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International Conference
On
Vertical Farming

Change & Challenge, Challenging The Change

Are we Ready for 2050?

By
Vertical Farming Association (India)
affiliated with
Association of Vertical Farming (Munich)
Society for Promotion of Horticulture (Karnataka)
India Council of Agricultural Research (Govt. of India)

The Taj West End
BENGALURU-INDIA
On 2nd & 3rd Nov. 2015

Taking Food Production to New heights

Preliminary Program Details

Day 1: Challeneges & prospects of Agriculture in India

Morning

09.00-09.30 Registration

09.30-09.35 ICAR Song

09.35-09.40 Welcome & Introduction to AVF by Christine Zimmermann-Loessl (Chairwoman, AVF)

09.40-09.45 Lightning the Lamp

09.45-09.55 Glimpse of Horticulture in India by Dr. N.K. Krishna Kumar DDG (Hort.) ICAR, Govt of India

09.55-10.15 Indian Agriculture at a Glance by Dr. S Ayyappan Secretary DARE & DG ICAR Govt. of India

10.15-10.30 Plans for setting up demo projects of Aeroponics & Vertical Farming by Dr. D. P. Biradar Vice Chancellor University of Agricultural Sciences, Dharwad India.

10.30-11.00 Vertical Farming Keynote by Dr. Richard Stoner

11.00-11.15 Tea Break

Session 1 - India's Challenges & prospects in Agriculture:

11.15-11.45 Financing Innovation in Agriculture by Mr. Rajiv Chawla (IAS), Principal Secretary Horticulture, Govt. of Karnataka

11.45-12.00 VF in India with its Futuristic technologies & Technology assessment by Mohan Bajikar

12.00-12.30 Panel discussion 1-Can VF be a part of India agricultural modernization?

12.30-14.00 Lunch Break

Afternoon

Session 2 - Technological developments & Business cases in VF:

14.00-14.30 Presentation by Mr. Mike Virmiji, Director CERTHON

14.30-15.00 Effect of Light Environment on photosynthesis & growth of vegetable transplants & Lettuce in a closed system under artificial Lighting by Mr. Paul Grey, ILLUMITEX, USA

15.00-15.15 Presentation by Mr. K. Krishan on Bio-Energy Systems

15.15-15.30 Karnataka Udyog Mitra Role in Urban Vertical Farm by Mr. M. Prabhu

15.30-15.45 Coffee Break

15.45-16.45 Panel Discussion II Opportunities and Challenges in VF

16.45-17.00 Wrap Up of Day 1 by Christine Zimmermann-Loessl (AVF)

19.00 Speakers Dinner

Day 2: Prospects of VF & Integrating Urban & Vertical Farming

Morning

09.00-09.30 Registration

09.30-09.45 Keynote-The Vertical Farm (Video Intro) by Prof. Dickson Despommier

09.45-10.05 Vertical Farming versus other forms of urban agriculture in the light of the development of sustainable urban food systems by Mr. Stuart Oda

10.05-10.25 Overview of VF in Europe by Mr. Maximillian Loessl (Vice Chairman, AVF)

Session 3 - Urban Planning, architecture & policies for Vertical Farming

10.25-10.55 Integration of UA into urban planning & policies in India-Thesis & Future of VF in India by Mr. Kukku Joseph Jose M.Tech

10.55-11.10 Coffee Break

11.10-11.25 Presentation by Mr. J. J. Price, Global Marketing Manager, Spread Co Ltd., Japan

11.25-11.40 Presentation on Hydroponics by Left. Commander C.V. Prakash

11.40-12.00 Urban Masterplans Bangalore or Mumbai/Singapore (TBD) by Mr. Maximillian & Mr. Zeff

12.00-12.30 Panel Discussion III-How to integrate and what do we need to include VF and UA into urban planning & architecture

12.30-14.00 Lunch with experts, speakers and guests

Afternoon

Session 4- Vertical Farming Market in India

14.00-14.20 Presentation on "Hydroponics to Vertical Farming" by Dr. G. L. Bansal

14.20-14.40 Smart Agricultural Solutions by Agrilution, Germany

14.40-15.00 Coffee Break

15.00-15.30 Two Presentations on Vertical Farming by Mr. Zeff

15.30-15.40 Presentation on "Climate Control Container" by Mr. Sharad Kumar, CEO Wernerfinley

15.40-15.50 Presentation by Mr. Pravin Sharma

15.50-16.00 Presentation by Mr. Vijay Yelmelle, Director CRAFT

Session 5 Workshop

16.00-16.45 Develop a Road Map for three Sustainable pilot vertical farm business models for India. Set up of 3 working groups to develop a sustainable pilot vertical farm business model for India (NGO, students, academia, business, local governments)

16.45-17.00: Presentations of a roadmap and introducing key steps to implement VF in India

17.00-17.30 Panel discussion on VF as a key technology for sustainable & safe food production for India cities

Hosted by

Association of Vertical Farming AVF - India

Association for Vertical Farming

Co-Hosted by

Society for Promotion of Horticulture

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SOCIETY FOR PROMOTION OF HORTICULTURE

भाकृअनुप ICAR

INTERNATIONAL CONFERENCE ON VERTICAL FARMING
NOVEMBER 2 AND 3RD
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BENGALURU

ABSTRACT BOOK

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CONTENTS

Abstract - 1

EMPOWERING URBAN AREAS TO BECOME NUTRITIONALLY SELF SUFFICIENT BY ADOPTING VERTICAL CROPPING SYSTEM

Banoth Shiva*, P. K. Nimbolkar, Manish Kumar and Sunil Kumar
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Urban and peri-urban horticulture is growing substantially in recent years and contributing significantly to the fruits and vegetables needs of many cities and its importance is inarguable. Today, around 15 % of the world's fruits and vegetable requirement is met from in horticultural activities taken up in urban and peri-urban areas. City and suburban agri./horticulture takes many forms (backyard, roof-top, balcony, community gardening in vacant plots and parks; vertical farming is one of the concept). Food and nutrition security, both of which are necessary for a healthy and balanced diet, require focus on the urban production of fruits and vegetables. As cities face ever greater population pressure with inadequate infrastructure, the role of vertical farming in urban environmental management will also become increasingly important. The concept of a vertical farm was developed to remedy these crises. This concept hardly new and it's based on one simple principle; instead of trucking food from farms into cities, grow it as close to home as possible in vacant space that stretch upward instead of sprawling outward. An important debate within the vertical farming movement is what level of self-sufficiency cities can realistically obtain. There is vast scope for the growth of this concept of farming as many cities still need to have the requirement for self-sufficiency in fruits and vegetables. Therefore, vertical gardening would have to be established on every available rooftop and vacant space. The vertical production of crops would allow more cultivation area on a relatively small base area and could therefore reduce the need for large expanses of arable land. The overall objective of vertical farming is to promote health and quality of life by increasing the amount and distribution of locally grown food, especially vegetables and short duration fruit crops. Among the horticultural crops, fruit crops like strawberry and range of vegetable crops have tremendous potentiality for inclusion in vertical farming system. In addition, a range of culinary herbs such as fenugreek and coriander are cultivated. Thus, it can be concluded that the vertical farming represents an opportunity for improving food supply, health conditions, local economy, social integration and environmental sustainability altogether. Therefore, need based and market led diversification concepts are being emphasized for inclusive development of vertical farming system.

Key words Urban population, Vertical farming, Sustainability, Nutrition self sufficiency

Abstract - 2

GREEN HOUSE BASED MULTITIER HI-TECH PROPAGATION IN ARID ZONE

Dhurendra Singh, P.N. Sivalingam, S.R. Meena, U.V. Singh and S.K. Sharma
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The prevalent climatic elements such as high wind speed, sand storm, high temperature during summer (48-50°C), low temperature during winter (2 to 3°C) and low atmospheric humidity (20-30 %) during most months of the year are not favourable for successful propagation of various horticultural crops in arid region. These climatic factors are detrimental for vegetative propagation of arid fruit crops. The technique of vegetative method of budding, grafting and stem cutting gives poor result. The growth and development of rootstocks are slow and difficult to achieve buddable size during current season. Looking into these inherent environmental problems of arid ecosystem we have designed and established hi-tech propagation facilities such as closed environmental chamber based on evaporative cooling system, glass house fitted with environmental controlled devices such as fan and pad cooling system, micro irrigation system, foggers, misters and heating system and shade house fitted with cooling pad made of local available biomass of wild ber (*Ziziphus nummularia*). These structures were also fitted with photoperiodic control devices containing fluorescent and incandescent lights and provision of control on natural light through shading nets. In order to utilize maximum use of green house space, humidity and congenial climate, the propagation and hardening of tissue cultured plants were subjected to a multitier design using iron rakes, bamboo rakes, and tables of MS sheet , fibre rakes and different propagation container such as portrays, root trainer, plastic pots, bags crates and trays. This multilayer approach was found effective in improving vegetative propagation efficiency of more than 15 species of arid horticulture crops and acclimatization of tissue culture plants of aloevera and cactus pear. Further, the concept of zero-day juvenility in planting material of pomegranate, karonda, mulberry, citrus and concept of accelerated growth technique(AGT protocol) using biophysical and chemical approach including application of Plant Growth Promoting Rhizobacteria (PGPR) in planting material propagated through terminal and soft-wood cutting. The resource conservation efficiency of facility was also enhanced by keeping a group of 25-30 cuttings in a single pot initially for root formation. The rooted cuttings were further shifted in separate containers for growth and development of saplings. The concept of plug production of fruit crops such as *ber, khejri, karonda* and *phalsa* was also optimized for improving their vegetative propagation efficiency. The plants produced under this facility have been largely supplied to urban people for kitchen gardening, farmers, several institutes and state agricultural universities.

Abstract - 3

VERTICAL FARMING: A SOLUTION FOR FUTURE AGRICULTURE

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The advent of agriculture has ushered in an unprecedented increase in the human population and their domesticated animals. Farming catalyzed our transformation from primitive hunter gatherers to sophisticated urban dwellers in just 10,000 years. Today, over 800 million hectares is committed to soil based agriculture. It has rearranged the landscape in favor of cultivated fields at the expense of natural ecosystems, reducing most of the natural areas to fragmented, semi-functional units, while completely eliminating many others. A reliable food supply was the ultimate result. Population is increasing at an alarming rate leads to the decrease in the horizontal expansion of arable land resources and most of the land resources we worked, often turning verdant, natural eco-zones to semi arid deserts. As if that were not enough to be concerned about, it is predicted that over the next 50 years, the human population is expected to rise to at least 8.6 billion, requiring an additional 10^9 hectares of land area to feed them using current technologies. One such alternative solution involves the exploitation of vertical spaces available. Construction of urban food production centres such as vertical farms, an entirely new approach to indoor farming in which our crops would be continuously grown inside of tall buildings within the controlled environment. If a building stood on a one hectare plot of land but had five stories, it would result in production from five hectare of land. The new farming technique envisages production of crops hydroponically (nutrient enriched water) or aeroponically (nutrient enriched air) without using soil or compost. The plants can get the required sunlight through glass windows or artificial light could replace sunlight as well. Produce would be available to city dwellers without the need to transport it thousands of miles from rural farms to city markets. Spoilage would be greatly reduced, since crops would be sold and consumed within moments after harvesting. If vertical farming in urban centres becomes successfully implemented, they offer sustainable production of a safe and varied food supply and the one anticipated long term benefit would be the gradual repair of many of the world's damaged ecosystems, that have been sacrificed for horizontal farming, through the systematic abandonment of farmland.

Abstract - 4

VERTICAL MUSHROOM GARDENING – A SYNTHESIS OF NUTRITION AND AESTHETICS

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Mushroom are fungi which are being industrially grown for nutrition and medicinal purposes. Among the 1500 varieties of edible mushrooms, Oyster mushrooms (Species of the genus *Pleurotus)* stand out for their special features. They bloom in all hues of pink, yellows, brown, white, blue, gray and black. They are not only a treat for the eyes but also immensely packed with nutrition. They are highly adaptive in terms of growth substrate requirement which can be any agricultural waste. They are equally adaptive in their environment requirement and can be cultivated from 15°C to 30°C. Oyster mushrooms are highly adaptive to spaces as well and can be grown in Polypropylene bags, bottles, gunny bags, cardboard boxes, trays, in PVC pipes etc. They can be grown in small spaces for family requirement or scaled up as entrepreneurial activity. They can be grown as vertical walls or as ground covers, as hanging baskets of mushrooms or in any other small or large space to blend with aesthetic imagination. Oyster mushrooms will not only be a novel concept of aesthetics but also of vertical nutrition as these mushrooms are a very high source of B vitamins, Selenium, Zinc, Iron and potassium. They are the only vegetarian source of vitamin D. Their protein quality is packed with all essential amino acids. Their very low sodium, low carbohydrate and low glycemic index, very low fat, high fibre, their ability to reduce cholesterol due to the presence of lovastatin, make oyster mushrooms a recommended diet for diabetics, people with high blood pressure and to keep healthy heart. These mushrooms are not only packed with nutrition themselves but liberally make it available through their high bioavailability to the human beings. It is time now to think differently and move towards the diversification of food through blend of diverse crops and if aesthetics and nutrition can be united then this blend can lead to better nutrition, creation of employment and eco-friendly agricultural waste management. Beauty definitely lies in the eyes of the beholder but mushroom science has the potential to diversify subjects of aesthetics for the eyes.

Abstract- 5

SUSTAINING LIFE THROUGH VERTICAL FARMING

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According to the estimates of UN population projection, by the year 2050, close to 80% of the world's population will live in urban areas and the total population of the world will increase by 3 billion people. To feed the increasing global population by 2050 requires 70 per cent increase in global food production with food production. Environmental stress (climate change), shrinking land and water resources are the major constraints haunting this task. To meet this challenge and requirement of food, intensive agricultural approaches *viz*., vertical farming, sky farming and urban farming are needed. The concept of vertical farming was given by Professor Dickson D. Despommier in 1999. Vertical farming is large scale agriculture in urban high rise structures. The concept foresees the cultivation of fruits, vegetables, medicinal, fuel producing plants and other plant products in the cities. A vertical farm of 9300 m^2 with 30 stories should provide around 15,000 people with 2000 kcal of nutrition per day. This farming technology confirms crop production all year-round irrespective of the environmental conditions. According to 'The Encyclopedia of Earth, 2010' a 30 storey high building with a basal area of 5 acres has the potential of producing crop yield equivalent to 2,400 acres of traditional horizontal farming. The advantages of vertical farming are less environmental destruction, year round crop production, higher productivity, low energy & water usage and sustainable urban growth.

Key words Vertical farming, Climate change, Productivity

Abstract - 6

VERTICAL GARDENING: A NEW CONCEPT FOR URBAN LANDSCAPING

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Vertical gardening has emerged as a new concept of landscaping in modern era for efficiently utilizing the vertical spaces in urban region where space is limited for the conventional method of gardening. Moreover, the unstoppable force of urbanization is consuming vast quantities of natural vegetation, replacing them with concrete buildings. These resulting changes in the thermal properties of surface materials and the lack of evapo-transpiration in urban areas lead to a phenomenon known as the urban heat island (UHI) effect. It is found that vegetation can alleviate UHI directly by shading heat absorbing surfaces and through evapo-transpiration cooling. With the idea of introducing nature back into the urban landscape, a partnership is strengthening between nature and the city with the aim to create a new sustainable urban lifestyle. Greenery is the key element of this transformation. Since the outer surfaces of building offer a great amount of space for vegetation in urban cities, planting on roofs and walls has became one of the most innovative and rapidly developing fields in the worlds of ecology, horticulture and the built environment. Urban areas become more crowded than ever, limiting the area for conventional gardening. So, many city centres today are trying to find areas for plants in order to transform the CO_2 produced by cars and buildings heat into oxygen. In this context vertical garden provides the best solution. These gardens have demonstrated that restorative effect of natural scenery holds the viewer's attention, diverts them from worrisome thoughts. This system results 5.5^0C reduction in the immediate outdoor temperature and corresponding energy reduction by 50-70%. This greenery system can filter hazardous gases like NO_2, SO_2 and CO by capturing airborne contaminants and depositing them on leaf surfaces. The garden further reduces the surface temperature of building with maximum reduction of 11.58^0C. Thus, it can be concluded that the vertical garden is beneficial in social, environmental and economical aspects. Hence the installation of the vertical garden is recommended in large cities where space is problem and the conventional method of gardening is not possible.

Key words Urbanization, Urban heat island, Vertical garden, Landscape

Abstract -7

ROOF TOP AND VERTICAL GARDENING FOR GREENING THE CITIES

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Today, the temperature raised in urban areas due to the replacement of natural vegetation with pavement, buildings and other structures. This scenario has increased the building and the ambient temperature. Roof top and vertical gardening has emerged as a new concept of landscaping in modern era for efficiently utilizing the vertical spaces in urban region. A green roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a water proofing membrane. Vertical gardening is a gardening technique that utilizes various resources to allow plants to extend upward rather than grow along the surface of the garden. Plants used in vertical garden in Indian condition are ferns, Coleus, Asparagus, Aspidistra, Chlorophytum, Gloriosa, Hyacinthus, Lilium, Mirabilis, Boungainvillea etc. Nowadays, some people are interested in developing green roofs for energy saving, reducing rain water runoff and improving building thermal and environmental performance. Others are interested in adopting solar PV (Photo Voltaic) systems at rooftops for renewable power generation. The electrical efficiency (η) of PV cells is the result of the relationship between the power delivered by the cell and the amount of solar irradiation. High rooftop temperatures increase the conductivity of the crystalline semiconductor of PV panel, which in turn inhibits charge separation and lowers the voltage of the solar cell. An effective way of improving efficiency and reducing the rate of thermal degradation of a PV module is by reducing the operating temperature of its surface. Another factor influencing the efficiency of PV system is the air pollution or dirt/dust level. Since green roof can help reduce temperature, dust level and improve air quality, the efficiency of PV system could be enhanced by integrating this system with green roof system, but no solid evidence has be found in the literature at present. Vertical gardens also help to clean the air of pollutants, encourage biodiversity, lower ambient temperature and energy consumption, and provide carbon sequestration and ecosystem services. Therefore, further studies on the role of the vertical greenery system to reduce heat and increase cooling effect should be given more attention, especially in relation to urban heat island (UHI) effect.

Abstract - 8

VERTICAL FARMING – A SCIENCE BEHIND INNOVATIVE HORTICULTURE

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Vertical farming is a method of large scale farming of fruits, vegetables, herbs and ornamental plants in multi-story buildings in an urban environment. It is also called controlled environment agriculture or building integrated agriculture. The idea of vertical farm given by Dickson Despommier in 1999. It is an intensive farming strategy, mainly employs advanced techniques such as hydroponics and aeroponics which enables year round production in any geographical location far more quickly than with traditional farming methods. Vertical farms grow plants hydroponically in large, multi-story buildings under artificial lighting, less quantity use of water, labour and minimal land. Anyone can experiment in creating his own vertical garden or wall garden, subject to financial limitation depending on the chosen design and familiarity with adopted plants, but grower has to know a proper scientific knowledge and skill of management. Two methods of constructing vertical gardening *i.e.*, one consist of a growing frame made of tubular steel covered with chain link fencing and another wall garden which is made on a 1.83m×3.65m wall made of concrete blocks. In vertical farms farmer can grow different crops like as spinach, lettuce, coriander, kale, strawberry, marigold, chrysanthemum, pansy *etc*. It enable a year round commercial production, versatility and rapid flexibility of crop variety being grown to meet seasonal market opportunities, production can be established in close proximity to any client or market locations. In the short term, vertical farms can be more productive than traditional farming and all produce is grown organically, because the nature of contained environment. Vertical farming brings a solution to the global problem of hunger, could reduce the incidence of armed conflict over natural resources such as water and land for agriculture, converts abandoned urban properties into food production centres, reduces greatly the incidence of many infectious diseases that are acquired at the agricultural interface greatly. This innovative approach could become the norm as soon as 2050, while crop land grows scarce and a booming population demands more food.

Key words Vertical farming, Hydroponics, Aeroponics, Artificial lighting, Multi-story buildings

Abstract - 9

VERTICAL VEGETABLE GROWING SYSTEM - AN ALTERNATIVE APPROACH TO SUSTAIN NUTRITIONAL SECURITY AMONG MASSES OF ARID REGION

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Due to prevalent adverse weather conditions and scarcity of water, poor fertility of soil and high solar radiation, cultivation of leafy vegetables in arid zones is an upheaval task. Leafy vegetables which forms an important constituent of diet is lacking among the cuisine of the rural masses residing in arid regions. Besides, as most of the leafy vegetables do grow well under hot and humid climate, it has become imperative to search for a model that can suffice the needs of the dry and arid tracts and it seems that vertical cultivation of leafy vegetables and others under controlled environment conditions can be a good start up venture. In our initial study, we have identified and introduced some leafy vegetables like basella (*Basella alba)*, amaranthus (*Amaranthus* species), thornless vegetable cactus (*Opuntia ficus-indica)* and sweet type aloevera *(Aloe barbadensis*), a sort of mix and match of sensitive and hardy crops which are complemented for their enriched nutritional components and phytochemicals. The vegetables were grown in pots and trays of requisite size in multitier racks so as to accommodate more number of plants as well as to raise the productivity per unit area. Temperature (20-35^{0}C), humidity (60-75%) and light (20-30Klux) regimes were controlled manually inside the green house to keep the environmental parameters congenial for the growth of the plants .The potting mix consisted of 3:1 ratio of sand and locally available sheep yard manure along with 25 g DAP. The leafy vegetables gets ready for harvest after a month of sowing followed by weekly harvest at intervals. Tender leaf pads of vegetable type cactus pear (nopals) and aloevera were cut and utilized for culinary purposes, a delicacy among the people of arid zones. This concept has high significance in minimizing post harvest losses in leafy vegetables which generally have poor keeping quality. In the long run, vertical system of farming needs to be commercialized under low cost naturally controlled protective structures in rural arid belts which we can coin as "VerVeg(Vertical Vegetable) farming" where space is available but the climate is harsh. This type of production system will ensure a steady supply of day to day fresh vegetables and can act as a substitute for kitchen garden in the cities too. Besides, the harvested produce will be free from any kind of pests, diseases as well as pesticides and who won't relish a palate of vegetables from one’s own household and therapeutic values itself gets raised.

Abstract - 10

CLEANTECH TECHNOLOGY IN VERTICAL FARMING

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Vertical farming as a component of urban agriculture is the practice of cultivating plant life within a skyscraper greenhouse or on vertically inclined surfaces. With state-of-the-art, cleantech technology using hydroponics, aeroponics with LEDs and AeroFarms is the commercial leader for vertical farming, utilizing a totally controlled growing environment without soil and minimizing transportation miles. Hydroponics is a subset of hydroculture and is a method of growing plants using mineral nutrient solutions in water without soil. Hydroponics systems are further categorized as open, where after the nutrient solution has been delivered to the plant roots, it is not reused or closed where surplus solution is recovered, replenished and recycled. Aeroponics is a cutting-edge type of hydroponic technology that grows plants in a mist. The aeroponic mist most efficiently provides roots with the nutrients, hydration and oxygen needed, creating faster growing cycles and more biomass than other growing approaches. AeroFarms has designed its aeroponics as a closed-looped system, re-circulating our nutrient solution and using over 95% less water than field farming. AeroFarms has been pioneering the use of LED (light emitting diode) lighting for growing and vertical farming systems, targeting specific wavelengths of light for more efficient photosynthesis and less energy consumption. LEDs can also be placed much closer to the plants, enabling greater vertical growing for even greater productivity per square foot. The principal advantages of cleantech technology include high-density maximum crop yield, crop production where no suitable soil exists, a virtual indifference to ambient temperature and seasonality, more efficient use of water and fertilizers, minimal use of land area, and suitability for mechanization, disease and pest control. The major advantage of cleantech technology compared to field grown produce is the isolation of the crop from the soil, which often has problems of diseases, pests, salinity, poor structure and drainage, year round, high quality production with better yields, faster 12 to 16-day crop cycles for 22 to 30 crops a year, patented, reusable growing cloth medium, no pesticide usage, 95% less water usage, closed-loop system able to recycle nutrients, no harmful run-off protecting the environment. The principal disadvantages of cleantech technology, relative to conventional open-field agriculture, are the high costs of capital and energy inputs, and the high degree of management skills required for successful production. Capital costs may be especially excessive if the structures are artificially heated and cooled. This is why appropriate crops are limited to those with high economic value such as tomatoes, capsicum and strawberry. Cleantech technology is most innovative, clean, safe and green technology for vertical farming. Combination of cleantech technology in vertical farming of horticultural crops is a boon for growers.

Abstract - 11

PROTRAY STEP SEEDER FOR VERTICAL FARMING NURSERY

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Protray step seeder for dibbling and sowing is useful for raising nursery of vertical farming. The functional components of the step seeder are i) chain coveyor operated by a step motor for indexed protray movement , ii) reciprocating dibbler, iii) vibrating seed singulation tray and iv) vacuum operated seed nozzles. The dibbling system is a set of conically shaped tubular shafts arranged in a common bar. A pneumatic cylinder is used to push the bar downwards to make the dibbling. This is done when the bar reaches the dibbling station and achieved using a proximity sensor. This action is synchronized with the chain conveyer indexing. The stroke of the operation is 30 mm and indenting will be 5-10 mm deep. The seeder picks a single seed from the seed tray and drops it into a single indent in the protray. For picking the seeds, a set of nozzles are used. The nozzle is a tube with a conical end with a small orifice. The size of the orifice can be changed according to the size of the seeds. The nozzles are mounted on an oscillating shaft and all the nozzles are connected to a vacuum source. The vacuum can be switched on or off using an electrical solenoid valve. The seeds are placed in a vibratory tray which will be continuously vibrated which would make the seeds vibrate continuously. When the oscillating shaft with the nozzles is brought near the vibratory tray, seeds are be picked up and held to the nozzle orifice due to the vacuum. When the oscillating shaft is moved to the second position, the vacuum will be cut off and the seeds are released to fall into a tubular duct positioned under each of the nozzles. This tubular duct guides the seed and makes the seed to fall into the protray cavity impression which is made in the earlier station. The entire cycle is controlled by a logic program and this synchronizes the conveyer motion (position/inching) with the seeder system as well as the indenting system. The capacity of the protray step seeder will be 400 protrays/h.

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SKYSCRAPING GARDENING- REVOLUTION ON RISE

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Sky towering buildings as a result of urbanization has diminished land availability for agriculture and least bothered for gardening devoiding aesthetic pleasure which is imperative for mental wellbeing of humans and good health. Recent concept of vertical gardening is on hot wheels which can be looked upon as an approach to landscape indoors. It facilitates year round flower blooming and lush greenery in an optimized, controlled environment, regardless of external environment. Aesthetic beautification kept aside, it also improves living conditions of the area through making nearby environment liable by reducing temperature, purifying air, etc. Ornamental plants rectify the languishing impact of the towering buildings on personal and public profile and significantly improve the visual amenity of the city. It also increases property values by transforming them into landmarks. Several species of annuals and herbaceous plants such as ivy leaved toadflax, wallflower apart from that as mosses, lichens, ferns and grasses can be grown successfully. This art requires skill and knowledge for each of their components for its successful implementation. A balanced combination of environmental considerations with sound economics for vertical gardening might serve as a feasible alternative for indoor gardening in future.

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HANGING BASKETS: BECAUSE WE ARE GOING VERTICAL

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With so little space in our urban dwellings and the desire for creating a scenic niche for ourselves exploring hanging baskets seems like the right choice. They are great for giving the illusion of bringing down the height of very tall spaces and making great visual impact. Plants are grown suspended over the balconies, porch ways, verandas, to walls, patios, basement areas, etc. This provides colour high up in the garden and soften all hard lines of a wall or building. We pick up some drought resistant plants and make a statement with our choice of colour and texture. Hanging baskets add a whole new dimension to gardening, helps to utilize all the available space. With hanging baskets and flower pouches we can brighten up a sunny wall, or with the right choice of plants, even add colour to those tricky shady areas. These modern day hanging basket are considered to be inspired from the Hanging Gardens of Babylon, one of the seven wonders of the ancient world. The vegetation imparts colour, texture, fragrance to the vertical environment where there is no natural flora at the eye level. It adds a new life to the dead balcony, walls and parapets. We can even grow fresh herbs throughout the winter with an indoor basket next to a sunny window. We can grow all sorts of plants in containers from perennials to bedding, fruits, vegetables and even shrubs and small trees. Climbing roses, clematis or sweet peas provide a drooping look. Fruits and vegetables such as herbs, lettuce, tomatoes, dwarf beans, blueberries, strawberries and rhubarb can be grown in containers. The best plants for hanging baskets and containers include bush cucumbers, chilli peppers, lettuce, tomatoes, strawberries, peas and dwarf beans. Herbs suitable for hanging baskets include parsley, basil, sage, chamomile, chives, marjoram, sorrel and thyme. Wire hanging baskets require a liner to hold in the compost and plants. Plastic lining is done to help with water retention, so that it does not dry out. Also, vegetables and herbs need more space than bedding plants. Baskets or containers can be in sheltered sunny sites avoiding windy and exposed sites, although herbs and cucumbers appreciate some shade. There is a variety of baskets available in the market. We just consider the best fit with your decor and the theme that works well with your garden and plant choices. We can select the size that best suits the type of plant that you will be planting, including consideration for their likely future growth. Hanging baskets are typically available in such materials as stout galvanised wire, solid plastic, ceramic pot, knotted hanger, basketry, ceramic pot attached with wire. Bark based growing media allows for better porosity and drainage, which contributes to a more toned, finished produce. We need to choose a growing medium with a lower bulk density for hanging basket production above benches. A peat based growing medium with perlite or perlite/vermiculite is good for this type of system. Two types of fertilizers can be used, liquid or timed-release.

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VERTICAL FARMING: A FUTURE BREATH FOR AGRICULTURE

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It is not only a universal fact but also a key concern of agriculture researchers that area of earth is constant and human population is increasing and that too with geometrical rate. In other simple words the land is shrinking and definitely one day will come when there will be no enough land to grow the adequate food for the nation and world. This critical situation lead to the genesis of different opportunities and innovations which ultimately aims to utilize cultivable to its best extent. These approaches involved the principles of best and efficient use of crop growing conditions like sunshine, land area, hydroponics, aeroponics etc. So that the sustainable manner for food production can be achieved, one of such farming system is vertical farming. Vertical farming is farming ex-situ on in-situ, like inside the building in which floors are designed to plant the crop vertically one over other instead of going for space consuming horizontal growing. Although some critics says that its initial investment is high but it's not always true, also when considered for the long run its feature of giving year round crop production in a protected, managed environment has proved to be having several advantages over traditional farming system. This system not only utilize our unused property like unused land, inputs etc. but also minimize the use of non-renewable resources (farm machineries etc.) as its component. Some of the other advantages of vertical farming involves, no weather related crop failures, offers the possibility of sustainability for urban centres, creates new urban employment opportunities, returns farmland to nature, helping to restore ecosystem functions and services. Thus it can be concluded that vertical farming is not only one of the best option of modern farming system but also the need of society and scientific community to resolve the emerging food related challenges in a sustainable manner.

Keywords Farming systems, Agriculture land, Vertical farming, Scientific community, Sustainable agricultuture

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VERTICAL FARMING: BOON AND CHALLENGE FOR THE FUTURE

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Vertical farming is a new invention to meet the food requirements of the growing population against the shrinking land holdings and resources. The benefits of vertical farming are numerous. In general, 1 indoor acre of vertical farming is equivalent to 4-6 outdoor acres or more, depending upon the crop. For the same floor area, vertical farm systems multi-level design provides nearly 8 times more growing area than single level hydroponic or greenhouse systems. There are no weather related crop failures due to drought, flood or pest attack as vertical farm systems are fully enclosed and climate controlled which ensures completely removing of external environment factors such as disease and pest attacks. In a well managed vertical farm system there is no such thing as seasonal crops and there are no crop losses. They are also not dependent on fertile arable land and can be established in any climatic region globally irrespective of seasonal daylight hours and extremes in temperature. This compact design enables cost-effective farming installations in industrial estates, urban warehouses and other low-cost and typically under-utilized environments. Irrespective of external conditions, vertical farm systems can reliably provide more crop rotations per year than open field agriculture and other farming practices. Vertical Farm Systems has a wide range of crops that are able to be grown in their systems. The crop growth is controlled by a comprehensive computer database that manages and maintains the optimum growing conditions for each specific crop variety being grown. As there is lack of suitable varieties/F_1 hybrids and management practices for vertical farming, it needs immediate attention to develop suitable high yielding varieties and management practices for wide adoption of this technology.

Key words Vertical farming, Climate change, Varieties/F_1 hybrids

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VERTICAL FARMING - REVOLUTIONIZING THE FOOD PRODUCTION

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Traditional farming is taking a huge toll on the environment, a problem that's set to worsen due to our ever-growing global population. Increase in the productivity of agriculture by employing techniques of conventional (20th century) agriculture is posing a limitation. There are some high-tech solutions like vertical farming and sky farming. The concept of vertical farming is a large scale extension of urban farming of fruits, vegetables and grains. It employs vertical stacking of the farms therefore small land (9 acre of horizontal land is equal to one acre of vertical farm) can be utilized for more production. These heights will acts as the future farms land and as architects we can shape these high rises to sow the seeds for the future. In addition, this technique is well suited for the rapidly growing global urban population as the demands of food supply can be met from within the cities and thus reducing the transportation cost and environment deterioration caused by fuels in the process and sustainable food production for growing urban people.

Key words Traditional farming, Vertical farming, Sustainability, Climate change

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VERTICROP FOR FOOD AND ENVIRONMENTAL SECURITY

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The 21st century keeps huge challenges for the system "city". Shortage of resources and world population growth forces architects to think in spaces with increasingly more structural linkages and framing. The vertical farming is gave the solution to city people for large scale extension of urban farming, it employs vertical stacking of the farms therefore small land can be utilized for more production with recreation. VertiCrop (Europe) is an integrated hydroponic approach that addresses the central issue of optimizing resource and vertical space use to grow crops near to where they are consumed, using the most advanced technology to ensure efficient crop production. Under this approach they grown 11,200 plants in a greenhouse of 100 square meters, using a conveyor driven stacked growing system various micro greens, lettuce and salad mixes have been planted sequentially to provide a regular supply of fresh green leaves; with the primary focus of economic profitability and improved nutritional value. The potential of Verti Crop opens up the way for schools, hospitals, housing estates in cities and towns to grow their own vegetables, to reduce their carbon footprint and associated food miles. In the future, it will be possible to extend the research direction to include vertical cultivation of food, biofuels and medicinal crops, such as high market value pharmaceutical products.

Keywords Food security, VertiCrop, Intensification, Hydroponic technology, Pharmaceutical, Energy saving

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VERTICAL FARMING PROSPECTS AND CHALLENGES IN INDIA

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It is predicted that the world population will reach 9 billion by 2050, of which 70% will live in urban centres. Now soil is becoming limiting factor due to increase in demand for agriculture, industry, housing etc. The new soil alternatives are required, vertical farming can be one of the ways for enhancing productivity through efficient resource management. “Vertical farming” term was coined by Gilbert Ellis Baily in 1915 in his book vertical farming. Vertical farming as a component of urban agriculture is the practice of cultivating plant life within a skyscraper greenhouse or on vertically inclined surfaces. The vertical farming with emphasis on hydroponics has positive impact upon the greening and cleaning of the cities, offering green zones for micro-climate changes (shade, temperature, sequestration of CO_2). Most of the vertical farming and gardening practices with hydroponics which reduces weight of the structure and also maintenance. The vertical frames are so adjusted that the nutrient solution flow up to down and keep media and roots moist and supply the nutrient. The Green City are demanded by the people, something like a new paradise to harmonize technical advances and nature, urbanization and countryside, population explosion and ecological balance. In India it is at very initial stage but gaining popularity. It is used for beautification and landscaping purposes and very less for food production. Vertical gardening mostly exploited for beautification of multi-store buildings, malls landscaping and interior decoration of offices, hotels, hospitals, schools, home etc. Real estates is also giving importance to vertical gardening as greenery and plantation decides the prices of the property. The vertical frame with slight slope with plants increase the space and give the feeling of more space. The vertical garden not only increases the aesthetic value of the surrounding but also change the indoor microclimate. The selection of plants should be done according to use and site where it is supposed to be established like for indoor, shade loving, dwarf plants. It is becoming important part of bio-aesthetic planning as land is a scared resource in city. In India vertical farming and gardening can be an alternative to mitigate urban pollution problems and to some extend climate change side effects. There is a huge scope for vertical farming and its derivatives in India.

Abstract - 19

Homestead Farming-The Future Agricultural Asset for Prosperity

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A research project on Homestead farming to develop model homestead units sponsored by NABARD was undertaken by ICAR- Central Coastal Agricultural Research Institute, Old Goa, Goa during 2010-13. A total of twenty farmers were selected for implementation of the project representing farmers within each taluka through survey by a team of scientists. Primary data on characteristic features of existing homesteads was collected through individual contacts and discussions. Gaps in the existing production technology were identified for each of the farmers based on the prevailing situation and need of farm family. Suitable interventions were identified to meet the identified production gaps.

The common biodiversity of crops observed under homestead farming system including a mix of vegetables, flowers and medicinal plants as intercrops in fruits and plantations involving spices could able to sustain the biodiversity of vegetation around the household with a change in the local micro-climate. The most interesting aspect of this family farming is that every portion of the land was used for cultivation. Depending on the type of space available with the homestead situations, the suitable vegetable crops were selected and their performance was assessed. Although a wide variety of vegetables are grown both during *kharif* and *rabi* seasons by the homestead farmers of Goa, it was observed that the vegetables production is more concentrated during October to March period (*rabi* season).

A perusal of the data on the distribution pattern of homestead grown vegetables indicated that nearly two-thirds of the homestead grown vegetables were consumed in the household with only one-fifth of the vegetable produce being sold in the market while a part it is exchanged among the neighboring households. Nutritionally, the homestead farming met a sizeable portion of the mineral and vitamin requirement of the household family members although the carbohydrate and protein requirements were met partially. The family nutrition through a mix of vegetables, including tuber crops, fruits, spices, plantation crops and medicinal plants as a mixed vegetation around the household with a change in the local micro-climate was also found to bring in long term benefits on health of family members. As regards returns from the homesteads, wide differences was observed among the farms due to variation in intensity of cropping, productivity levels as well as assets owned by the project beneficiaries.

Based on the data collected and the interactions with the clients, model homestead units for different holding sizes of the household were attempted based on the family requirement and the marketing potential keeping in view the resource situations including part or full time availability of the family members to work in their gardens. As the majority of the households have a holding of 500, 1000 and 2000 m^2 relevant models to suit to these holdings were developed. These models although are apt for West coast situations could also be used in other parts of the country with suitable modifications.

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