmful to the hydroponics garden.

Tips for the care of the hydroponics

1. Monitoring the nutrient solution level:

It is important to gauge the amount or level of nutrient solution. Without this information, it is quite likely that the plants will be killed by either under or overfilling. The simple solution to this problem is the use of a see-through container, a transparent inspection window or a float system that will allow a visual check of the nutrient level.

2. Cleaning the system

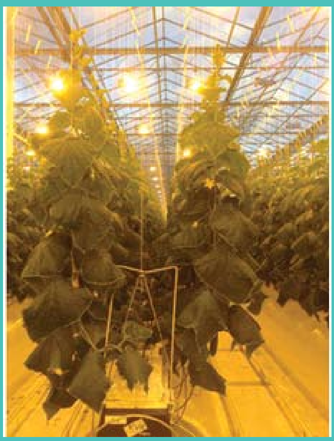
Remove dead leaves before they rot, for this is an ideal place for fungus infection.Keep a close watch for red spider and white fly infestations. They are the two greatest insect problems in hydroponics. After every crop, clean out the system. The system should be flushed every thirty days to remove accumulated mineral hardness left by water additions as the accumulated minerals and salts will slow down the plants' growth. Flushing is done with plain water. If the system has drain holes, plug them temporarily and fill the planter to the brim.Don't worry about the plants. Let the water stand for about an hour and then drain away. If you are flushing the system because of a nutrient oversupply, operate the planter on plain water for a week and only then begin a nutrient solution again. Otherwise, you should return to a nutrient solution right away.

Conclusion

Hydroponics technology is thoroughly practical and has very definite advantages over the conventional methods of vegetable production. Besides higher yield, hydroponics can be used where in ground gardening is not possible. People living in crowded cities without gardens, can grow fresh vegetables in window boxes or small discarded containers etc. By means of hydroponics, a regular supply of fresh greens can be produced from the barren areas at relatively low cost.

ORCHIDS AND MINI CUCUMBERS IN ULTRA-CLIMA GREENHOUSE

In addition to the success with tomatoes in the Ultra-Clima® greenhouse, good results are also being achieved now with mini cucumbers. In the Lipetsk project in Russia, mini cucumbers are being cultivated on an area of 2.6 hectares under assimilation lighting. Our cultivation consultant Eef Maassen, who has been involved in the project from the start, says this is a world first.



And it is not just mini cucumbers: Ocean Orchids has been successfully cultivating orchids in an Ultra-Clima® greenhouse. One of KUBO's large Ultra-Clima® customers in California has had 4 hectares planted with cucumbers on high wire systems for more than 1.5 years with good results. Last autumn 4 hectares of peppers were also started in an Ultra-Clima® greenhouse. The Ultra-Clima® success started with tomatoes, and now, after 5.5 years of cultivation experience, it can be concluded that this has been extremely successful. Other crops are also achieving good results now.

Throughout the world there are now almost 173.5 hectares contained in Ultra-Clima® greenhouses. This concept has provided the solution to many problems in relation to food safety and year-round cultivation with minimal use of resources (water, power, fertilisers, CO_2) and with higher yield per square metre. This makes the return on investment higher than for traditional greenhouses.

PLASTIC GREENHOUSES MAY EXACERBATE FLOODING

RECENT flash floods in Viet Nam's horticultural capital, Da Lat, in the Central Highlands, left many homes roof-deep in water and killed one person. But many people in the region wonder why flooding has become such a problem in recent years. Residents, both officials and the general public, offer many reasons.

Oddly enough, much of the blame is centered around the endless hectares of plastic greenhouses that keep spreading over farmland.

Tuan attributed the sudden, quick rises in river water and higher frequency of flash floods to the uncontrolled spread of horticultural greenhouses.

Flooding is happening repeatedly in horticultural areas along the 60km-long Cam Ly river, including the districts of Thai Phien, Chi Lang and Me Linh.

Of the 18,000 hectares of land under agriculture in Da Lat, greenhouses account for 1,320 hectares - or about one thirteenth, but most were in key production areas near the river. Greenhouses were a wall-to-wall blanket of plastic that prevented rain, light or otherwise, from penetrating the soil.

This causes the rain to run off directly into rivers and streams, often leading to sudden rises and violent flows. The long-term effect was even worse because lack of penetrating rain could lead to the water table drying up, meaning there was no groundwater for wells or other domestic use. This is not a story of the future but is happening right now.

Greenhouses in cold countries were designed to raise temperatures inside to grow crops more easily. Greenhouses in the tropics, including Da Lat, were used only to shield crops from rains.

It is suggested that tropical greenhouses have two roofs, an outer layer made of nylon, which can open and shut, and an inner layer made of netting. When rain was needed, the outer layer could be left open and the fixed inner layer used simply to ease the pressure of torrential rain damaging crops.

If this was done crops could be watered, groundwater topped up and violent surface runoffs prevented from developing into flash floods.

Farmers grow vegetables in a greenhouse in Da Lat City. A sudden quick rise in river water and a higher frequency of flash floods, it is feared, may be due to the spread of horticultural greenhouses. The aspect needs investigation.

NEW: PLANT TAPE TRANSPLANTING SYSTEM

PLANT Tape exhibited at The London Produce Show. It's the hottest innovation in farming today because it maximizes crop production efficiencies, reduces labor costs and embraces sustainable material while promoting water conservation.

Plant Tape is a real game changer production system .Plant Tape is six times faster than traditional transplanting, uses 97% less peat, requires 80% less labor and is a true space saver with 2500 plants per meter square versus only 750 plants with traditional transplanting trays.

The Process: Plant Tape uses a growing medium which consists of a mixture of peat and vermiculite. The growing medium is sandwiched between two layers of biodegradable

tissue. This "sandwich" is produced on the Plant Tape sowing line after seeding and is then cut into individual tapes.

The individual tapes are packed in zigzag formation into plastic trays designed for the system. Each tray typically contains about 45 meters of tape, equivalent to about 900 plants.

The trays can be wetted right away to initiate the germination process, or they can be stored for germination at a later time. European tray dimensions are 40 cm x 80 cm to fit on a Euro pallet of 80 cm x 120 cm.

After germination the seedlings develop normally in the plant pockets of the tape. The plants can be transplanted at any stage of development, from a few days after germination up to a full grown seedling plant.

The standard chassis of the transplanting machine is a two meter chassis and can be equipped with up to eight planting modules. The trays are loaded onto the transplanting machine and the automated planting module pulls the tape from the tray, cuts the tape around each individual plant and accurately places the plant in the soil. An operator simply replaces the trays on the transplanter and guides the tape to the modules.

NEW PARTHENOCARPIC F1 HYBRID IN CUCUMBER FOR POLYHOUSE FROM KAU

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Dr. Pradeepkumar, T completed his BSc (Agriculture) and MSc (Horticulture) from Kerala Agricultural University and PhD Horticulture from IARI, New Delhi. He has undergone overseas training at University of Wisconsin, USA. Acted as a member of BSMA (Broad subject Area Committee) constituted by Indian Council of Agricultural Research to formulate the National PG syllabi in Horticulture. He is also a recognized guide at national level for Joint Science Academies Summer Research Fellowship Programme for students and teachers. He has won Dr. Harbhajansingh award in vegetable science and received award in fourth, fifth and sixth Indian Horticulture Congress for his research accomplishment. He is the Managing Editor of research journal, Journal of Tropical Agriculture, published by Kerala Agricultural University. He has published 52 research papers, 9 books and contributed 12 book chapters.

Salad cucumber (*Cucumis sativus L.*) has emerged as a profitable crop in Kerala. Cucumber is ideally suited for polyhouse cultivation as the fruit is harvested in immature stage and vertical height of the polyhouse structure can be exploited for producing more number of fruiting nodes. Parthenocarpic cucumber hybrids are grown for commercial cultivation in greenhouses and these hybrids have the ability to set fruits without pollination. At present farmers are depending on the cucumber hybrids marketed by corporate sector and the seed price of cucumber parthenocarpic hybrid in Kerala ranges from Rs. 4-6/seed. The project on development of F_1 hybrid suitable for polyhouse cultivation in cucumber was started in the Department of Olericulture, Kerala Agricultural University, Vellanikkara in 2011. True breeding parthenocarpic lines were generated through selected crossing and selfing and F_1 hybrids were developed by crossing most stable lines.

Hybrids were evaluated during the period, June to September 2014 and December to February 2015 inside naturally ventilatedpolyhouse (24x 16 m) protected with insect proof net. Seedlings raised under portable trays were transplanted after 12th day on raised beds covered with polythene mulch (B/W 25 micron) at a spacing of 1.0 x 0.5 m. FYM was applied at the rate of 20 kg m-2 during the preparation of bed. Fertilizer was applied at the rate of 120 : 100: 160 kgha^{-1} and 20% of N and K and entire quantity of P was applied as basal dosage. Fertigation was given through inline dripper starting from 3rd week after transplanting at a frequency of twice a week.

Plants were trained on plastic wires following vertical cordon system. Among the two hybrids developed at KAU, KAU Parthenocarpic Cucumber Hybrid-1(KPCH-1) is found to be significantly superior to commercial hybrids with respect to fruit number, yield and earliness (Table 1). 10 cents polyhouse could yield 5 tonne fruits in a period of 3 month. KCPH-1 yielded dark green long (20 cm) fruits (Photo-1) weighing 240 g and can be stored up to 1 week at room temperature without any loss in quality. Downy mildew caused by *Pseudoperonospora cubensis* is a major limiting factor for

Table 1: Performance of cucumber F1 hybrids under polyhouse(Mean of two season)								
Hybrids	Fruit number	Yield/plant (kg)	Average fruit wight (g)	Days to harvest	Fruit length (cm)	Fruit perimeter (cm)	Parthenocarpy (%)	Yield/plot kg $(100m^2)$
PPC2	14.16	3.75	259.96	43.50	23.47	14.67	80.66	750.90
PPC3	14.33	3.33	222.89	43.38	19.20	14.03	73.00	667.10
Hilton	15.66	3.37	212.00	37.50	16.66	13.53	82.26	673.90
Kiyan	16.50	3.31	203.60	41.10	17.26	15.16	85.28	663.30
KCPH-1	21.83	5.26	240.75	35.83	20.98	15.88	92.18	1052.00
KCPH-2	21.00	4.14	193.39	36.66	20.68	15.15	93.00	829.83
(CD) (p=0.05%)	1.22	0.297	12.948	0.527	0.478	0.34	0.39	59.41

cucumber cultivation during rainy season inside naturally ventilatedpolyhouse in Kerala and KCPH-1 exhibited fair degree of tolerance against this dreaded disease.

Now farmers are relying on hybrids from private companies and this F1 hybrid (KPCH-1) can be tried under farm trial as they have the advantage of unique parthenocarpic expression inherited from both male and female parent and possess high yield potential. Since KPCH-1 is produced using breeding lines generated at KAU, hybrid seeds can be made available to the farmers at an affordable cost.

KVK- Indian spices research institute, Calicut, Kerala

Protected cultivation of vegetables – A Success story

In Kerala the production of vegetables is low during the monsoon period due to heavy rainfall and unfavourable conditions. Kerala depends on neighbouring states for its vegetable requirements during the period. If the local farmers were able to take up vegetable cultivation during the off season, they can to realize better income. Protected cultivation helps the farmers to grow vegetables year-round, but a hi-tech green house with sophisticated environmental control cannot be recommended to farmers with limited resources. The rain culture technology comes to the rescue of such farmers. Rainshelter is a low cost structure with a frame work made of locally available materials and covered

with transparent UV stabilized polythene sheet. The approximate cost of a structure with wooden or bamboo frame having a floor area of 100 m2 will be about Rs.15,000/-

Technology assessment programme on rainshelter cultivation of vegetables was initiated in three farmers' fields at Koorachundu, Thamarassery and Chakkittapara panchayats of the district. Vegetables such as okra, tomato, brinjal, chilli, amaranthus, cucumber and cool season vegetables like cabbage, cauliflower, carrot and beet root were cultivated in the shelter. The trial was a great success and farmers harvested 25 to 30 percent additional yield compared to open field cultivation. The quality attributes of the produce were better with fewer incidences of diseases. Since the vegetables were organically produced, the farmers could easily sell out their produces at high remunerative prices. Cool season vegetables like cabbage and cauliflower, introduced for the first time in the locality, out performed more than the expectations. Realizing the success of protected cultivation, more farmers decided to adopt the technology. ♦

Description of KAU Parthenocarpic Cucumber Hybrid-1(KPCH-1)	
Characters	**Description**
Plant growth habit	**Vigorous, viny (Average vine length-6.5 m)**
Days to first female flower opening (days)	18.8
Node at which first female flower formed	3.3
Days to first harvest (days)	35.83
Parthenocarpy(%)	92.18
Number of fruits / plant	21.83
Average weight of fruit (g)	240.75
Fruit length (cm)	20.98
Fruit perimeter (cm)	15.88
Density of prickle on fruit at harvestable stage	Nil
Colour of fruit rind at tender harvestable stage	Dark green
Crispness	High
Flesh thickness (cm)	1.13
TSS(o Brix)	2.95
No. of seeds/fruit	Nil
Average yield/ plant (kg)	5.26
Average yield/plot ((Mg 100 m^{-2})	1.052
Potential yield/plot (Mg 100 m^{-2})	1.397

TECHNO-ECONOMIC FEASIBILITY OF ROOF TOP RAIN WATER HARVESTING SYSTEM FORPOLYHOUSEVEGETABLES IN HILLS

– **Dr. Awani Kumar Singh**- SeniorScientist- CPCT- IARI- New Delhi
Dr. Soban Singh Rawat-Scientist- D. NIH- Roorkee

Dr Awani Kumar Singh, Senior Scientist, CPCT, IARI, New Delhi, has 18 years experience in research, teaching and extension in protected cultivation/ Hi-tech horticulture or plasticulture under plains and hill conditions. He has handled total 8 Research Project of HTM, NAIP, DST and others organizations. He has published 35 research papers and 40 popular articles on protected cultivation in horticultural crops.

A view of Big and Baby Colored Capsicum under Polyhouse at CPCT-IARI. New Delhi

A view of Roof Top Rain water harvesting at KVK-Lohaghat

India rank first among the countries that practice rain-fed agriculture both in terms of extent and value of production. Out of an estimate 140.03 m ha net cultivated area, 79.44 m ha(57%) is rain-fed, contributing 44% of the total foodgrain production. It is estimated that even after achieving the full irrigation potential; nearly 50% of the net cultivated area will remain dependent on rainfall. According to Indian Council of Agricultural Research (ICAR), 280 million ton food grain would be required to match the country demand by 2020. At current growth rate of crops, when productivity is just half of the irrigated area, there is a huge gap between actual and potential yield which can't sustain the economic growth and food security in future. It is necessary to increase agricultural productivity of the rain-fed area by proper utilization of even a single drop of water.

According to some studies food grain yields vary from 1 to 2 tons ha-1 in the rain-fed region, however yields can be achieved more than 4 tons ha-1 by providing one supplementary irrigation with the application of stored rain water.India receives 4000 billion cubic meters (BCM) of rainwater annually and nearly 1600 BCM falls on agricultural land, about 240 BCM rainwater is available for harvesting in small-scale storages. About 80 BCM (only one third part of available harvested water) of water is needed for providing a single supplemental irrigation of 100 mm depth at the reproductive stage of rain-fed crops in area of 79.5 m ha (country total rain-fed area). Analysis has shown that providing onlya single supplemental irrigation of 100 mm depth in a rain-fed area of 79.5 m ha, annual production of food grain can be enhanced by 26.8 million tonswhich would by quit helpful to achieve the country target of 2020.

In India traditional farming is very common but now new farming technology like protected cultivation technology provides better income in a short period of time with less labor. Farming under protected environment is an alternative new technique which provides favorable climate for the growth of plant and hence productivity increase in terms of quantity as well as quality. Adopting polyhouse cultivation the productivity of vegetable crops can be increased by 3-5 times as compared to open environment. Besides productivity, the better quality of produce is also obtained under polyhouse cultivation. Keeping all these subtleties, techno-economic feasibility of the roof top rain water harvesting system (RRWH) equipped with roof of 200 m2 polyhouse is being investigated to ensure the proper irrigation in rain-fed condition for the entire cropping season of the vegetables grown under it.

What is Roof Top Rain water harvesting (RRWH)?

Collection of rain drops which fall on the roof of any premises/ building and further storage is called roof top rain water harvesting. Roof water is collected into a storage tank through the different shape gutters and plastic pipes. Stored water is normally used for irrigation in kitchen garden and domestic works. However, after purification it can be used for drinking. Roof water harvesting is essential for the water scarcity areas especially in hilly areas where availability of water is very low.

Advantages of RRWH System

There are some unique advantages RRWH system and they are as follows:

- Being adjacent to the house/ premises, water is easily available at home for use.
- Being personal and own, the maintenance of roof water harvesting system can be done in a better way.
- The construction cost is lower than the water collected by the motor, pump, etc.
- The material required for construction is easily available on a reasonable price/cost.

Limitations

The main limitation of roof water harvesting is the irregular interval/variation of the rainy season. Normally, there are two rainy seasons and in between there is a long dry season (approximately 3 months), so it is a very hard task or major constraint in the design of RRWH system to conserve the water for this long period.

Material Required

Main thing which is most important for RRWH system is the heavy rain. Roof works as the basin/catchment for collection of water. The area of roof required for collection of water must be at least 20 m^2 or more. Volume of water that can be harvested from the roof of any area is calculated by the following formula:

Total rain water harvested (liter/year) = total area of roof (m^2) x annual rain (m) x runoff

Co-efficient x filter coefficient x 1000.

The runoff co-efficient of any type of the roof is depending on the slope of the roof and the evaporation of the water by air and sunlight. This varies from 0.6-0.8 (concrete roof surface) to 0.8-0.9 (tiles roof) and 0.7-0.9 (corrugated metal sheet). Filter co-efficient is normally taken as 0.9. For angled roof, first it should be 'projected' the surface to thehorizontal to correctly estimate the amount of rain that falls on the roof.

Guttering

Gutter of different shapes is used to carry the harvested water from roof to storage tank. Gutter is formed by folding the metal sheet of 2 mm thick and 32 cm width in the shape Englishalphabet of "U" and "V". Gutters are usually fixed to the building just below the roof and catch the water as it falls from the roof. Different type of gutters and their fixation with the roof are shown in Figure 1.

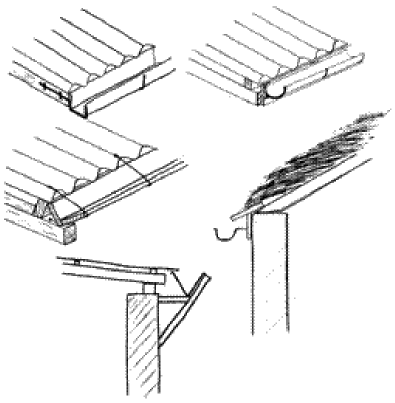

Figure 1. Different type of gutters and their adjustment

Filter

To avoid collection of waste material and garbage of the roof into the tank, a filter is placed at the junction of gutter and PVC pipes by which rain water finally goes into the tank.

Storage Tank

Normally four types of tanks are used to store the harvested rain water. These are "*kaccha* tank", cement-concreate tank, plastic or ferro-cement tank and low density polythene (LDPE) tank. There is significant seepage losses in "*kachha*"tank and hence cannot be recommended when water stored for long duration. However, there are possibilities of cracking of cement -concreate tanks due to landslides and earth quakes which is frequently occur in hilly area. Use of plastic tanks/ferro-cement tanks are restricted due to their limited capacity and handling problem. Due to low cost (5 to 6 times less than same capacity cement-concrete tank) of LDPE tank, easy to construct, flexible against any disturbance in land are mostly preferred for storage of harvested rain water.

Estimation of capacity of LDPE tank

The optimum size of storage tank is the most crucial element for successful RRWH system. While constructing a storage tank number of factors like type of crop grown, water requirement of different periods, size and type of the roof, rainfall amount and pattern should be considered carefully.

Shape of the tank

Normally, tanks may be of three shapes i.e. square, rectangular and round. Geometrical studies revealed that round shape tank contain more volume of water than the other shape for same area. But the construction of round shape tanks is tough due to its complex shape, therefore square and rectangular shape tanks are preferred. Once the required capacity of the tank is fixed, the length and width of the tank can be decided by the following formula for rectangular shape tank.

$$V = \frac{D}{2}\{LW+(L-2D)(W-2D)\}x1000$$

Where, V is capacity or volume of tank (liter); D is the depth of tank (meter); L is the length of tank (meter); and W is the width of tank (meter).

Slope of walls of tank

Adequate slope of the side wall of the tank is very important factor in construction of poly tank. The main purpose of providing slope in the side wall is to divert the pressure of water through the side wall of the tank unless polythene sheet is punctured or teared. Normally, the slope of side wall is kept 1:1.

Depth of tank

In hilly areas, the depth of friable soil is less, so depth of tank should not be kept more than 1.5 m. Furthermore, digging below this depth becomes tougher and also costly job.

LDPE lining

Life of a tank is largely depending upon the quality and thickness of the polythene (LDPE) sheet. Thickness of polythene sheet is measured in GSM, micron (μ) and sometime in Gauge. A sheet having specification of 250 GSM means the weight of 1 square meter piece of this polythene sheet will be 250 gram or in other words 1 kg polythene sheet of 250 GSM specifications will cover 4 square meter area. Size of polythene (1:1 slope tank) can be measured by the following formulae:

Total length of polythene (m) = $2D\sqrt{2} + (L - 2D) + 1.5$

Total width of polythene (m) = $2D\sqrt{2} + (W - 2D) + 1.5$

The life of polythene lining tank is normally 5-7 years. Life can be increased upto 20-25 years by covering the polythene sheet by bricks/stone boulders. A typical arrangement of RRWH system with polyhouse and harvested water collected in PDPE tank is shown in Figure 2.

Fig. 2. Photograph showing typical RRWH system equipped with polyhouse and LDPE water storagetank

Technical feasibility of RRWH system with polyhouse

To check the feasibility of polyhouse assisted RRWH system

Table 1: Estimation of minimum storage required for matching the water demand of the crop grown under polyhouse.								
Month	**Rainfall (mm)**	**Harvestable Water (liters)**	**Water demand (liter/day/ plant)**	**Irrigation Frequency demand**	**Monthly Water water**	**Excess harvested demand (3-6)**	**Cumulative excess (3-6)**	**Cumulative excess harvested water**
(col. 1)	**(col. 2)**	**(col. 3)**	**(col. 4)**	**(col. 5)**	**(col. 6)**	**(col. 7)**	**(col. 8)**	**(col. 9)**
JAN	41.2	5132				0	5132	54942
FEB	63.0	7855	0.28	Alternate	4200	3655		58598
MAR	44.8	5587	0.44	Alternate	6600	-1012	1012	
APR	38.3	4773	0.50	daily	15000	-10226	11238	
MAY	73.4	9158	0.70	daily	21700	-12541	23779	
JUN	156.6	19528	0.93	daily	27900	-8371	**32151**	
JUL	267.8	33390	0.51	daily	15810	17580		17580
AUG	286.2	35690	0.49	daily	15190	20500		38080
SEP	165.1	20587	0.49	daily	14700	5887		43967
OCT	21.8	2713				0	2713	46680
NOV	6.9	858				0	858	47539
DEC	18.2	2270				0	2270	49810

to meet the demand of capsicum crop inside the polyhouse, an experiment was conducted in the mid hill of Uttarakahndi. e. KrishiVigyan Kendra, Lohaghata regional research and extension center of G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand during 2006-10. The experimental site was located at an altitude of 1750 meter above msl and receives an annual average rainfall of 1183 mm. A polyhouse structure 200 m2 area was selected for cultivation of hybrid capsicum (var. Swarna) from Feb-March to Sept-October in each year. 1000 plants were grown at 50 cm x 30 cm spacing in the polyhouse. Calculation has been done on a simple spreadsheet using demand and supply data to find-out the minimum water storage required for providing uninterrupted water supply throughout the cropping season and depicted in Table 1. Monthly average of 25 years historical data (col. 2) had been used to find out the volume of monthly harvestable water (col 3). It is evident from the table, from month of March to June, there is deficit of water, however in the rest of season water is surplus. If this surplus water is stored in adequate capacity tank, it can be used for the deficit period. Since, volume of cumulative harvestable water is excess to cumulative excess demand, therefore water harvested from the roof of 200 m2 polyhouse is sufficient to fulfill the water demand of capsicum crop grown inside it. Minimum storage required in this case was estimated 32151 liter. Accordingly a storage tank of capacity 37000 liter capacity (15% safety factor taken) is required to construct. The cost of 37000 liter capacity tank with roof water harvesting system

Table 2. Cost estimation of a 37000 liter capacity polythene tank				
Sl. No.	**Particular**	**Quantity**	**Rate* (`/unit)**	**Cost (`)**
1.	Excavation of tank	37 m^3	100	3700
2.	Finishing by Slurry	1 job	One time	1000
3.	Polythene sheet (250GSM)	75.8 m^2	80	6064
4.	Spray of Atrazine inside tank	1 job	One time	200
5.	Cost of pipe, gutters, filter with fitting	1 no.	2000	
			Total cost	**12964**

*Rate quoted are subjected to vary with market and time

e 3. Economics of RRWH assisted polyhouse cultivation	
Particulars	**Cost (`)**
Amortized establishment cost of polyhouse for one year	20000
Amortized establishment cost for polythene storage tank	2592
Total Fixed cost	**22592**
Total variable cost (cost of cultivation)	4075
Total cost (Fixed+ Variable)	**26667**
Yield of capsicum (kg)	2000 Kg
Total return (@`40/kg)	**80000**
B:C ratio	**3.00**

has been depicted in Table 2. Storage tank should be constructed upper side of the polyhouse so that sufficient head due to gravity can be available to run the drip irrigation system.

Economic Feasibility

Fixed cost and variable cost of RRWH assisted polyhouse cultivation have been calculated and depicted in Table 3. Amortized establishment cost of polyhouse and LDPE storage tank were estimated by assuming life of theses structure as 5 years.Total cost (fixed + variable) for cultivation of 8 month capsicum crop under 200 m2 was estimated `26667. The total yield of capsicum from 200 m2was recordedas 2000 kg which give total return as `80000 (capsicum @ `40 kg -1).Handsome B:C ratio was found i.e. 3.00. However, total Income obtained from the same area (200 m2) by the traditional method under open field condition were only Rs5000. Study indicates that hill farmers can obtain significantly high income i.e. as much as 16 times higher than the traditional method by adopting the model proposed here. Study reveals that a polytank of 37,000 liter capacity coupled with drip irrigation system was found adequate for irrigation incapsicum 200 sq. m area prevailing the similar rainfall pattern. Integration of roof water harvesting-LDPE storage tank-drip irrigation with polyhouse canenhancevegetable production in hilly area. This is practical and economical technology for hilly region for boosting vegetable production.

DUTCH TECHNIQUES IN GREENHOUSES GEORGIA

Both, a small- and large-scale horticulture project in Georgia have been realized. The two greenhouses, one located in Samtredia and the other in Khobi, Georgia, are owned by FoodVentures. Unique about these projects is the focus on both small- and large-scale greenhouses in Georgia. Applicable technology for both greenhouses is provided by Hoogendoorn, which enables the growers, regardless of their type of cultivation and greenhouse, to produce a healthy crop with high yields. At the same time, the use of water, energy and fertilizer is reduced to a minimum.

With an annual growth between 5 to 7 percent, Georgia is one of the countries with the fastest growing economies. However, the horticulture industry still is in its initial stage. Until now, Georgia obtains mainly small-scale greenhouses, where outdated technology is being used. Projects such as FoodVentures are great opportunities for the development of the horticultural sector in Georgia. Dutch companies such as FoodVentures, Hoogendoorn, Patron, Grodan and KUBO work together in sharing their knowledge and providing applicable technology for both small- and large-scale greenhouses in Georgia and other countries.

Sustainable demonstration project

For the demonstration project in Samtredia, a 3.400 meters high tech greenhouse is being built by greenhouse constructor KUBO. Unique about this project is the use of geothermal energy to heat the greenhouse. Their aim is to produce 15.000 heads of lettuce per week. To achieve their goal and thus to control all processes in the greenhouse, such as climate, irrigation and energy, they choose the most advanced process computer, the Hoogendoorn iSii. This project serves as a demonstration project for local growers to gain knowledge on sustainable production with horticultural automation. Clients include supermarkets and catering industry, but they also export their crop.

Modern small scale project in Khobi

In Khobi, a plastic greenhouse was built in 2011, where cucumbers, tomatoes and lettuce were being cultivated. The greenhouse has undergone major changes, which turned the greenhouse into a modern greenhouse. For this small scale project, Hoogendoorn supplied its irrigation and climate system iSii compact. This system is integrated in Patron's irrigation unit Triton for an optimum control of irrigation. The choice for the iSii compact, is due the needs for irrigation and climate control in the plastic greenhouse in Khobi.

Other changes that were made in this greenhouse, are the switch from growing directly into the soil to substrate. The hydroponic system is provided by Grodan. This enhanced the growing conditions and lead to being less affected from soil diseases. Furthermore, the greenhouse replaced their multiple crops into growing Nickerson-Zwaan midi-cucumbers, which led to a monoculture.

Training in Georgia

In addition to the progress in the greenhouse in Khobi, FoodVentures has been awarded a subsidy to conduct a feasibility study to organize a training course. The training sessions are aimed at greenhouse investors, managers and greenhouse staff. The goal is to educate (potential) investors and managers in taking the right investment choices when it comes to topics such as location, crops and obviously equipment. Also, part of the training is an introduction to advanced technologies in a modern greenhouses, such as irrigation, heating, substrate, etc. Moreover, a vocational training is provided to greenhouse staff

About FoodVentures

FoodVentures developed several greenhouse projects in emerging economies. Current projects under development are based in Ukraine, Turkey, Georgia and Nepal. FoodVentures supports local investors in their investment planning and decisions. FoodVentures is set up in 2010 by Dirk Aleven. "We believe in a rational approach based on consumer demands and ROI of the investments. We acknowledge the strong dependence on a performing team, next to state of the art technology driven solutions. Therefore we help local investors in selecting Dutch horticulture managers and the development of the soft skills of the organization."

LOW COST PLASTIC SHELTERS FOR YEAR ROUND VEGETABLE PRODUCTION IN NORTH EASTERN HILL REGIONS

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Introduction

India is the second largest producer of vegetables in the world next to China. The total vegetable production of India is 162.2 million tonnes from a total area of 9205 thousand ha in 2012-13 (www.iivr.org.in). Vegetables are an important source of food and nutrition and provide regular cash income. However, prolonged wet seasons with high rainfall intensities and severe winter in North Eastern Hill Regions causes several biotic and abiotic stress conditions under open field cultivation and have a serious negative effect on vegetable yield and quality. On one hand, low light intensity has a negative effect on plant production processes; on the other, excessive wetness and warm temperatures encourage incidence of insect pests and diseases. Because of poor land quality and excessive wetness, fields often become heavily infested with weed species that are adapted to soil and environmental conditions. Weeds compete for space and nutrients (Lambert and Arnason, 1980) and are difficult to eradicate. Weeding costs add to the overall cost of production. Additionally, cultivation of fields to remove weeds during the rainy season increases the risk of erosion. High volume, high-intensity rainfall causes physical damage to plants. Young seedlings are particularly affected. Soil splash produced by raindrops disperses soil particles into the plant canopy, thereby depositing soil-borne organisms on leaf surfaces. The wet foliage provides an ideal surface for disease organisms to flourish. Moreover, frequent saturation of soil leads to intermittent exclusion of oxygen, resulting in an unfavourable soil environment for root growth and plant functions (Else et

al., 1995). Thus, vegetable plants growing under diverse climatic conditions are subjected to several simultaneous stresses, often resulting in heavy dependence on plant protection chemicals. There is a great demand of vegetables all year round. Prices are at the highest at the start and end of the season. Year round offseason cultivation of vegetables like broccoli, cabbage, root crops and leafy vegetables can be done successfully under low cost plastic shelters in the mid hill conditions of North Eastern Regions.

Advantages of Plastic Shelters

- 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.

Construction Cost of Low Cost Plastic Shelters (per 100 m^2)				
#	Particulars	Quantity	Rate	Amount
1.	Bamboo	28 no's	Rs. 150/ Bamboo	Rs. 4,200
2.	Plastic	9 kg	Rs. 145/kg	Rs. 1,305
3.	Binding wire	2.5 kg	Rs. 100/kg	Rs. 250
Miscellaneous				**Rs. 2,000**
Grand total				**Rs.7,755.00**

Note: *Construction cost per plastic shelters of size 15×1.5 m = Rs. 1745.00*

- 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.

Plastic Shelters

Plastic shelters 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 plastic sheet is placed on the bamboo structure to allow sunlight during the day passes through the plastic sheet, and is absorbed by the soil. 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.

Important Points for Farming under Low Cost Plastic Shelters

- Prior to start off-season vegetable farming in tunnels, the farmer must have practical knowledge about vegetable farming.
- Soil and water quality should be tested before starting the farming.
- Self-pollinated plant should be grown.
- Recommended seed should be used.
- Farmer must have the updated market information to earn high profit.

Field Preparations

The land should be prepared to a fine tilth before construction of low cost plastic shelters and well decomposed FYM to be applied @ 1.5-2.0 kg/m^2 or vermicompost @ 0.5-1.0 kg/m2 along with neem cake @ 200 g/m^2 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. About 4-5 inch raised bed should be prepared.

Nursery Management

Seeds can be sown in nursery about 28-32 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 5m X 1m 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 weeks after seed sowing the seedlings are ready for transplanting. Direct seeding should be done for leafy vegetables. Irrigation should be stopped one week before transplanting. Cole crop seedlings should be treated with *Azospirillum* + 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 45cm X 45cm and sowing of leafy vegetables should be done at 15-20 cm apart in the rows.

Vegetable Production under Low Cost Shelters

Production of vegetables under low cost shelters such as plastic low tunnels provides the best way to increase the productivity and quality of vegetables, especially during rainy season and severe winter season. Row covers or low tunnels are flexible transparent covering that are installed over the rows or individual beds to enhance plant growth by warming the air around the plants using heat from the sun especially during winter season. Plastic tunnels are transparent which provides required sunshine to the plants, and the plastic also plays a barrier against the cool air in winter. Low tunnels are also advantageous in warming the soil, protecting the plants from bad weather, preventing the plant to get injured and advancing the crop by 10 to 25 days as compared to the normal sowing. The tunnels also protect plants from unfavorable environment like high rainfall, hail, low temperature, frost, wind, insect-pests etc. which can destroy or damage them. Greater overall crop yields are obtained when the plants come into earlier production and continue to bear throughout the season. This combination of earliness and greater yields can significantly increase profits for the growers. Plastic shelters or low tunnels are less expensive as compared with the greenhouses however, crop yield is comparatively low and soil preparation, planting and harvesting is a bit difficult under the tunnels.

Vegetables Varieties Suitable for Cultivation under Low Cost Plastic Shelters in Sikkim Conditions

#	Vegetable Crops	Varieties
1.	Cabbage	Rare Ball, Magic Ball, BC-76
2.	Cauliflower	Suhasini, Sumedha
3.	Broccoli	TSX-0788, Aishwarya, Everest
4.	Coriander	Super Midori, Khushboo, Saurabh
5.	Fenugreek	Local
6.	Palak	All Green, Pusa Jyoti
7.	Rayo Sag	Pusa Sag-1, Local
8.	Garlic	Local
9.	Carrot	Nantes
10.	Radish (Winter)	Pusa Chetki (Summer), Indam Shwetha
11.	Lettuce	Green Roman, Green Lot, Lolo Rossa, Red Lot
12.	Beetroot	Ruby Queen, Detroit Dark Red
13.	Green Pakchoi	Shuko
14.	Pea	TSX-10, GS-10, Sweet Pearl

Vegetable Cultivation under Low Cost Plstic Shelters

Growing of vegetables under low cost plastic shelters can give superior yields and early production. At ICAR RC for NEH Region, Sikkim Centre, Tadong, Gangtok we have tried several high value vegetables viz. Cabbage, Cauliflower, Broccoli, Coriander, Fenugreek, Palak, Rayo sag, Lettuce, Pakchoi, Garlic, Beetroot, Carrot, Pea and Radish under low cost plastic shelters and observed that all the vegetables can be grown successfully year round under low cost plastic shelters and have shown significant increase in earliness with higher production and productivity.

Pollination should be a major problem under low cost plastic shelters so it is advised to grow self pollinated vegetables or leafy vegetables under low tunnels. The various vegetables and their suitable

Sl. No.	Vegetable Cropping Sequences	B:C Ratio
1.	Broccoli - Palak - Coriander - Broccoli - Coriander	1 : 5.19
2.	Broccoli - Coriander - Cabbage - Radish - Coriander	1 : 4.44
3.	Cabbage - Palak - Radish - Coriander - Broccoli	1 : 4.05
4.	Coriander - Radish - Coriander - Radish - Coriander - Radish	1 : 4.03
5.	Cabbage - Broccoli – Local Rayo Sag - Coriander	1 : 3.28
6.	Local Rayo Sag - Broccoli - Cabbage – Local Rayo Sag	1 : 2.89

varieties for growing under low cost plastic shelters under Sikkim conditions are given below:

Profitable Vegetable Cropping Sequences

At ICAR RC for NEH Region, Sikkim Centre, Tadong, Gangtok we have tried several high value vegetables under low cost plastic shelters. The profitable vegetable cropping sequences are as follows:

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 two to three hoeing and weedings 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. The dry conditions adversely affect the quality and yield of shoots by being more fibrous.

Conclusions

Vegetables are important source of nutrition and its year round cultivation under low cost plastic shelters is potential horticulture production technology for the better utilization of land, yield of quality produce from producer, whole seller, processer and consumer point of you. It ensures round the year production of vegetable crops either early or late production. Protected cultivation is emerging as future horticulture production technology because of its potential to overcome emerging problems of climate variations and urbanization.

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MULTIMILLION DOLLAR GREENHOUSE IN GEORGIA TO PRODUCE 15000 MT PRODUCE ANNUALLY

A multi-million dollar greenhouse has opened in the Kapanakhchi village in Georgia's Gardabani region within the framework of the state program Produce in Georgia. The project was implemented by French company Richel Group and Georgia's Co-Investment Fund. The greenhouse was built on 4.4 ha territory and employs 108 people from the Gardabani area. Together with Georgian agronomists, French and Ukrainian agro-engineers, biologists and technologists work in the greenhouse. The latest type of modern machinery and seed crops to be used in the greenhouse are being imported from Holland and France.

The production will be sold initially in the local market and later produce will be exported.

"This is the highest greenhouse in Georgia and the second construction in the Caucasus region. The higher the greenhouse is, the easier is to control climate and dampness. This is an energy efficient automated greenhouse," said Georgia's Greenhouse Corporation director Dimitri Kolensikov.

Within the Produce in Georgia program, in August 2014 the Co-Investment Fund was given 35 ha of land for the purpose of building a greenhouse. The greenhouse development project was designed to boost the country's growing agriculture sector and reduce its reliance on imports.

Construction of the facility started on September 19, 2014.

The first stage of the project was officially completed. The second stage will be completed by September, 2015. An additional 85,000 sq.m. will be added to the existing greenhouse and a further 20 million GEL will be spent.

When fully complete, the facility will have the capacity to grow over 15,000 tons of produce annually and contribute 435,000 GEL per year to the local municipality. The project will also reduce the country's reliance on tomato imports by 30 percent.

A total of 45 million GEL (20 million USD) will be invested in the project, officials said.

AUTOMATIC IRRIGATION SYSTEM

— Latika Deb

Latika Deb

Automating an irrigation system for plants/ landscapes, along with smart weather sensing systems reduces water consumption in irrigation saving upto 30% water and almost 10% of pumping costs, which is significant

WATER is critical for our survival. Our fresh water sources are getting depleted, making water more and more scarce, by the day. As they say, the days are not far, when nations will be at war for water. Water needs to be conserved and it is possible by adopting various water conservation techniques. As we all know about 93% of fresh water consumed in agriculture, which is approximate hundred times of water used for our personal needs. Thus we stare at a pressing need to conserve water used in agriculture.

A plenty of smart techniques have evolved over the years and are commercially available and viable which reduces the water wastage in irrigation and gives superior results, also saving huge amounts of water and energy costs. Automating an irrigation system for plants/ landscapes, along with smart weather sensing systems reduces water consumption in irrigation saving upto 30% water and almost 10% of pumping costs, which is significant. For vegetative growth and development, plants require water in adequate quantity and at the right time. Crops have very specific water requirements, and these vary depending on local climate conditions. With manual intervention it is very difficult to achieve desired results. Automation of watering to plants is the best way to solve all the problems like wastage of water, power, labour and also minimizes human errors. Automation of every kind of irrigation system (Drip, Spray and Sprinkler) is possible with the help of smart technologies like sensors, controllers, solenoid valves and computer programs. Automation of irrigation system is a highly customizable domain, to suit as per the yield required, desired plant growth, site conditions, functionality and most importantly system economics.

Let's briefly describe a few automation options in irrigation:

1) **Time based automation:** Here timers or controllers are main component of automation, which basically switch ON and OFF the pump as per program feed in controller. The program or schedule of irrigation depends upon operating time and power supply. The operating time of particular zone will depend upon crop water requirement, soil type and weather conditions.

Xeri-Bug-Emitter-Beauty

2) **Volume based automation:** Irrigation system can be controlled on volume basis with the help of flow meters which allows pre-set flow to all valves. This helps in precisely allowing only as much water as is required for the plants, keeping a check on wastage and water consumption planning.

3) **Real time feedback automation:** This kind of automation depends upon actual dynamic need of plant which can be calculated with the help of sensors like soil tensiometer, rain sensor, humidity sensor, EC & pH sensor, temperature sensors.

4) **Computer based automation:** The combination of hardware and software makes the automation sophisticated. This system also having sensors to control exact amount of watering and fertigation. System software controls the frequency and amount of irrigation.

Advantages of Automation of irrigation system:

- ❖ Changes in scheduling are simpler according to weather conditions.

ESP-Me

- ❖ It makes operation possible in night and reduces the evaporation losses, as night irrigation is considered to be best for plants.
- ❖ Nil, or minimal manpower requirement.
- ❖ Scheduling can be done zone wise as per plant water requirement and it optimizes the energy usage.
- ❖ **Eliminates chances of human errors**

As we all know human errors are bound to happen, it can be eliminated through automation. Manpower intervention can be reduced which is becoming costlier by the day. Also it's very difficult to find skilled manpower who can understand the plant water requirement. For home owners having small lawn area/ nursery growers this problem is very common.

To solve this problem, there are economic and simple solutions available to irrigate plants without worrying about wastage of water and power, for example ready to install drip/ sprinkler kits with irrigation hoses equipped with timer based control. These kits are very simple to install and one can irrigate up to 10 pots to 1000-300sq feet lawn area. Hose timers can easily connect with tap and it works perfectly with normal water pressure required to operate drip irrigation equipments i.e. 1.5-2.5 kg/cm2.

It is not wrong to say that automation will be necessity of every plant grower, farmers and lawn owner in coming future, keeping in mind that water, energy and manpower is become costlier entity.

We can do our small bit, by adopting smart irrigation technologies in our home gardens & landscapes, to conserve water. And of course, it also saves us a lot of hassles. Spend time with family or read a good book; leave irrigation to the automation. ■

AQUAPONIC- AGRICULTURE

Integrated farming of fish and farm crops mainly vegetables and flowers is called aquaponic farming. Such farming is future farming and suitable for urban farming and home farming. Fish farming coupled with soilless hydroponics (generally organics- fish waste enriches water with plant nutrients).Vegetables, herbs, flowers etc can be grown in the system organically.

The vegetable which have been successfully grown under aquaponics in Kerala are leafy vegetables like broccoli, lettuce, spinach, palak, mint, tomato, lady's finger and brinjal. Two to three crops of vegetables can be taken in a year.'

Tilapia and carp fish are best suited

Aquaponics farm in Palakkad

for aquaponics. Other fish varieties such as sea bass, prawns, cat fish, mullet and fresh water mussels can also be bred under this system.

Fish feed generally account for a significant part of the expenditure which can be reduced by using natural feed such as rice bran, coconut and groundnut oil and other oil cake.

According to Vijaya kumar Narayanan- a successful aquaponics farmer, researcher and trainer at Palakkad a small scale aquaponic unit meant for a family having 10,000 litre water in 435 sqft area costs Rs. 50,000. From this one can breed 200 kg fish and can harvest 800 kg vegetables per annum. He is managing Aquaponics Research and Development Centre, Nanniode.

Aquaponics farms have come up in Idukki, Ernakulam, Kozhikode, Telangana, and Coimbatore.s

The Kerala State Fishery Department has drawn up plans to use aquaponics system with tilapia to help the newly launched efforts to produce safe to eat vegetables.

GLIMPSES OF CUT CHRYSANTHEMUM PRODUCTION IN TAMIL NADU

– S. Ganesh and M. Jawaharlal
Tamil Nadu Agricultural University, Coimbatore

FLORICULTURE is a fast growing industry in Horticulture. Floriculture includes the production of commercial flowers (loose flowers), cut flowers, foliages and ornamental plants and development of value added products. The cut flowers produced in Tamil Nadu and other parts of the country are sold in domestic and as well as exported to other countries. Cut flowers like Rose, Carnation, Chrysanthemum, Lilium, Gerbera, Gladiolus, Orchid and Anthurium are having potential of being grown in Tamil Nadu. Especially chrysanthemum is now being cultivated commercially since 2000. Research and development in this crop have already been started and interventions were made for production of quality stems suitable for export markets.

Among the countries Netherland, Kenya, Japan and China have involved in the production of chrysanthemum under protected condition and are exporting to countries like Singapore, Malaysia and India. In India, cut chrysanthemums were grown in states like Karnataka (Bangalore), Maharashtra (Pune), West Bengal (Kolkata), Tamil Nadu (Yercaud, The Nilgiris, Kodaikanal and Hosur) and other states in a meager quantity. In Tamil Nadu loose chrysanthemum are grown in

an area of 1724 ha with a production of 15, 516 tonnes whereas chrysanthemum under greenhouse are only nearly 8.0 ha at present.

Potential for Chrysanthemum in Indian market

Chrysanthemum, world over, is a popular and important flower crop, grown for loose and cut flower market. It is the second largest grown flowers for cut flower industry in the world. In India, chrysanthemum occupies a prime position as a pious cut flower for all the traditional users and ornamental flowers with high aesthetic value. Today with the advancement of technology like using greenhouse for protected cultivation, chrysanthemum is all set to go hi-tech.

Chrysanthemum flowers are mostly used in stage decorations, floral arrangements and hand bouquets - which gain importance in the domestic market. Today, although there are over 8 lakhs stem demand per week, production of chrysanthemums is hardly 10% of the demand. Apart from cut flower, the whole or parts of the flower can be used in dry flower industry for making home decors. There is, therefore, a huge opportunity for India to grow chrysanthemums for not only the fresh cut flowers but also a huge potential market of dry flowers using chrysanthemum as one of the component.

Growth potential for farmers investing in cut chrysanthemum

India has diverse agro climatic conditions ranging from tropic to temperate. Tamil Nadu posses' conducive climate for the successful production of cut chrysanthemum under greenhouses. This crop is very well suited for lower elevation of hill stations in Tamil Nadu such as Yercaud, Kodaikanal, Kotagiri and some parts of Hosur. The production of cut chrysanthemum by the farmers is quite profitable by adopting the scientific techniques and by knowing the response of the crop to different growing conditions. Rather, chrysanthemum production fetches good price throughout season growers get a remunerative price throughout the year. Since all these strong reasons may validate and support the commercial growers of chrysanthemum to raise their economy and ultimately meet the demand of cut flowers in the international export market.

Potential areas in Tamil Nadu

As said above, potential areas are identified to be the Eastern Ghats of TamilNadu (Yercaud), the lower Pulney hills (Kodaikanal), lower elevation of The Nilgiris (Kotagiri) and some parts of elevated regions of Krishnagiri (Hosur). The potential of each region is huge.

Eastern Ghats of Tamil Nadu

Yercaud is a hill station in Salem district of Tamil Nadu state in India. It is located in the Shevaroys range of hills in the Eastern Ghats; the Yercaud hill area is called the Shevaroys Hills. It is situated at an altitude of 1515 metres (4970 feet) above mean sea level. The climate of Yercaud is moderate. Winters are fairly mild, starting from September and ending in December. During winter, the hills are covered in mist. Winters temperature ranges from 12°C to 25°C, and summer from 16°C to 30°C. Rainfall is 1500–2000 mm. This is a place where peculiar climate is prevailing for the successful production of chrysanthemum under naturally ventilated polyhouse and also in high-tech greenhouses. The winter is not harse and summer is not extreme which favours the production throughout the year. The cultivation requires the technical know-how by changing the photoperiod based on the change in day length which prevailed during different seasons of the year i.e., particularly in summer and winter. Yercaud holds an area of 2.50 ha at present and it posses' huge opportunity by production of quality flowers from these regions for both domestic and export markets.

In hot sunny days, i.e during summer the prevalence of sucking pests like red spider mite, aphids and thrips hamper the production by destructing the quality of cut stems while in winter, occurrence of diseases like white rust, crown gall and leaf miner infestation threaten the growers by causing yield and economic loss up to 100 per cent. Proper management of environmental conditions inside the greenhouses (temperature and relative humidity) and following of preventive measures through physiological, biological and chemical methods can prevent the loss to the growers at the maximum. Also improper lighting inside the green house will result in change in physiology of the crop.

The Nilgiris, Kotagiri

Kotagiri is a panchayat town in The Nilgiris district in the state of Tamil Nadu. Kotagiri is situated at an elevation of around 1793 metres above mean sea level and is one of the three popular hill stations located in the Nilgiris. Kotagiri has seen the growth of many hi tech cut flower units since 1995. Many enterprising farmers have put up climate controlling systems in which high value flowers such as carnations, liliums, gerbera and foliages thrive well in this environment. Summer is moderately hot (April – July) and the temperature ranges between 18^0C - 30^0C while November - February mark the winter season in Kotagiri. The temperature lies in the range of 11^0C to 20^0C. At present, chrysanthemum under polyhouses is growing in an area of about 3.0 ha. The difference in the temperature (DIF) range between the season's favours for the comfortable production of chrysanthemum during summer while in winter the growers facing hurdles due to extreme cold whether causes the destruction in quality due to biotic stresses such as occurrence of diseases and pests. The increase in temperature by heating of greenhouses may reduce the spread of foliar pathogens or taking alternate crops during winter will save the growers from economic loss.

Kodaikanal hills

Kodaikanal is the major cut-flower producing centre in the State, next to the Nilgiris. Conducive climate, including right temperature range of seven to 24 degree Celsius, relative humidity of 45 to 94 per cent and average annual rainfall of 1,450 mm favour the production of cut flowers. City has a monsoon-influenced subtropical highland climate. Though, there is least production at these regions, at present about 0.25 ha, there is ample scope for its cultivation under greenhouses. With the encouragement of the departments and scientists, the growers of these regions may promote the cultivation and its marketing.

Hosur

Hosur is a town and a municipality in Krishnagiri district of Tamil Nadu. Hosur experiences a tropical savanna climate with distinct wet and dry seasons. Due to its high elevation, Hosur usually enjoys a more moderate climate throughout the year, with occasional heat waves. The coolest month is January with an average low temperature of 17.1^0C and the hottest month is April with an average high temperature of 33.6^0C. Winter temperatures rarely drop below 12^0C, and summer temperatures seldom exceed 36^0C. Hosur receives rainfall from both the northeast and the southwest monsoons and the wettest months are September, October and August. The summer heat is moderated by fairly frequent thunderstorms but no flooding. Humidity is 31% and average rainfall is 84 cm. All these weather parameters indicate the possibilities of growing cut chrysanthemum under protected condition like roses and other cut flowers. At present, the cultivation of chrysanthemum holds an area of 1.0 ha under greenhouse in these regions. There is a huge opportunity to exploit the productivity to full of its potential during winter. But in summer due to an extreme weather, crop suffers for its survival and production interms of yield and quality.

Present status of Floriculture is still in its infancy in India, and is being viewed as a high growth industry. Moreover, commercial cut chrysanthemum production becoming important from the export angle also. ■

ENHANCINGSMALL FARMERS'INCOME THROUGH OFF-SEASON VEGETABLE PRODUCTION UNDER TEMPORARY LOW HEIGHT POLYHOUSEPROTECTIONS

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Dr Kalia is presently Coordinator, School of Horticultural Sciences and heading Division of Vegetable Science at IARI and has contributed significantly in upbringing the Division in R&D, academics and reaching out to farmers with new technologies and varieties to enhance their profitability and nutritional security. He has bred 25 varieties/hybrids of different vegetable crops including 4 of broccoli, 4 of cauliflower, 4 of radish, 4 of carrot and one each of Chinese cabbage, garden pea, knolkhol, leek, bunching onion, cherry tomato and onion and two hybrids one each of tropical carrot and snowball cauliflower. Of late, he is actively using molecular tools in cauliflower resistance and carrot quality improvement programmes. He has also undertaken transformation of cabbage and cauliflower for resistance against insect pests. Besides, he has established cytoplasmic male sterility system in tropical carrot and Indian cauliflower for facilitating F1 hybrid breeding in these vegetable crops. He pioneered popularising exotic vegetable crops broccoli and leek by developing indigenous varieties for diversification and nutrition.
He served as member of working group on Horticulture for Eleventh five year plan and that of Crop improvement and Seed Enhancement working group of AVRDC for South Asian Region. He is also member of two sections and four commissions of International Society of Horticultural Science (ISHS). He is consulting Editor of International Journal of Vegetable Science (IJVS) published by Tailor and Francis, USA. He served as Professor of Horticulture at Indian Agricultural Research Institute, New Delhi for two years.
He is recipient of Commonwealth scholarship, Dr.Kirti Singh Gold Medal, Himotkarsh Himachal Shri and Himachal Gaurav awards. He is also fellow of Horticultural Society of India, Indian Society of Vegetable Science and National Academy of Agricultural Sciences (NAAS)

He visited United Kingdom, Japan, Belgium, Portugal and Taiwan for post doctorate, presenting research papers in International Horticultural Congresses and representing India in APO sponsored meet, respectively.

Importance of vegetable crops is now being realised from the point of view of food, nutritional, environmental, health and livelihood security in India. Though the vegetable sector is growing very fast, still we have to go a long way to meet the rising demand of ever increasing population in order to ensure balanced diet to each and every Indian. To achieve this target, we have to increase our vegetable productivity by incorporation of various technologies, like, protected cultivation, drip and sprinkler irrigation, off-season vegetable production, container and terrace gardening etc. The low cost polyhouse technology is highly suitable for large farmers and economical even for tiny farmers, who cannot afford huge cost of high-tech poly house. Due to extreme weather during winter, it is difficult to grow high value vegetables like french bean, tomato, capsicum, amaranth, summer squash, okra etc. in open field condition, therefore, low-cost polyhouse technology was introduced for off-season production of high value vegetables under protected structure. Keeping above in view, low height poly structure for raising nursery as well as crops with temporary protection were constructed. Seedlings as well as crops of various vegetables were grown under these structures. The recommended cultural practices were followed to raise a good crop.

1. Raising nursery under low cost polyhouse:

Raising off-season nursery of high value vegetables is a very good option for tiny farmers to increase their farm income and also to improve their livelihood condition. Keeping above fact in mind, the low cost poly houses were made with PVC pipes and tied with sutli. These structures were covered with 700 gauges (200 μm) UV stabilized polythene sheet. The seedlings were raised in two types of containers viz. Polybags and protrays. Well-decomposed and sieved farmyard manure in combination of FYM: sand: soil in ratio of 2:1:1 by volume was used

Figure 1: Vegetable nursery under low-cost temporary protected polyhouse

as growing media. For cucurbits, the polybags of 9x5 cm sizes were filled with the above mixture (FYM, sand and soil) keeping 2-3 cm vacant from the top. 3-4 fine holes were made in the bottom of filled bags to drain extra water during irrigation. The filled bags were kept inside poly house in groups in such a way that one person can easily sow the seeds and work. A poly house of 10 x 5 m size could accommodate 8000 polythene bags (9 x 5 cm sizes) on ground. One seed was sown in each bag during last week of December after treating them with thiram @ 3g/kg seed. After sowing of seeds, a thin layer of sand was put to fill the top of the polybags in order to facilitate proper germination and to avoid crust formation. Immediately after sowing the seed, light irrigation was given by watering can, which contained captaf @ 2ml/litre of water. After one week of sowing again new seeds were sown where seed germination could not take place. After 30-35 days of sowing, when the seedlings became 10-12 cm long and four true leaves had emerged, they were kept outside the polyhouse for 2-3 days for hardening by holding irrigation for two days. Hardening of vegetable seedlings before transplanting in the main field was very effective in reducing transplanting shock and also resulted in better crop stand. In the first week of February when danger of frost was over, the seedling were transplanted on the northern slope of prepared channels in the field after removing the polythene bags with the help of blade without distributing the earth ball. After transplanting, light irrigation was given for better establishment of plants. The vertical space of polyhouse was occupied by preparation of two stories bamboo benches on which 7000 seedlings of cucurbits were raised in protrays (10 cc) filled with same media in same way. The cost of construction of polyhouse (50m2) is given in Table 1.

A poly house of 10 x 5 m size could accommodate 8000 polythene bags (9 x 5 cm sizes) on ground. One seed was sown in each bag during last week of December after treating them with thiram @ 3g/kg seed. After sowing of seeds, a thin layer of sand was put to fill the top of the polybags in order to facilitate proper germination and to avoid crust formation. Immediately after sowing the seed, light irrigation was given by watering can, which contained captaf @ 2ml/litre of water

The high-tech nurseries are raised in soilless media (cocopeat, perlite and vermiculite mixture) and the nursery

Table1: cost of low Cost Polyhouse for raising vegetable nursery

Size of structure (10m (L) x 5m (W) x 7´ (H)) = 50m^2

S. No	Particulars		Rate (Rs.)	Expenditure (Rs.)
1.	13 PVC pipes (20´, 1.25´´ size)		Rs. 400/-	5,200/-
2.	16 PVC pipes (20´, 0.75´´ size)		Rs. 300	4,800/-
3.	Polythene	100 m^2	Rs. 19/-	1,900/-
4.	Sutli	1 kg	Rs. 400/-	400/-
5.	Bamboo Bench	9 m x1.5 ft. (3 Nos.)	-	2,000/-
6.	Labour charges	4 Nos.	Rs. 300/-	1,200/-
	Grand Total			15,500/-

Note:25% cost can be reduced if made privately

Figure 1: Raising vegetable crops under low-cost temporary protected polyhouse

management and plant nutrients supply is a specialized and tedious work as these soilless media do not contain any nutrients. In soilless media, nutrients are applied in the form of N: P: K (1:1:1) @ 140 ppm once a week through the fine sprinkler to maintain the uniformity in application of nutrients. However, in our study the FYM: sand: soil mixture was used which

sowing and it was made airtight. The seeds germinated due to conducive environment under protected structures. Once all the seeds have germinated the polythene sheet was removed daily from both end during sunny day and again covered in evening to maintain the inside temperature optimum. All the cultural practices recommended for cultivation of

Economics of raising nursery under poly house	
Size of structure (10m (L) x 5m (W) x 7′ (H)) = $50m^2$	
No. of seedlings 8000 (polybags) + 7000 (portrays)	= 15,000/-
Seedling @ Rs.2/-	= Rs. 30,000/-
Investment cost (polyhouse, polybags, protrays)	= 15,500 + 5,000 =Rs. 20,500/-
Net profit 1st year (30,000 – 20,500)	= Rs.9500/-
Net profit 2nd year (30,000 – 5000)	= Rs.25000/-
Net profit 3rd year (30,000 – 6000)	= Rs.24, 000/-

The low cost polyhouses were found economical for small and marginal farmers, who cannot afford huge cost of high-tech poly house. By adopting this technique, a cucurbit crop was raised one and a half months in advance than normal method of direct seed sowing in the field. Similarly the nursery of other vegetables like, tomato, chilli, capsicum, cole crops etc. can be raised and sold to get higher profit

was found easy to manage even by small and marginal farmers. Seedlings were raised in protrays and polybags which helped in proper germination, provided independent area for each seed to germinate, reduced the mortality rate, maintained uniform and healthy growth of seedlings, easy in handling and storing, reliable and economical in transportation. Production of off-season vegetable nurseries under protected structure was found a profitable business. Higher profit and disease free seedlings were found in off season to raise early crop in protected condition or/and open field condition. The low cost polyhouses were found economical for small and marginal farmers, who cannot afford huge cost of high-tech poly house. By adopting this technique, a cucurbit crop was raised one and a half months in advance than normal method of direct seed sowing in the field. Similarly the nursery of other vegetables like, tomato, chilli, capsicum, cole crops etc. can be raised and sold to get higher profit. The nursery was raised for 45 days under this structure; however, the same structure can be used for round the years by applying various types of cladding materials. The economics of raising vegetables nursery is given below:

2. Low cost polyhouse technology for raising crops

The low cost polyhouses which were used for raising nursery, the same type of structures was utilized for raising crops during winters. The high value crops like cherry tomato, gherkin, bitter gourd (gynoecious) and cucumber (parthenocarpic) were grown during November second fortnight. The temperature inside polyhouse was 6-100C higher than outside. The cold waves during December-January did not enter and the growth of the plants was normal. All the recommended cultivation practices of these crops were followed to raise a good crop. Harvesting of gherkin started from last week of January. Gherkin recorded Rs. 43,500/- and Rs. 59,000/- profit from 1000 m2 area during first year and second year, respectively.

Harvesting of cherry tomato was started from mid- February and net profit of Rs. 33,750/- during first year

Table2: Off-season vegetable production under low cost polyhouse(1000 m^2)

Crop	Variety	Spacing (cm)	Crop duration (Months)	Total Production (kg/1000 m^2)	Estimated Sale Price (Rs./kg)		Cost of cultivation (Rs.)*	Total Income (Rs.)	Net Profit (Rs.)
					Farmer	Market			
Gherkin	DG-6	50 x 50	4	2,300	30	50-60	25,500	69,000	43,500
Cherry Tomato	Cherry Red Cherry Yellow	60 x 50	5	2,000	30	80-100	26,250	60,000	33,750
Bitter gourd	Gynoecious	60 x 50	4	2,000	25	50-60	26,250	50,000	23,750
Cucumber	Parthenocarpic	50 x 50	4	2,500	25	40-50	25,500	62,500	37,000

Table3: Cost of temporary protected low height low cost poly-house for raising vegetable crops

Size of structure (10m (L) x 5m (W) x 3´ (H)) = 50 m^2

S.No	Particulars	Expenditure (Rs.)
1.	19 PVC pipes (20´, 0.75´´size) @ Rs. 300/- per pipe	5,700/-
2.	4 PVC pipes (20´, 1´´ size) @ Rs. 400/- per pipe	1,600/-
3.	Polythene sheet (700 Gauge, 12 x 5m) = 60 m^2 @Rs. 19/- per m^2	1,140/-
4.	Sutli (1/2 kg)	200/-
5.	Labour charges 3 No. @ Rs. 300/- Per labour/per day	900/-
	(Total)	9,540/-

Note: polyhouse structure may last for minimum 3years.

Table4: Off-season vegetable production under temporary protected (winter protection)

Low Height Polyhouse (1000 m^2)

Crop	Variety	Spacing (cm)	Crop duration (Months)	Total Production (kg/1000 m^2)	Estimated Sale Price (Rs./kg)		Cost of cultivation (Rs.)*	Total Income (Rs.)	Net Profit (Rs.)
					Farmer	Market			
French bean	Contender PusaParvati	50 x 7	110	950	40	70-80	20,000	38,500	18,500
Summer Squash	Pusa Alankar Australian Green DS-8	50 x 50 50 x 50	115	4500	15	40-50	20,250	67,500	47,250
Amaranth	Pusa Lal Chaulai Pusa Kiran	50 x 50	120	1500	20	40-50	15,000	30,000	15,000

and Rs. 50,000/- during second year was recorded.

In Bitter gourd (gynoecious) a net profit of Rs. 23,750/- was recorded in first year and Rs. 40,000/- during second year onwards.

Parthenocarpic cucumber recorded Rs. 37,000/- profit during first year and Rs. 52,500/- during second year onwards.

Second year onwards profit:- Gherkin: Rs. 59,000/-, Cherry tomato: Rs. 50,000/-, Bitter gourd: Rs. 40,000/- , Cucumber: Rs. 52,500/-

The crops were raised for 4 to 5 months duration under polyhouses. However, with the same structure other crops can also be grown by utilizing different types of cladding material like shade net etc.

3. Growing crops under temporary protected low height polyhouse:

Vegetable crops, like French bean, amaranth and summer squash which are determinate in growth habit and cannot be grown under open field condition during winter season successfully, they were grown under low height low cost temporary poly structure which was highly suitable for raising these crops during off season. Seeds were sown on raised bed during IInd fortnight of November and whole bed was covered with low height poly structure after the crops raised under protected structures were followed. In February when outside temperature was ideal and frost chances were over, the polythene sheet was removed and structure was dismantled and kept safely for future use. The cost of construction of temporary protected low height poly structure is given in Table 3.

French bean was harvested during first week of February. The results showed that French bean recorded a net profit of Rs. 18,500/- during first year and Rs. 33,000/- from second year onwards. Summer squash, which is a bush type cucurbit, harvesting started from second week of February and it recorded net profit of Rs. 47,250/- in first year from an area of 1000 m^2 and Rs. 59,500/- from second year onwards. Amaranths harvesting was started from last week of January and it recorded Rs. 15,000/- and Rs. 25,000/- profit from 1000 m2 area during first year and second year respectively.

Second year onwards profit:- French bean: Rs. 33,000/-, Summer squash: Rs. 59,500/-, Amaranth: Rs. 25,000/-

The structure was utilized for raising crops from November to February. However, with the same structure other crops can also be grown by utilizing different types of cladding material like shade net etc.

Conclusion:

Cultivation of high value off-season vegetable crops under low cost protected structure have been found a viable technology for growing various vegetables viz. tomato, okra, summer squash, French bean, amaranth etc. during winter season. The off-season production obtained thus fetches higher price in the market. Therefore, to enhance productivity and to ensure profitability of the tiny farmers, off-season vegetables cultivation under low cost temporary protected poly-house is found to be economical and profitable enterprise. Protected technology in high value vegetable crops can be established as a small scale industry in major vegetable growing areas of our country by progressive farmers especially in peri-urban areas. ■

PROTECTED CULTIVATION OF TOMATO

Jawahar Lal Mangal, Amrita Bhattacharya, Sanjay Sudan and **Anuradha Awasthi**
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Dr J L Mangal, has worked for 33 years on vegetable crops and published 140 research papers, 8 review articles and 14 book chapters 2 bulletins, one text book in Hindi, one practical manual and 70 popular articles. He worked mainly at CCS Haryana Agriculture University, Hisar and retired as Head and Professor, Vegetable Science. He was Emeritus scientist ICAR. He is Managing Director, Institute of Horticulture Technology, Greater Noida and contributing in development of Human Resource in Protected / Greenhouse cultivation. He has guided 4Ph D and 8 MSc students. Dr Mangal has served in Ethopia also as Professor under UNDP. He is a fellow Indian Society of Vegetable Science.

Tomato is one of the important vegetable crops. It is grown throughout the world. In India, Andhra Pradesh, Karnataka, Odisha, Maharashtra, West Bengal, Bihar, Gujarat, Chhattisgarh and Madhya Pradesh are major tomato producing states. In open field in India its average yield is 180.6 Q. per hectare (2013-14) which gets multiplied by five to ten times under protected cultivation.

What is Protected Cultivation?

Protected cultivation is defined as improved technology of growing crops under controlled environment. Under this crops are protected from abiotic (temperature, rain, wind, humidity etc) and biotic (diseases and insect-pests) stress.

Important aspects to be kept in mind before undertaking protected cultivation

- Climate of the place
- What crop you want to grow
- Resources to undertake protected cultivation
- Knowledge on Government support to protected cultivation
- Market for selling quality produce

Type of greenhouses

Climate controlled greenhouse

During summer cooling pads are provided in the greenhouse to lower the temperature. During winter heaters are provided to raise temperature. Night temperature is not allowed to go down 12-13 degree centigrade. Such greenhouses are expensive both in construction and maintenance.

Zero energy naturally open ventilated Polyhouse

There is no mechanical or electrical device for ventilation in the green house.

It is naturally ventilated through insect proof netting mainly at the top and sides also. There is no requirement of energy to regulate temperature inside the green house. Being less costly such greenhouses are liked by farmers.

Shadenet House

It is a cheap temporary or permanent structure. 30-75 % shade can be provided to the plants by using shade net as claddings. Shade Net houses are suitable for places where night temperature does not go below 15-18 degree centigrade and generally temperature during day time is 28 – 30 degree centigrade.

Insect-proof nethouse

It can be made temporary or permanent structure. Structure is cladded with 40 mesh U V stabilized insect proof nylon or rust proof metal net. These are used for growing tomatoes in places where annual temperature does not fluctuate much. The purpose of the structure is to provide barrier for the entry of harmful insect-pest and vectors of diseases.

Walk-in-tunnel

It is made of ½ inch thick G I pipe/ iron rod or plastic pipe or tree branches or bamboo bended semi spherically, temporarily grounded to support U V stabilized (150-200 micron) polyethylene as cladding. The central height is kept 6 to 6.5 feet and width 4.0 t0 4.5 feet. Length of the structure can vary according to requirement.

Climate

Tomato is a summer/tropical crop. It does not tolerate water logging and frost. Temperature below 15 and above 27 degree centigrade is not suitable for its growth and development. A very high temperature fruit set is very poor and flower drop is common.

Soil and its preparation

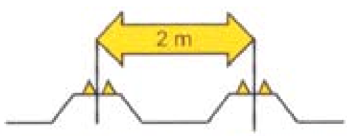
Loam and sandy loam soils are suitable for tomato production. Soil should have good water absorbing and holding property with pH of 6 t0 6.8. For preparing the field 5 to 6 ploughings/ harrowing can be done which helps in reducing chances of weeds and insects through solarization. With last ploughing

mix 4 Kg of vermicompost per square meter of land/soil to get better crop of tomato.

Soil solarization

Soil solarization is essential for polyhouse/greenhouse cultivation. After mixing vermicompost soil is covered with 30 micron polyethylene sheet. Irrigate alternate day with drip irrigation. This helps in effective solarization. Solarization is done for about six weeks during May and June month when temperature is very high. Solarization helps in destruction of seeds of weeds, insects eggs and larvae, nematodes and plant pathogens.

Indeterminate varieties of tomato are grown in polyhouse. G S 600, Him Sona, Him Shikar and Shreshta varieties of tomato have been found suitable for polyhouse. The fruit of these varieties weighs about 110 to 120 gm. The fruits of these varieties have good blend of acid and sugar making them tasty



Suitable Varieties

Indeterminate varieties of tomato are grown in polyhouse. G S 600, Him Sona, Him Shikar and Shreshta varieties of tomato have been found suitable for polyhouse. The fruit of these varieties weighs about 110 to 120 gm. The fruits of these varieties have good blend of acid and sugar making them tasty.

Indeterminate cherry tomato varieties grow very well under polyhouse. The individual fruit weighs 12-15 gm. Each cluster has 35-55 fruits. Suitable varieties of cherry tomato are VR 124, Pusa Cherry tomato, Ole, Sairan, N S Cherry -1 and Paireso.

Nursery raising: After selection of crops healthy and disease free seedlings are raised in plastic trays in polyhouse using cocopeat, perlite and vermiculite in the ration of 3:1:1

Bed preparation: For planting tomato crop in polyhouse 15-20cm raised beds are prepared at a distance of 2m from the centre to centre of adjacent bed. The base of bed is kept 80cm, top is kept 45cm and on the top of the bed two lines at 30cm distance are made, where planting is done at a spacing of 40cm on both the lines.

Arrangement of drips and mulching: Drip lines are laid at a spacing of 30cm on both side of bed. Drippers are arranged in each lateral at a spacing of 40cm. It is ensured that, flow of water from each emitter is perfectly normal. After this operation complete bed is covered with 40-50micron polythene sheet of yellow/ black/ white or silver colour. The polythene sheet is thoroughly pressed by soil at all four side of the bed. Mulching helps in saving water up to 40-50% and control weed population by almost 90%. After this operation a pvc pipe of 8-12cm diameter is taken to make hole on mulch at proper planting distance.

Transplanting: Optimum time of planting tomato in polyhouse is 15 August to 15 September in northern India. Planting is always done in the evening and immediately after transplanting a light irrigation is essential.

Trellising: For supporting the plants

9-10m long nylon rope is required. One rope is required for large fruited varieties, whereas two ropes are required for support in the case of cherry tomato. This rope is rolled on rollerplast which is attached on the strong wire net present in the polyhouse at a height of 3-4m. One end of rope is kept free and pressed in soil near the plant from very beginning. On this rope plant is trained in clockwise direction. This operation of trellising is start after 20-25 days of planting and continued till the end of the crop (8-9 months). These ropes are arranged in parallel direction to the bed. This operation is practiced very carefully without damaging flower clusters and growing leaves.

Pruning and bending: Pruning is an varieties essential operation in tomato when cultivated in polyhouse. In large fruited tomato only one main branch is allowed to grow and all side shoots developing from the axile of a leaf are pruned at a very early stage and single stem plants are kept. The height of the plant is not allowed more than 5-6 feet and it is managed with the help of supporting rope. In case of cherry tomato two branches per plant are kept and both the branches are trained on two separate ropes available for this purpose.

Optimum time of planting tomato in polyhouse is 15 August to 15 September in northern India. Planting is always done in the evening and immediately after transplanting a light irrigation is essential

Pollination: Tomato is a self pollinated crop but under polyhouse where air flow is low an artificial help in pollination process is essential. This can be done by a battery operated vibrator. 10am-12pm in the morning and 3pm-4pm in the evening are most suitable time for this operation. This operation is done till the end of April and May at an interval of one day.

Fertigation: In polyhouse tomato all nutrients are supplied along with irrigation water through drip. Details are given as under in tabular form for 4000 sqm area.

Topping: This is an essential operation in polyhouse tomato where top of each plant is removed by a sharp secateurs or pruner by the end of April or up to mid of May. This operation will help in the development of smaller fruits in big size and add to higher production per plant.

Yield: In case of regular (large fruited) tomato, average yield was received 20-25kg per square meter, whereas in case of cherry tomato yield was 10-12kg/sqm.

Plant protection: In general polyhouse grown tomato does not require sever plant protection measures but, regular inspection of the crop is required the

Stage of plant/crop	N:P:K	Application rate (gm)
Transplanting to emergence of first flower bunch	19:19:19	2000.0
First flowering bunch to first harvesting	19:19:19	850.0
	46:0:0	1400.0
	0:0:50	2200.0
Fruit harvesting to topping stage	19:19:19	850.0
	46:0:0	2000.0
	0:0:50	2200.0
After topping up to last harvesting	19:19:19	450.0
	46:0:0	2000.0
	0:0:50	1100.0
1. Requirement of water depends on temperature, humidity and types of soil		
2. Application of above stated fertilizers with mentioned quantity is practiced two times a week		

early stage plant showing symptoms of virus infection are removed with roots, packed in polybag and buried in the soil. By continuous cultivation of the same crop several soil borne fungus developed, which can be easily controlled by solarisation technique.

The field worker who helps in various intercultural operations in polyhouse should have clean dress and all implements used should be sterilized before use in the solution of 1% sodium hydrochloride. No one should smoke inside polyhouse.

Physiological disorders:

Blossom end rot: Rotting or blackening of fruit at flower end.

Cause:

- Irregular water supply
- Higher nitrogen content to soil
- Poor availability of calcium in the plant

Control measures:

- Regular irrigation
- Optimum nitrogen application

- Spraying of CaCl2 @0.5% solution on the fruit and flowers when fruit size is like a pea grain.

Fruit Cracking

There are two types of fruit cracking, that is concentric and radial cracking. In both types of cracking, fruit surface cracks which reduce the quality of fruit.

Spongy Fruits

Cause:

- It may be hereditary
- Irrigation at irregular interval
- Excess irrigation after a dry spell
- Boron defficiency

Control measures:

- Regular irrigation should be practiced
- Two sprays of borax @ 0.4%. First at the time of flowering and second after 15 days of first spray.

Fruit and Flower Drop

Cause:

- This is because of high temperature condition (more than 320C during day time and more than 200C in the night)

Control measures:

- This can be easily controlled by spraying 50ppm PCPA (Perachloro Phenoxy Acetic Acid) at the time of flowering.

ARE POT PLANTS MORE ECO FRIENDLY THAN FLOWERS?

THE global horticultural industry is huge. At the Aalsmeer flower auction in Holland, 20m stems change hands every day. In the week before Valentine's Day 200m red roses will pass through this behemoth (yes, we really are that predictable). Most of your flowers will travel via this place.

But their origins will be much farther flung. The main exporters are Kenya, Ethiopia and Colombia. Given that many producing countries with the right climatic conditions to grow at this scale are also water-scarce and low-wage economies, there are myriad ethical issues. So look for certification – the Fairtrade logo is on a number of flowers – or there's Florverde, an eco-certification programme for flowers from Colombia. Check baseline standards and suppliers at ethicaltrade.org.

Scale and price mean we've lost grower co-operatives (especially in the Netherlands) as flower farms are acquired by global conglomerates. What

a shame. The supply chain of everyday flowers is eye-popping, as blooms are trucked to Nairobi then flown with a stopover in Saudi, where the plane might be cooled with a hosepipe. Airfreighting flowers has been likened by industry insiders to "flying compost heaps". These are perishable goods that once on a pallet in a plane begin to rot.

But it's not a straight win for potted plants. Many are imported. China, for example, has 60,000 hectares given over to pot plants, and there are few details on the carbon cost of this. Also global retailers push the idea of weekly potted plants, and people are beginning to buy for colour rather than longevity.

Resist the impulse-buy of a supermarket African violet and invest in some quality pot plants (preferably from an independent nursery where they can actually tell you something about origins and expectations). If you can verify the supply chain, plants probably are the better option. Even Nasa rates house plants as air purifiers from research conducted in the 1980s. Also, once a plant is under your care, you can take control, adding vermicompost (from a wormery) or feeding with a seaweed-based organic fertiliser.

On that note, despite 500 years of collective experience of housing plants (since Columbus returned with a pineapple), we do struggle to keep them alive. The more green-fingered you are, the greater the plant's longevity and the better your switch from flowers to plants.

NATIONAL SEMINAR ON "HI-TECH HORTICULTURE FOR ENHANCING PRODUCTIVITY, QUALITY AND RURAL PROSPERITY"

January 19-20, 2015 at ICAR- National Research Centre on Seed Spices,Tabiji,Ajmer-305 206 (Rajasthan) Jointly Organised by Indian Society of Seed Spices (ICAR-NRCSS, Ajmer-Rajasthan) & Indian Society for Protected Cultivation (CPCT-IARI, Pusa, New Delhi)

Recommendations

In the present scenario horticulture production needs hi-tech interventions such as hydroponics, window hydroponic, vegetable grafting etc which should be promoted for getting vigorous seedlings, higher yield free from residue.

In order to get safe and healthy vegetables, low cost drip fertigation, precision farming, home gardening, roof gardening etc. should be promoted..

More attention should be given to develop improved varieties of solanaceous vegetables, cucurbits for off season production under protected conditions for getting higher yield and good quality vegetables.

Hi-tech intervention like pneumatic seed planter, low pressure drip irrigation, raised bed technology, nursery raising and transplanting and pollination management should be applied for higher yield and good quality seed spices.

In order to promote export of horticultural crops, a model should be developed for export oriented green house for vegetables and flowers. Soil-less cultivation in India is in a stage of infancy, therefore the standardized protocols must be worked upon thoroughly for different crops.

Nematode , particularly root knot nematodes,management in protected cultivation is becoming a big challenge; hence, research information on nematode management is to be published preferably in local languages for the benefit of farming communities.

Different protected structure need to be modified for utilizing solar radiation efficiently in cold desert of our country to increase the production of vegetables for armed forces in Ladakh region.

There is urgent need to breed trait specific varieties of vegetables suitable for polythene cultivation so that good quality production of vegetables can be realized.

There is a need for intensive exploration for collecting diverse genetic resource of seed spices from the centre of origin viz., cumin (Syria, Turkey, Iran, Iraq), coriander (Europe and Russia), Fenugreek (Ethiopia and Morocco), fennel (Europe) for widening the genetic base and for pre-breeding activities.

The emerging physiological problems of longitudinal cracking should be studied with respect to abiotic stress.

Efficient management of nutrient and water is the need of the time hence, there is an urgent need to develop cost effective automation equipments for fertigation and low pressure drip irrigation for protected cultivation of vegetables, fruits, flowers and seed spices.

The maturity indices for all the horticultural crops should be developed to identify proper stage of harvest for getting good quality produce for consumer and market.

Cryogenic grinding has the potential to retain and maintain quality and medicinal properties of spices and herbs; therefore, it is necessary to popularize cryogenic grinding technology.

Underutilized fruits and vegetables like snap melon, kachri, khejri, ker etc. have very high value due to their medicinal properties; therefore these should be exploited for domestic consumption and export. Prices of spices specifically, seed spices are unstable resulting in very low price in bumper crop. Therefore there is urgent need to cover seed spices also in the ambit of minimum support price.

3rd Edition

2013 EDITION

Floriculture, Nursery & Landscape Industry DIRECTORY

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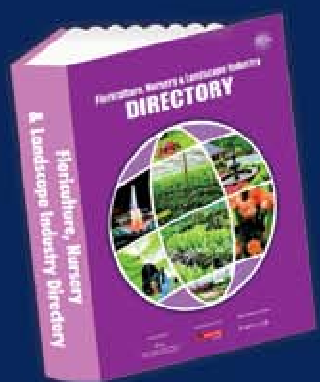

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