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Message from the Chairman's Desk

Dear friends,

The month of October started with the celebrations of the 150th birth anniversary of the Father of the Nation. In an era where critics fear that the canker of need based and greed based corruption is eating into the moral fabric of the nation, Gandhiji's views hold much more relevance than in yester years. His concept of Swaraj focused on sustained growth of agriculture as the cornerstone of all development. Mahatma Gandhi's model was not centralised mass production, but production by the masses. He wanted policies that would help build up agriculture and production of essential goods through a network of cottage industries that would generate employment for the people. His emphasis on decentralization, community based economics, self-sufficiency, handicrafts, rural development and use of low capital intensive appropriate technology indicate his vision for a self-sufficient economy. When the rural economy turns self reliant, it equips the community with livelihood security which in turn leads to social security.

"I, for one, am a farmer and I wish you all to become farmers or to continue as such if you have already become a farmer. I prefer this work and consider this alone to be my duty" thus spake Gandhiji.

The concept of decentralized self-dependent units bound together by the bonds of mutual cooperation and interdependence emphasized by him is visible in the three tier Farmer Producer Organizations facilitated by the Board. Empowering farmers through organizing them into communities with common interests not only leads to the development of the individual, but also development of the community at large. Increased self confidence of the farmers results in better decision making in cultivation and marketing, which in turn reflects in increased remunerative returns, better standards of living and socio-economic development. This leads to the ultimate Gandhian goal of Sarvodaya which means development of all in all facets of life. Gandhiji's basic aim was to have an all-round development of the society intertwining human development with socio-economic and political development.

He believed that agriculture should be organic and should focus on efforts to return to the soil, at least as much as that was taken there from. In today's scenario of global climate change and depleting natural resources, world over the cry is for environmentally sustainable agricultural practices. Coconut Development Board promotes such practices including organic farming methods, soil and water conservation measures, rain water harvesting, recharging aquifers, use of renewable energy resources like solar energy etc in coconut gardens which in turn will lead to the development of an enriched ecosystem. The integration of intercropping and mixed farming in coconut gardens through a community/ cluster based approach nullifies the negative effects of monocropping and promotes sustainable agriculture.

Gandhiji also believed that farmers should have enough cultivable land which will provide for a complete and reliable means of livelihood. They could join hands and form a cooperative or community to cultivate their lands. But he was specific to add that all efforts should be spontaneous, arising from within the community and must be completely voluntary in nature. He wanted to bring about rural reconstruction with sound scientific and spiritual values. Through his 18-point Constructive Programme, Gandhiji successfully implemented his rural reconstruction activities in Sevagram Centre near Wardha in 1935.

The Board facilitates the establishment of coconut processing facilities under the auspices of farmer organizations. Value addition by farmer groups will lead to the benefits of value addition trickling down to the grass root level small holder farmer. This is in line with the concept of village industries mooted by Gandhiji wherein rural development means self- sufficiency and development of village industries.

To quote Mahatma Gandhi again, " The juice of coconut tree can be transformed into a sugar as soft as honey ….. Nature created this product such that it could not be processed in factories ….. can only be produced in palm tree habitats. Local populations can easily turn the nectar into coconut blossom sugar. It is a way to solve the world's poverty. It is also an antidote against misery".

The relevance of agriculture specially coconut sector in Indian economy is never going to become insignificant considering the high proportion of population that is still dependent on this sector. And agriculture is not a dying occupation, it just requires reform, rejuvenation and improvement. I am reminded of the famous dictum "There is only one culture and that is agriculture". But let me caution to state that farmers often get less than what they need for proper sustenance and unless this situation changes, sustained development in the agricultural sector will at best remain a premise on paper.

Let us reiterate the great words of the Father of the Nation "To forget how to dig the earth and tend the soil is to forget ourselves". And rededicate ourselves to the cause of those who toil and moil to feed the nation. Needless to say steps in this direction will be the best tribute to Gandhiji as October 2018 stands relegated to history – for they will go a long way to fulfill his dream of "wiping every tear out of every eye".

Jai Hind

Dr. Raju Narayana Swamy IAS
Chairman

Artificial Intelligence and its applications in agriculture with special reference to the coconut sector

Dr. Raju Narayana Swamy IAS,
Chairman, Coconut Development Board, Kochi - 11

Introduction

Food security is the major challenge faced by the world, in the wake of swelling population, increase in input and labour costs, depleting natural resources, reducing land size, global climate change, rising temperatures and high incidence of pests and diseases. According to the Food and Agriculture Organization, the global population is expected to increase by two billion by 2050 while only 4% additional land will come under cultivation by then. Smart farming, therefore, becomes the need of the hour. Needless to say, up-gradation of conventional farming techniques in a cost-friendly approach is imperative. Technologies such as Artificial Intelligence (AI), Cloud Machine Learning, Satellite Imagery and advanced analytics can empower small-holder farmers by increasing their income through higher crop yield and greater price control. Today agriculture is seeing a rapid adoption of AI in the form of sensors, drones and robots. A combination of algorithmic advances, data proliferation and the growth in computing power and storage have

transformed AI from a hype to a reality. Cognitive computing in particular is all set to become the most disruptive technology in agricultural services. Drones or unmanned aerial vehicles (UAVs) for instance enabled farmers to move from traditional farm practices to precision farming. A day may come in the not so far future when swarms of autonomous UAVs collect data and perform tasks in tandem.

AI and its applications in agriculture :

AI is typically defined as the ability of a machine to perform cognitive functions we associate with human minds such as perceiving, reasoning, learning and problem solving. It is the study of mental faculties through the use of computational models and makes computers more powerful and useful. Most recent advances in AI have been achieved by applying machine learning to very large data sets. Machine learning - the branch of computer science that is used to construct algorithms which exhibit self learning property – falls under three major types – supervised, unsupervised and reinforcement learning. Popular algorithms in the supervised category include artificial neural networks, decision trees, K-means clustering, support vector machines and Bayesian networks. Unsupervised learning algorithms include COBWEB & DBSCAN. It is like reading a book in an unknown language where the understanding is minimal, but by keeping on reading, patterns are identified and slowly the understanding process starts. Reinforcement learning works on feedback and includes in its ambit genetic algorithms and Markov decision algorithms.

Deep Learning is based on artificial neural networks which try to mimic how the brain processes and makes decisions. The neural networks are trained on data sets to acquire knowledge and apply that knowledge to solve problems. It uses algorithms to self train from the data. It allows additional layers to be developed from the primary data that is collected and uses that information to solve other problems. Fundamentally, neural networks are interconnected networks of nodes parallel to the vast network of neurons in the human brain. Artificial neural networks have come a long way since the first model was proposed by Mc. Culloch and Pitts in 1943. The major types of neural networks are Single-Layer Perceptron (SLP), Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) Networks, Kohonen's Self-Organizing Map (SOM) Networks, Probabilistic Neural Networks (PNN) and Convolutional Neural Networks (CNN).

The major applications of machine learning and AI in agriculture are summarized in the following table and are enumerated below :

Sr.No.	Field of study	Author	Algorithm used
1.	Crop selection and crop yield prediction	Washington *etal* Snehal *etal* Shivnath *etal* Rakesh *etal*	Classification algorithms Neural Networks Back propagation neural networks CSM
2.	Weather forecasting	Y Radhika *etal*	Support Vector machines
3.	Smart irrigation system	Aditya Gupta *etal*	General machine learning algorithms
4.	Crop disease prediction	Rumpf *etal* M.P.Raj *etal* Mehra *etal*	Support vector machines Pattern recognition Artificial neural networks Regression trees Random Forests.

(Source : Karandeep Kaur IJARCCE Vol. 5 Issue 4 April, 2016)

Crop Selection and Crop Yield Prediction : Techniques like artificial neural networks, K-nearest neighbours and decision trees are used in the context of crop selection. A crop selection method called CSM has been proposed by Rakesh Kumar etal (2015) in the International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM). Expert Systems (ES) on variety selection have also proved to be useful tools to select suitable varieties based on the characteristics required by the enduser for getting maximum returns. An expert system, it needs to be mentioned here, is a computer program that uses knowledge and inference procedures to solve problems that are ordinarily solved through human expertise. The main components of an ES are knowledge base, inference engine and user inference. To quote N.Sriram & H.Philip (Expert System for Decision Making in Agriculture), "In agriculture, expert systems are capable of integrating the perspectives of individual disciplines such as plant pathology, entomology, horticulture and agricultural meteorology into a frame work that best addresses the type of adhoc decision making required of modern farmers".

Providing advisory services : It is possible to provide advisory services to farmers on sowing, land preparation, fertilizer application and so on.

Huge volumes of data on historical weather pattern, soil reports, new research, rainfall, pest infestation, images from drones and cameras etc are used to generate insights to improve yield. It may be noted that Microsoft had worked with 175 farmers in Andhra Pradesh and has been successful in achieving 30% higher yield per hectare in comparison to previous year. The pilot project, it must be mentioned here, used an AI sowing app to recommend sowing date, land preparation, soil test based fetilization, optimum sowing depth and more to farmers.

Image based insight generation : Alerts could be generated in real time to accelerate precision farming. Resource optimization is achieved to a large extent. Even ripeness of the green fruits could be assessed and the farmers can plan harvesting according to demands from different markets.

Supply Chain Efficiencies and Credit Risk Management : Companies are using real-time data analytics on data-streams coming from multiple sources to build an efficient and smart supply chain. Crowd-sourced data, algorithms and analytics overcome the credit default problem, the most challenging problem of current supply-chain, to ensure a very low risk operation.

Transition Discovery: Real-time data analysis on multiple data-streams along with crowd-sourced data from producer/buyer marketplaces and transporters feeds their automatic transaction discovery algorithm to obtain high-margin transactions.

Quality Maintenance - Agricultural Product Grading: Automated quality analysis of images of food products is an accurate and reliable method for grading fresh products (fruits, grains, vegetables, cotton etc.) characterized by color, size and shape. Their solution reads the image that a farmer has taken on his phone and determines the product quality in real time, without any manual intervention. Thus computer vision and AI-based automatic grading and sorting creates an international agri-commodity standard for reliable trading across country boundaries.

Agri-Mapping: Deep-learning based satellite image analysis and crowd-sourced information fusion obtains a real-time agri map of commodities at a resolution of 1 sq-km.

Application of drones : Drones are no new technology, but thanks to robust investments and a relatively relaxed regulatory environment, their time has arrived in agriculture. They have the ability for smooth scouting over farm fields, gathering precise information and transmitting data on real time basis. They replace sizeable amount of human drudgery and reduce cost of labour. With a wing span of 1-2 m, drones can in one flight cover approximately 12 square km in 50 minutes. There are four stages in field monitoring by drones:

a) Capture of high resolution images

b) View of data in real time

c) Processing of data in the cloud and translating into useful information

d) Generation of maps providing different types of information.

It must be mentioned here that drones are easy to maintain, largely water resistant and are operational under adverse weather conditions too. According to a prediction of Goldman Sachs, the agricultural sector will be the second largest user of drones in the world in the next five years. There are broadly six options for agricultural drones:

i) Soil and Field Analysis: Drones produce 3D maps for early soil analysis, useful in planning seed planting. In fact soil characterization can be done using proximity sensing and remote sensing. Remote sensing uses sensors in airborne or satellite systems while proximity sensing uses sensors in contact with soil or at a very close range. Characterization of soil below the surface at a particular place is achieved this way. Drones can be used to produce a 3D field map of detailed terrain, drainage, soil viability and irrigation. Nitrogen level management can also be done using drone solutions.

ii) Planting: Drone planting systems can decrease planting costs by 85%.

iii) Aerial Spraying: Drones can scan the ground and spray the correct amount of liquid. Reduction in the amount of chemicals penetrating into ground water is the advantage. UAV sprayer does not need a run way. It can take off and land vertically. Flying at low altitude, the crop spraying can be controlled in any distance range.

iv) Crop Monitoring: As opposed to satellite imagery where images had to be ordered in advance, were imprecise and extremely costly (not to mention disadvantages such as images could be taken only once a day and the quality suffered on certain days, today time series animations have shown the way in crop management.

v) Irrigation: Drones can identify which parts of the field are dry. They also aid calculation of vegetation index and show heat signature. In fact irrigation could be automated with machines trained on historical weather pattern, soil quality and kind of crops to be grown. This is found to result in an increase in the overall yield. In a world moving through water scarcity with 70% of the world's fresh water being used in irrigation, automation could help in better water management and water conservation. Smart devices are being designed on principles of machine learning, working with sensor's data and improving the system over time all by itself. EDYN Garden Sensor is a classic example.

vi) Crop Health Assessment: By scanning a crop using both visible and near field infrared (NIR) light, drone – carried devices can identify which plants reflect different amounts of green light and NIR light. This information can track changes in plants and indicate their health. As soon as sickness is brought to light, farmers can apply remedies. The hybridization of neural network – hyper spectral approach has emerged as a powerful tool for disease detection and diagnosis. Recently the International Water Management Institute carried out trials in Sri Lanka with a NIR. It was observed that a drone with NIR camera can identify stress in a plant ten days before it becomes visible to the naked eye. When a plant goes into stress, photo synthetic activity decreases and that affects the chlorophyll. That is what NIR can detect but human eye cannot until it is more advanced. Needless to say a ten day warning could prevent large scale crop losses. In fact for disease detection and pest attack, the image is captured, preprocessed and transmitted to remote labs. Algorithms can identify diseases and different species with 99% accuracy. This is all the more beneficial in pest identification, nutrient deficient recognition etc.

AI - Powered Chatbots (Virtual Assistants): Currently they are used in retail, travel, media and insurance sectors. Agriculture could also leverage this technology by assisting farmers with answers and recommendations on specific problems.

Case studies of AI start ups in Agriculture

Prospera founded in 2014 in Israel makes predictions with a cloud based solution that aggregates all existing data like soil/water sensors, aerial images etc combined with in-field devices.

Blue River Technology founded in 2011 based in California combines AI, computer vision and robotics. Computer vision identifies each individual plant, ML decides how to treat each individual plant and robotics enables the smart machines to take action.

FarmBot founded in 2011 which helps the farmer to do end-to-end farming all by himself from seed plantation to weed detection and soil testing to watering of plants all by using an open source software system.

AI Sowing App - Microsoft in collaboration with ICRISAT, developed an AI Sowing App powered by Microsoft Cortana Intelligence Suite including Machine Learning and Power BI. The best part – the farmers don't need to install any sensors in their fields or incur any capital expenditure. All they need is a feature phone capable of receiving text messages.

CropIn – Using AI to Maximize per-Acre Value Essentially, CropIn uses technologies such as AI to help clients analyze and interpret data to derive real-time actionable insights on standing crop and projects spanning geographies. Its agri-business intelligence solution called SmartRisk "leverages agri-alternate data and provides risk mitigation and forecasting for effective credit risk assessment and loan recovery assistance.

AgVoice : This system provides a voice-to-data, work flow management service for food and agriculture professionals. They can be deep experts like plant breeders in an R&D environment or professional agronomists or pest control advisors supporting growers. But by combining a uniquely tailored industrial grade voice enabled user experience with a clou based proprietary analytics platform, AgVoice enables users to achieve verifiable fast inspections, reporting and work flow management for the agri-food supply chain more accurately than existing conventional processes.

Intello Labs – Using Deep Learning for Image Analysis - Bengaluru-based Intello Labs provides advanced image recognition technology that can recognize objects, faces, flora fauna and tag them in any image. The company claims to use deep learning algorithms on which a new generation of intelligent applications are being built for applications including agriculture, eCommerce, advertising, manufacturing, and curation.

Gobasco — The Intelligent Agri Supply Chain: Based in Uttar Pradesh, Gobasco employs real-time data analytics on data-streams coming from multiple sources across the country aided with AI-optimized automated pipelines to dramatically increase the efficiency of the current agri supply chain.

Potential applications of AI in coconut

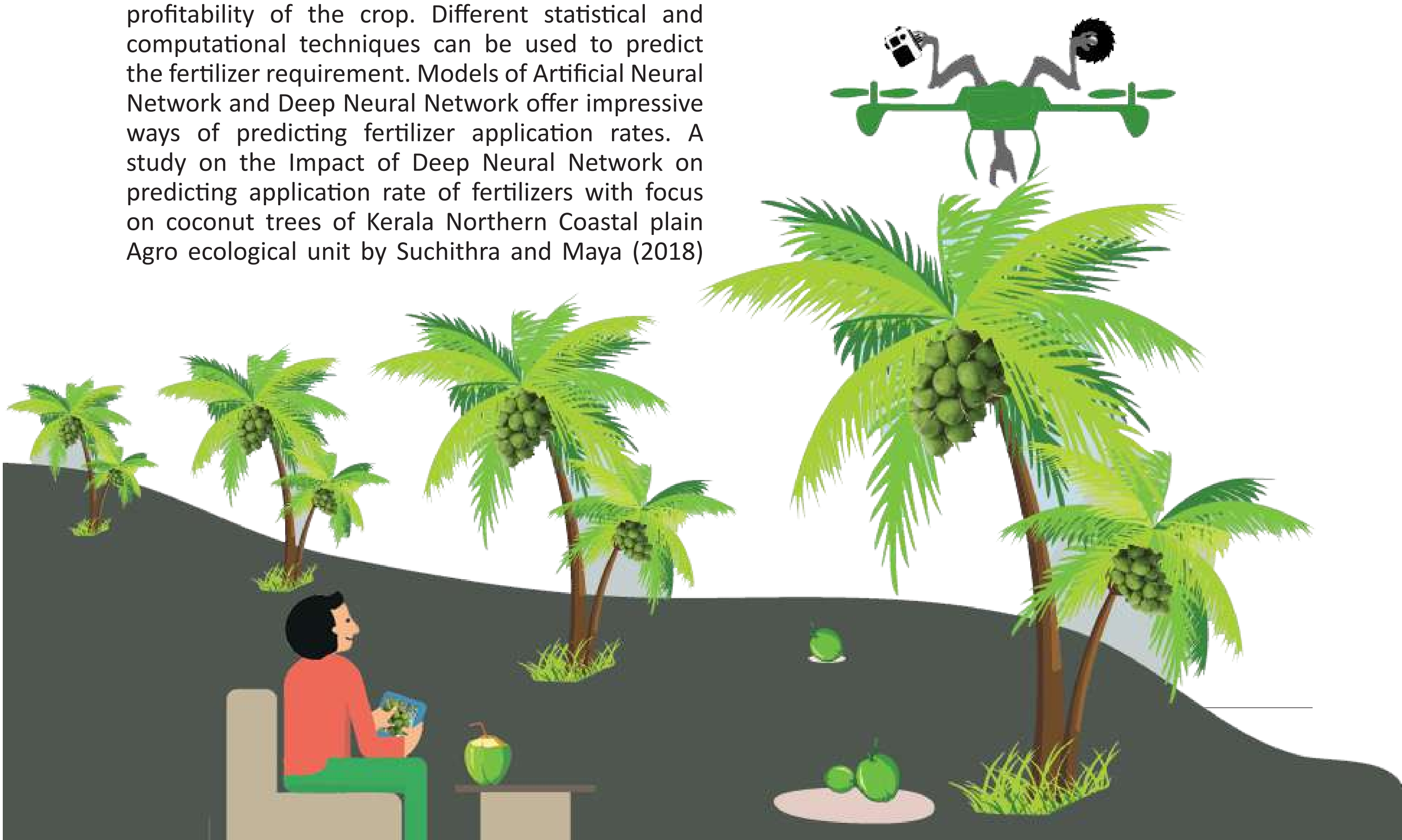
The applications of AI in agriculture discussed earlier are all applicable in coconut. Apart from that uses of AI in coconut processing industry and quality control have huge potential. A number of studies on use of AI in coconut have been undertaken, a few of which are enumerated below.

Fertilizer application in coconut : Timely application of fertilizers in adequate quantities is crucial in determining the productivity and profitability of the crop. Different statistical and computational techniques can be used to predict the fertilizer requirement. Models of Artificial Neural Network and Deep Neural Network offer impressive ways of predicting fertilizer application rates. A study on the Impact of Deep Neural Network on predicting application rate of fertilizers with focus on coconut trees of Kerala Northern Coastal plain Agro ecological unit by Suchithra and Maya (2018) has revealed that the predicted accuracy rate for fertlisers - Urea, Muriate of Potash and lime using Deep Neural network was more than 95% accurate in the coconut sector.

Automated harvesting of coconut through robots : Studies have been done on Colour and contour based identification of stem of coconut bunch in which it was shown by Rajesh et al (2017) that identification of coconut for harvest and cutting of the bunch could be achieved through completely automated robotics. Remote controlled robots have been developed to climb the palm and harvest coconuts.

Modelling of an industrial drying process through artificial neural networks : Assidji et al (2008) have found that the quality issues in grated coconut due to the poor control of product humidity could be solved through a neural network architecture. The rate of rejected products in the first cycle of drying could be reduced to 3%. Such applications could be undertaken in coconut processing in production of various value added products like desiccated coconut coconut milk powder etc.

Identifying adulteration in coconut oil : This is a serious issue in the marketing of coconut oil where high rate of adulteration with cheaper oils and even other chemical substances is undertaken. A study undertaken by Ordukaya and Karlik (2017)



in olive oil showed that adulteration test for quality control in olive oil could be successfully done using ML and electronic nose. Both methods were found to be faster and very cheaper than the classical chemical analysis techniques for identification and classification of quality control in different types of olive oils. The application of similar techniques could be undertaken in coconut oil.

Modeling and forecasting of production : Forecast of production would result in better marketing decisions. Modeling and forecasting of coconut production could be undertaken. Rathod et al (2018) had done modeling and forecasting of oilseed production through AI using Time Delay Neural network and Non Linear support vector regression.

Challenges in implementation of AI in agriculture: The major challenge in implementation of AI in agriculture is the lack of quality data infrastructure. Applications like Deep learning require analysis of lots of good quality data to train the different models. Reliable data is required for getting accurate outputs. Temporal data is hard to get. Most crop specific data can be obtained only once in a year and the data infrastructure takes time to mature, significant amount of time is required to build a robust machine learning model. Lack of familiarity with high tech machine learning solutions in farms is also a constraint. In addition to these, exposure of farming to external factors like weather conditions, soil conditions and presence of pests is quite lot. So what might look like a good solution while planning during the start of harvesting may not be optimal due to changes in external parameters. Exorbitant cost of different cognitive solutions for farming also make AI unaffordable. As far as drones are concerned, safety of operations, privacy issues and insurance coverage questions are paramount. Moreover, the push for more sophisticated sensors and cameras as well as research towards development of drones that require minimal training and are highly automated is yet to take off in a big way.

Pilot Project with the help of CPCRI.

It is in keeping with the spirit of these developments that the Coconut Development Board is planning to team up with the CPCRI for the project "Pest and disease surveillance on coconut palms by unmanned aerial vehicle". The objectives of the project as stated in the proposal include :

a) To develop an early detection system for surveillance of important diseases and pests of coconut palms using real time images captured through multi spectral / hyper spectral camera fitted to a UAV.

b) To determine the feasibility of real time spot delivery of biorationals / bioagents to the pest or disease affected palms.

Needless to say, its practical utility will include surveillance for pests and diseases in places where manual surveillance is difficult like valleys or remote islands. The net result will be that thousands of coconut trees can be saved which will otherwise succumb to lethal diseases like bud rot, ganoderma wilt or pests like rhinoceros beetle or red palm weevil.

Other technologies: AI is by no means the only way technology is revolutionizing agriculture. There are a host of other technologies too. Hydroponics, for instance, is a method of growing plants without soil, using mineral nutrient solutions in a water solvent. Sundrop, an Australia based company, has used this technology to put a sea water green house to grow vegetables anywhere in the world. 3D printing, also known as allied manufacturing, is now being applied in food production. Block chain, the distributed ledger technology behind Bitcoin, can be used to help fight food fraud. Nano technology has come in, driving a new revolution of precision agriculture. Nano encapsulated fertilizers today release nutrients in a slow sustained manner resulting in precise dosage to plants. Vertical Farming – the process of growing food in vertically stacked layers – is also catching up producing food in environments where suitable land is unavailable. The US based Aerofarms for instance is a pioneer in hi-tech, data – driven vertical farming and has shown that productivity can reach new heights hitherto unachieved. Netherlands too has witnessed an indoor growing boom thanks to technology with its green houses that occupy less than 1% of its farm land producing 35% of the country's vegetables. Per se, these technologies may not be applicable to the coconut sector. But technologies cannot be seen in isolation. Neither can a coconut sector be divorced from the agricultural sector viewed in a holistic perspective. For example, for finding coconut oil adulteration, a prototype can be developed for tracking and recording supply chain in block chain and checking its authenticity through a mobile application. The road ahead must be characterized by Right Place, Right Time and Right Product. The choice before the agricultural sector, its multifarious stakeholders and multilevel players is clear. ■

Towards establishing a molecular marker based accreditation laboratory for coconut hybrids

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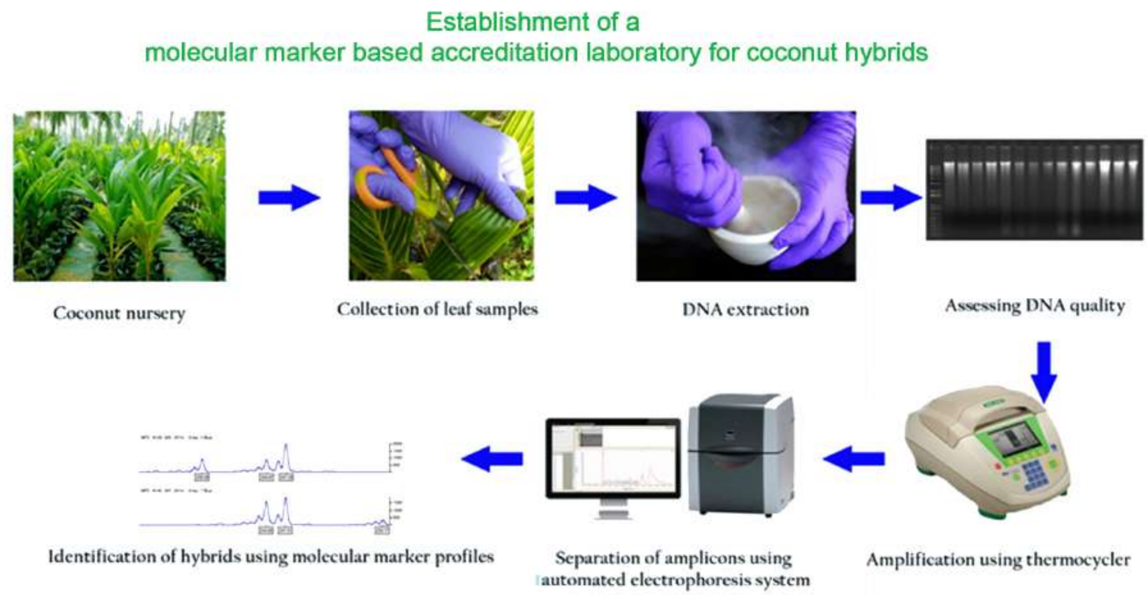
Seed market is becoming global and globalization is growing very fast. To compete favourably in this new global seed world, quality and cost are and will be certainly the key issues. High seed quality can only be obtained by a thorough control of the entire seed production process, step by step, from planning to final delivery. That requires science, technology, expertise, experience, good management and certainly, the most important, an absolute and unconditional commitment with quality. Seed testing for quality assurance is one important step in the process of production of high quality seed.

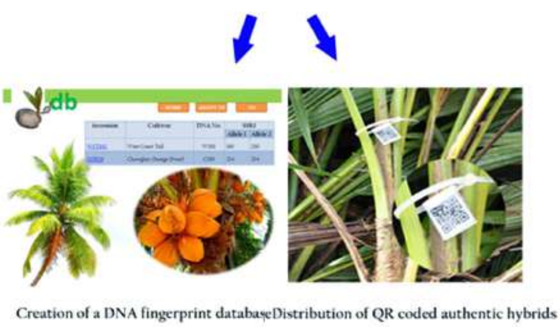
The increasing price for nuts, expanding markets for tender nut water, arrival of neera and other value added products have rekindled the interest in coconut, both among farmers and consumers. Farmers are turning to coconut cultivation for better returns, taking advantage of the situation. The changing scenario has been creating huge demand for coconut planting material, but has worsened the already strained environment of planting material production and distribution, opening avenues for unscrupulous elements to exploit the situation by pushing dubious seedlings. The situation warrants development of strategies to improve the availability of quality planting material and to develop a mechanism to check the quality of the material in distribution chain.

The development of hybrid varieties should be supported by the availability of high quality seeds. Genetic purity is one of the quality criteria required for successful seed production of hybrids. In producing hybrid seed nuts in coconut, it is frequently contaminated by crossed pollen from another variety or the occurrence of selfing. In a long duration crop like coconut, to assure the uniformity and stability of field performance and yield, it is necessary to examine the genetic purity of hybrid seedlings prior to distribution to farmers and other stakeholders.

The increasing price for nuts, expanding markets for tender nut water, arrival of neera and other value added products have rekindled the interest in coconut, both among farmers and consumers. Farmers are turning to coconut cultivation for better returns, taking advantage of the situation.

Presently, hybrid coconut seedlings are generally identified in the nursery stage based on morphological characters like early germination,





petiole colour, collar girth, number of leaves and early splitting of leaflets. Petiole colour is the most widely used marker to select hybrid seedlings in the nursery stage. In coconut many of the varieties and hybrids are phenotypically less distinct, making morphological evaluation more difficult. It is not possible to identify genuine hybrids if both the parents possess the same petiole colour. Hence, identification of molecular markers associated with hybridity will be the solution which will aid in selecting genuine hybrid seedlings in the nursery stage itself and will benefit farmers as they are assured of the performance of hybrid seedlings purchased.

To test the conformity of hybrid seedling, one must be able to distinguish the true hybrid resulting from cross between the male and female parents and one coming from self pollination of the female parent. The DNA finger printing of parental lines, hybrid and off-types can be used as a database to identify off-types in the nursery. Molecular markers have already been identified and utilized for authenticating coconut hybrids at ICAR-CPCRI (Rajesh *et al.*, 2012). Establishment of a 'hybrid testing laboratory' will, therefore, ensure strict seedling quality control and ensure distribution of genuine and quality seedlings to the farming community.

In order to fulfill the commitment to supply quality coconut seedlings to the farming community, ICAR-CPCRI has started distribution of QR (QR response) code tagged coconut seedlings (Thomas *et al.*, 2016). Scanning the QR code, affixed on the labels tagged on individual coconut seedlings, will enable the farmer to reach ICAR-CPCRI's website which will provide specific information about the characteristics of each seedling being distributed from ICAR-CPCRI. This QR coding is aimed to help the farmers to get only quality assured seedlings for planting in their field. This is more important at time when spurious seedlings are being sold by vendors who claim that they are distributors/dealers of ICAR-CPCRI's authentic coconut seedlings.

References: *1. Rajesh MK, Thomas RJ, Rijith J, Shareefa M and Jacob PM (2012) Genetic purity assessment of D x T hybrids in coconut with SSR markers. Indian J Gen Plant Breed 72(4):472–474*

2. Thomas RJ, Shareefa M and Krishnakumar V. (2016) QR coded labeled coconut seedlings. Kalpa CPCRI Newsletter 35 (2): 3.

Coconut + Cocoa+ Nutmeg

cropping system at the foot hills of Western Ghats - Success story

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Coconut is one of the important horticultural crops which has a significant bearing on the livelihood security of millions of small and marginal farmers of the country and particularly in Tamil Nadu wherein it contributes 21% of the national production. Coconut cultivation spreads over an area of 85,832 ha in Coimbatore and the 'coconut city' Pollachi contributes 25,225 ha. across 96 villages. The versatile crop, coconut frequently hits the headlines of mass media because of multitude of challenges viz., fluctuating price of copra, outbreak of devastating pests and diseases and large stock of senile palms etc. Compared to other leading coconut producers of the country, the average national productivity of coconut monocropping system is slowly declining over the years mainly because of the deteriorating soil condition of the gardens and practice of imbalanced fertilization.

A large portion of the area under coconut cultivation, representing over 20% of the available arable land may be used for increase the productive

capacity of existing cultivated land with either a single selected intercrop or several intercrops in a multi-storey cropping system, arranged based on a logical and practical manner. With coconut as the tallest crop in this Coconut Based Farming System(CBFS) practice, the selected intercrops are planned in the same piece of land considering the full heights and canopy expanse of each intercrop in achieving productivity and profitability during the long-term cropping period and hence coconut based intercropping system became the need of the hour.

In Pollachi area, there are many innovative farmers involved in scientific cultivation of the crop. One of the innovative progressive farmers, Mr. OVR Somasundaram of Odayakulam village, interestingly adopted the technical resources of coconut intercropping system after seeing the coconut based cropping system model from different coconut research centres across the world and particularly from Coconut Research Station, AICRP (Palms) centre, Aliyarnagar and coconut based

Hindi Fortnight 2018

The valedictory function of Hindi Fortnight 2018 of CDB was held on 16th October 2018 at Board's headquarters at Kochi. Dr.Raju Narayana Swami IAS, Chairman,CDB chaired the function and Shri. Kumar Pal Sharma, Deputy Director(Implementation), Regional Implementation Office, Kakkanad was the chief guest of the programme. Dr.Raju Narayana Swami IAS distributed cash prize and certificates to the winners of the Hindi Essay competition held for the students and Hindi teachers in Ernakulam District. Prizes were also distributed to the winners of the Hindi competitions conducted for the officers and staff of the Board and their children.

cropping system model at CPCRI, Kasaragod. He has planted coconut at a spacing of 29 feet (8.8m) to accommodate intercrops viz., cocoa and nutmeg. The moderate climatic conditions of the region, availability of water for irrigation throughout the year, annual rainfall of 1200 – 1300 mm in southwest and north east monsoons and humidity range of 70-85% favoured intercropping in coconut.

The farmer initially started intercropping venture with cocoa which fitted well in the coconut plantation without exacting an independent climate of its own. Cocoa cultivation, as an intercrop with coconut and arecanut seems to be expanding at a faster rate. The farmer witnessed an array of benefits due to cocoa intercropping viz., controlled weed growth, improved soil fertility status due to addition of leaf litter and an improved ecology of the farm due to the movement of pollinators and insects. The farmer also observed an invisible positive impact on palm yield. The additional income accrued from cocoa intercropping motivated Mr.OVR Somasundaram to venture other spice intercrops like nutmeg. Cocoa planted in intra-row spacing of coconut with spacing of 7.5m x 3m whereas, inter-row spacing utilized by nutmeg planting with 7.5m x 7.5m. His farm planting pattern is coconut- nutmeg in the ratio of 1:1 and coconut – cocoa in the ratio of 1:2. Each nutmeg is planted at the centre of four coconut palms. He followed the recommended cultivation practices in training, pruning, irrigation and nutrient management. He scrupulously applied biofertilizers and biocontrol agents to enrich soil microflora. To meet the nutrient demands of the crop, the farmer adopted fertigation technology with water soluble fertilizers. He opined that mulching helps in maintain the soil moisture as well as to protect the raising soil temperature during summer and equally to keep the soil temperature warm during winter.

Farmers who have practised intercropping of cocoa with coconut have seen their incomes double with net income of about Rs.3,75,000/- per hectare obtained per annum through coconut based intercropping system. The average nut yield from coconut was 150-200 Nuts/palm/year and 1-1.3kg of beans from per cocoa tree. The intercropping of nutmeg yielded 1000 fruits from 7th year onwards. He has realised that the per tree yield of coconut is far better than the monocropped garden, and hence the per unit area production also increased remarkably.

At present, many farmers are adopting the cocoa based intercropped system in this region. Thanks to the efforts taken by Mondelez India Foods Ltd., (formerly Cadbury India) towards the promotion and popularising of the system among the coconut farmers. Now there is assured inputs supply technology flow and buy back policy for the produce with assured income. ■

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Ecological Bio-engineering in Coconut Ecosystem to deter pests

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Plants, which constitute significant proportion of insects' natural environment, emit diverse volatile compounds that affect insect behavior. Plant volatiles usually vary depending on crop species. Even the same plant emits different volatile cues based on physiological stage of growth and circadian rhythm. Host plants may provide cues for food sources, habitats and ovipositional sites for phytophagous insects, which attack plants at times and also parasitize pests. With varying amount of volatiles produced by individual plants and taking into account the highly variable combination of plants in their natural habitat, even the dynamic olfactory environment of pests sometimes, gets perplexed. Therefore, the orientation behavior of insects in the selection of host plant has to be carefully orchestrated by the perception of specific signals.

The crop diversity in a plantation based cropping system is likely to emanate diverse volatile cues than a system of intensive mono-cropping, which is restricted to cultivation of one crop in a small piece of land over a long period of time. This concept of crop diversity in cropping system is emerging as the sustainable livelihood model auguring long-term ecological and economic benefits enabling farmers to double their income. The novel idea of 'An inch of Land with a Bunch of Crops' caters to this phenomenon ensuring ecological stability, continuous income and employment, effective organic biomass recycling, soil-buffering ability, minimizing crop loss through avoidance of pest and finally accelerating net farm income.

This paper presents a different dimension of coconut based cropping system in root (wilt) disease prone areas in South India as demonstrated at ICAR-CPCRI, Regional Station, Kayamkulam wherein crop diversity could deter pests in a pest dominant tract of Kerala.

> **The concept of crop diversity in cropping system is emerging as the sustainable livelihood model auguring long-term ecological and economic benefits enabling farmers to double their income.**

Homestead farming in Kerala

Kerala is the home for homestead farming wherein a farmer cultivates an array of crops including coconut for his household needs ensuring economic and nutritional sustainability. Solar radiation and nutritional requirements of all crops in this system are well taken care of and such a system had been a role model of farming in this part of the country. Farmers invariably visit their farms on all days mainly to harvest produce and the crops are systematically nourished.

With the passage of time, this homestead farming concept got diluted as the farmers started to plant more crops in the limited area available. This

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encouraged etiolation of all component crops which resulted in poor returns mainly due to low light entrapment and attracted more pests in the system. Most importantly, coconut palms in such homesteads were weak, distorted and harnessed minimum photo-energy for its survival. Many a times, big trees in the homesteads dominated and, interfered with the photosynthetic efficiency of component crops. Crop geometry concept failed and homestead farming became uneconomical and unviable. This is not because of the failure of homestead farming system per se, but can be attributed to improper execution of the concept due to negligence and ignorance by the present generation farmer.

Fig. 1 Agro-ecosystem based pest suppression through stimulo-deterrant approach

Coconut based crop-habitat diversification

Coconut palm, being an excellent ecosystem service provider, accommodates several component crops by its unique leaf architecture and rooting pattern. Besides, the palms attract a spectrum of pollinators during inflorescence blooming stage catering to the nectar and pollen requirement of these foraging insects. The perennial nature of the crop thus forms a wind shield along the coastal region braving the gusty wind. During the Ockhi cyclonic storm in November 2017, except coconut palms, most other trees such as rubber, jack, teak, jungle jack (or Anjili) were uprooted. Thus, coconut based multi-species cropping system is an ever successful model for regular crop yield and acted as a potential source for sustained income and employment generation. By fine-tuning this system, an ecological bio-engineering model is presented in coconut aimed at disorienting pests and making the system more robust, viable and ecologically feasible and sustainable.

Thirty-nine Kalpa Sankara coconut seedlings were planted at 7.5 x 7.5 m spacing during August 2012 so that, when the palms grow up, the fronds do not touch each other restricting the emanation of coconut volatiles. Kalpa Sankara is the first root (wilt) disease tolerant coconut hybrid (Chowghat Green Dwarf x West Coast Tall) released from ICAR-CPCRI recommended for root (wilt) disease affected tracts of South Kerala. In the central point of four palms, nutmeg (*Myristica fragrans*) was grown which is shade loving and their litter encouraged organic matter content of the sandy soil. Along the borders, rambutan (*Nephelium lappaceum*) was planted so that coconut palms friction out with rambutan and not with neighbouring palms. Nine different banana cultivars (*viz*., Matti, Chemmatti, Chingan, Charapoovan, Chengalikodan, Njalipoovan, Poongalli, Chenkadali and Robusta) were planted within the system for harnessing maximum sunlight and also for infusing diversity. Besides bunch yield, it produced enormous quantum of organic biomass for effective recycling in this system. In addition, the system housed, *Anona muricata* (lakshmanpal), *Anona squamosa* (seethapal), *Carica papaya* (papaya), *Artocarpus heterophyllus* (jack), *Mangifera indica* (mango) *Manihot esculenta* (cassava), *Curcuma longa* (turmeric), *Elettaria cardamomum* (small cardamom) and all seasonal crops including *Cajanus cajan* (red gram) and vegetables along the areas where sunlight was available. In this approach, coconut and some of the intercrops were planted either simultaneously or in a phased manner during a period of two-three years.

Coral vine/Mexican creeper (*Antogonon leptopus*), one honey bee colony, a bird perch and owl nests were also installed in the garden as part of biodiversity infusion strategy. The basic element achieved was that all the crops in the system were provided with sufficient light and coconut leaflets would have chances only to stroke against other intercrops, and not with adjacent coconut leaflets. Such a system emits volatile cues with less of coconut based odour in the experimental plot and attracted more of pollinators and other defenders in to the system. With the extensive presence of pollinators, scavengers and defenders in the system induced by crop plurality, key pests of coconut were substantially under check.

Pest incidence

The most ubiquitous coconut pests *viz*., rhinoceros beetle (*Oryctes rhinoceros*), red palm weevil (*Rhynchophorus ferrugineus*), eriophyid mite (*Aceria guererronis*) and the invasive rugose spiraling whitefly (*Aleurodicus rugioperculatus*) in the experimental ecological engineering plot were compared with mono-cropped coconut garden in Block VI during 2017 inside ICAR-CPCRI, Regional Station, Kayamkulam.

Pest incidence was comparatively low in the ecological engineering plot, whereas, two to three fold increase was observed in the mono cropped coconut (Table 1).

Table 1. Pest incidence in mono-cropped coconut garden and ecological engineering garden

Pests	Incidence (%)	
	Mono crop	Ecological engineering garden
Rhinoceros beetle	15.4	7.7
Red palm weevil	1.2	0.0
Rugose spiralling whitefly	71.8	20.5
Eriophyid mite	38.5	28.2

Susceptibility of palms to pests in mono-cropped garden could be due to excessive volatile cues of coconut favouring orientation of pests to the palms, which is otherwise diminished in ecological engineering plot due to admixture of volatile cues from coconut and also from adjacent intercrops. Furthermore, precocious bearing of palms in ecological engineering plot could be realized due to balanced fertilizer application including organic manures and chemical fertilizers (macro and micro nutrients) and need based care in terms of supplying water and plant protection chemicals. More than 85% Kalpa Sankara palms initiated flowering within a period of 18-24 months.

Nut yield

The yield of nuts from the coconut palms in the mono-cropped and ecological engineering plots is presented in Table 2.

Table 2. Nut yield of palms in mono-cropped and ecological engineering coconut garden

	Yield (nuts/palm) years after planting		
	IIIrd year	IVth year	Vth year
Mono-cropped garden	Nil	Nil	36
Ecological engineering garden	85	131	164

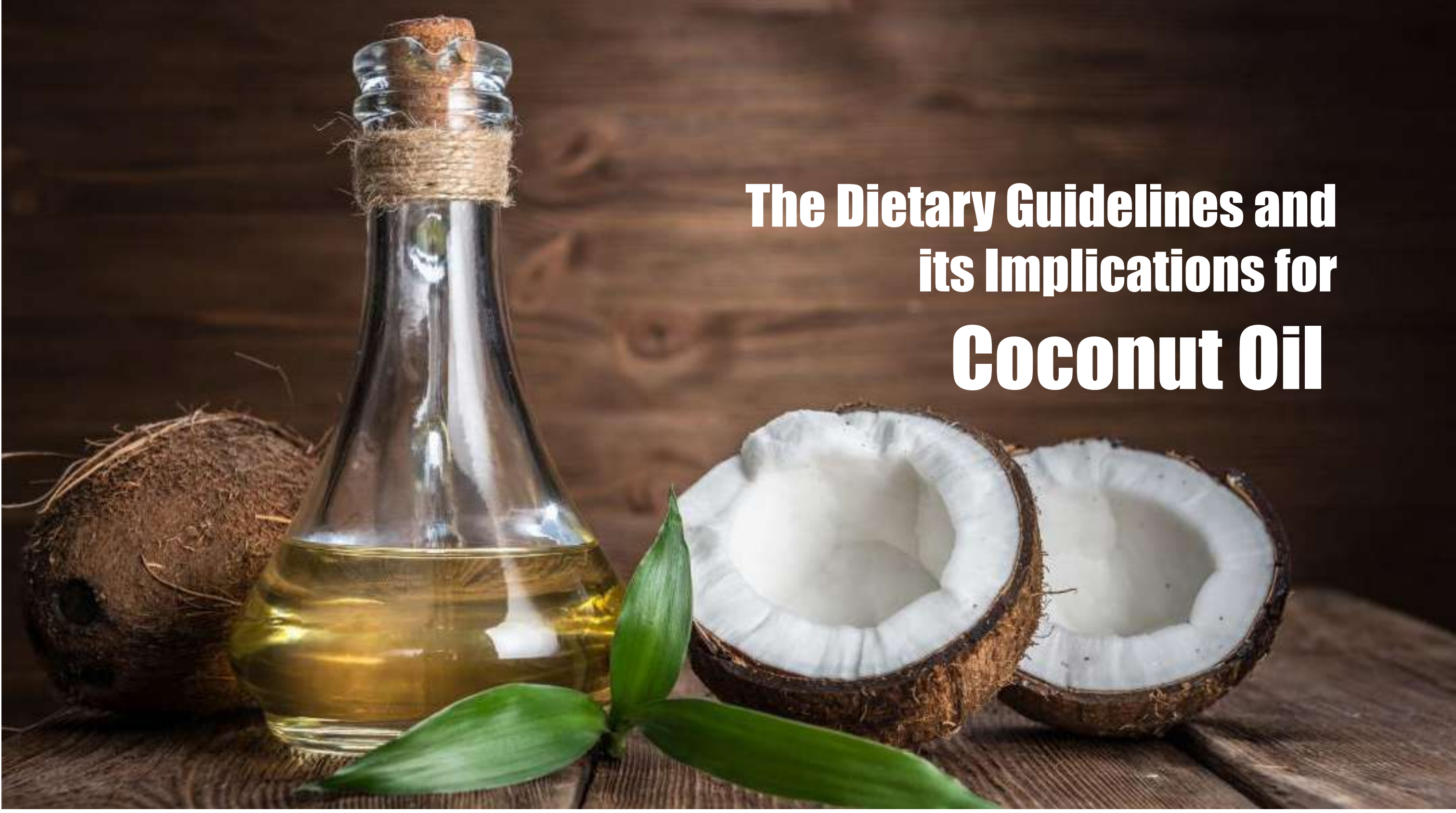
Nut yield could be realized from third year onwards in ecological engineering garden, whereas, it took five years for commencement of yield in mono-cropped garden and yield potential was also found to be very high in ecological engineering experiment. While a maximum of 164 nuts per palm per year could be realized in ecological engineering garden, it yielded only 36 nuts in other mono-cropped garden with less intense management. This module is presently showcased at ICAR-CPCRI's Regional Station, Kayamkulam.

Mixed species cropping is often perceived as a viable tool to increase on-farm crop diversity in organic agriculture and is a potentially important component of any sustainable cropping system. Apart from increasing total farm productivity, such a system can bring many important benefits such as improvement of soil fertility and suppression of pests and/or diseases. In this context, it can be seen as performing different eco-services in the farm system. The functional diversity contributes to ecological processes to promote the sustainability of the whole farm system. In a system with 149 pest species, the pest population was found lower in intercropped garden, dominated by monophagous (60%) and polyphagous (28%) species. The population of natural enemies of pests was higher in the intercrop system by 53%, whereas, it was lower by 9% in monocrop system (Altieri, 1999).

Conclusion

A holistic approach of crop care, nutrition, irrigation and intercropping is the need of the hour for inclusive development and doubling farmers' income. The yield is faster and higher in ecological engineering system and accumulation of organic wealth is quite profound. Sustainability mode and ecological viability is well realized in this concept of functional diversity coupled with generation of continuous income and employment making farming lucrative and as a security from eventualities. Such module needs better attention at policy level to augment income and maintain the ecosystem. Not only pests are reduced in the system, the spectrum of pollinators, scavengers and defenders dominate the niche making biotic system well balanced and also for sustaining the fragile ecosystem.

Reference: *Altieri, M.A. 1999. The ecological role of biodiversity in agro-ecosystems. Agricult. Ecosys. Environ 74(1-3): 19-31.*



The Dietary Guidelines and its Implications for Coconut Oil

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The dietary advice that is generally followed nationally and internationally closely follows the Dietary Guidelines for Americans which was first published in 1980 and which has been through eight editions. All of the editions of the Dietary Guidelines recommend a diet that is low in fat, and most editions recommend the replacement of saturated fat with polyunsaturated fat. This recommendation is based on the saturated fat-cholesterol-heart disease hypothesis that was first proposed by Ancel Keys in the 1950s. Coconut oil was labeled as unhealthy because of its high saturated fat composition. However, this label is unwarranted. Re-analysis of the work that Keys undertook reveals that he used some inappropriate assumptions that invalidate his hypothesis. Keys undertook a large controlled feeding study, called the Minnesota Coronary Survey (MCS), to prove his hypothesis but he did not publish the results of this work. A recent re-analysis of this work has shown that his results do not support his hypothesis. Further, historical documentary evidence has revealed the significant involvement of the American sugar industry in influencing dietary policy by blaming saturated fat for heart disease. Populations that have adhered to the low-saturated fat dietary recommendation have become significantly overweight and obese. In contrast, populations that continue to follow their traditional diet which includes coconut have not had high rates of obesity. The Keys hypothesis needs to be abandoned.

Introduction

In 1980, the U.S. Departments of Agriculture, and Health and Human Services published the first edition of the Dietary Guidelines for Americans to serve as the basis for U.S. federal food and nutrition education programs. Despite almost four decades and eight editions of the Dietary Guidelines, heart disease and obesity have remained major health concerns in the US. Cancer has crept up in the list of non-communicable diseases (NCI 2017) and Alzheimer's disease, which is still untreatable, is already exacting significant financial and social costs (Alzheimer's Association 2017). These non-communicable diseases have a dietary link. All editions of the Dietary Guidelines contain warnings against saturated fat, and all (except two editions) warn against coconut oil.

The objective of this article is to recount the history of the campaign against saturated fat in general and coconut oil in particular. It also seeks to discuss, given what is known about the science, whether these dietary recommendations were scientifically valid in the first place. This review will cover mainly the issues related to saturated fat and coconut oil and will only briefly include the issue of cholesterol where this is essential.

Coconut oil has the following approximate fatty acid composition (carbon number: %): caproic acid, C6: <1%; caprylic acid, C8: 7%; capric acid, C10: 7%; lauric acid, C12: 49%; myristic acid, C14: 18%; palmitic acid, C16: 8%; stearic acid: C18: 3%; oleic acid, C18:1: 8%; linoleic acid, C18:2 (ω-6): 2%; linolenic acid: C18:3 (ω-3): <1% (Codex Alimentarius 2015). Since C6, C8, C10, and C12 are classified as medium-chain fatty acids (MCFA) and C14, C16, and C18 are long-chain fatty acids (LCFA), the total proportion of MCFA is about 63% and LCFA is about 29%. Unsaturated fatty acids make up about 8%. Therefore, coconut oil is considered as a medium-chain saturated fat (Bach & Babayan 1982).

Ancel Keys and the Saturated Fat-Heart Disease Hypothesis

The campaign against saturated fat began with Ancel Keys, who was one of the most influential personalities in nutritional science during its foundational years from the 1950s to the 1980s. A very prolific researcher, he was able to develop wide scientific collaborations. His most influential paper was his 1986 "Seven Countries Study," an epidemiological study involving 15 cohort populations comprising 11,579 healthy men aged 40 to 59 years old in seven countries who were followed over 15 years (Keys *et al.* 1986). This was a pioneering multi-country, multi-year epidemiological study which had a great influence on nutritional science. In the said paper, he concluded that: "Death rates were related positively to average percentage of dietary energy from saturated fatty acids."

This paper capped a 35-year effort to link saturated fat, cholesterol and heart disease, an idea that Keys first mentioned in a conference paper that he delivered in South Africa (Keys 1955). Two years later, Keys formalized his saturated fat-heart disease hypothesis and advocated for a limit to be placed on saturated fat in the diet (Keys *et al.* 1957a). Briefly, this hypothesis claims that dietary saturated fats and cholesterol both raise serum cholesterol, and high serum cholesterol causes atherosclerosis that increases the risk of coronary heart disease (Figure 1). In effect, saturated fat and cholesterol were identified as major causes of heart disease.

However, a re-evaluation of Keys' work has exposed several mistakes that formed part of the basis for his hypothesis. Keys' early experiments on coconut oil used hydrogenated coconut oil (Keys et al. 1957a, 1957b). It had already been reported three years earlier that partially hydrogenated fat which produces trans-fat resulted in the formation of atheromas in rabbits (Kritshevsky *et al.* 1954). In 1957, it was reported that trans-fats had been found in the arteries of humans who consumed hydrogenated vegetable oils (Johnston 1957), and later research showed that trans-fats raise serum cholesterol (Mensink & Katan 1990; Matthan et al. 2000). Keys' use of hydrogenated coconut oil may explain his results and his consequent bias against coconut oil.

Yerushalmy & Hilleboe (1957), in an immediate critique of Keys' 1957 papers, wrote: "In the proposition considered in this paper – the suggested association between fat in the diet and heart disease mortality – the examination of all available basic data and the tests for specificity show that the association lacks validity. Consequently, the apparent association in itself cannot serve as supporting evidence for the theory that dietary fat plays a role in heart disease mortality." Keys quickly responded to this critique in an editorial writing that: "This is not a test to prove causality which is seldom accessible to critical test by epidemiology but simply a way to decide whether the hypothesis is consistent with the distribution of the disease." (Keys 1957c).

Keys acknowledged the importance of obtaining comprehensive information regarding the distribution of a disease (in this case, heart disease) and this may have been the motivation for his Seven Countries Study. This study collected data on diet and lifestyle, but the subjects were predominantly Caucasian and middle-aged males. The countries that were included were the following: Finland, Greece, Italy, Japan, Netherlands, USA, and Yugoslavia (Keys *et al.* 1986). The fats consumed in these countries would have been mainly animal fat, which are long-chain fats. None of these countries consume coconut oil as a major component of their diet.

As early as 1965, the metabolic differences among the saturated fatty acids were already known. In a paper entitled, "Quantitative effects of dietary fat on serum cholesterol in man," Hegsted and co-workers (1965) identified myristic acid (C14) and palmitic acid

(C16), both LCFA, as primarily responsible for serum cholesterol. Nevertheless, Keys' warning against all types of saturated fat, coconut oil included, remained.

The Dietary Guidelines for Americans, 1980 to 2015

First published in 1980, the Dietary Guidelines for Americans has gone through eight editions. All of them, without exception, include Keys' warning to limit the consumption of saturated fat, regardless of type. Beginning with the 1995 edition, an upper limit of 10% of calories was recommended for saturated fat. Avoidance of coconut oil is specifically mentioned in all, except the 1995 and 2005 editions. Two important comments should be made here. First, although the metabolic and physiological differences between MCFA and LCFA have been known since the 1950s (Bach & Babayan 1982), the guidelines do not acknowledge this difference and have consistently considered them as one group. Second, because one needs to maintain 30-35% of calories from fat in one's diet, the recommendation to keep saturated fat below 10% meant an increase in consumption of unsaturated fat.

- An analysis of the content of the 2015 edition of the Dietary Guidelines shows a bias of recommendations against saturated fat in favor of soybean oil (an omega-6 oil), with a weak warning against refined sugar, in particular high-fructose corn syrup (HFCS)
- The warning against saturated fat is mentioned at least 54 times, without distinguishing medium-chain from long-chain fat.
- In contrast, the warning on trans-fats, which have been known for over two decades to cause coronary heart disease (Kris-Etherton 2010), is mentioned only 11 times and hydrogenated oil only nine times;
- Soy products are mentioned 59 times as a beneficial food item, including seven times for soybean oil. There is no warning against consumption of an excess of omega-6 fats.
- High-fructose corn syrup (HFCS), which is a major driver of obesity in the US (Bray *et al.* 2004), is mentioned only twice.

So what has been the result of the Dietary Guidelines for Americans? In 2010, 30 years after the first edition of the Dietary Guidelines, the Americans were overweight (37%), obese (35%) and extremely obese (6%). Since the early 1960s, the prevalence of overweight, obese, and extremely obese rose from 48% to 78% in American adults (NIDDK 2012). It is noteworthy that there was a sharp increase in obesity beginning in 1980, the year the first Dietary Guidelines was published. Is this merely coincidental? Might there be a link between the advice being given by the Dietary Guidelines and this rise in the trend of overweight, obese, and extremely obese?

Americans in general have been obediently following the nutrition advice given in the Dietary Guidelines: since 1980, consumption of fats dropped from 45% to 34% while carbohydrate consumption increased from 39% to 51% of total caloric intake. The conclusion from the results is clear: adherence to recommendations to reduce fat and increase polyunsaturated fat consumption coincided with (or resulted in) a substantial increase in obesity (Cohen *et al*. 2015).

Soybean Oil and American Health

One constant warning of the Dietary Guidelines is to replace saturated fat with polyunsaturated fat. Soybean oil, a polyunsaturated fat, currently accounts for approximately 50% of vegetable oil consumption in the US, while coconut oil accounts for less than 3% (USDA 2014, Index Mundi 2016).

The saturated fat in the American diet comes mostly from meat and meat products, such as milk, cheese, and butter. Red meat accounts for 58% while fish accounts for only 10% of protein consumed in the US (Daniel *et al.* 2011). The large consumption of soybean oil (an omega-6 oil) and the relatively low consumption of fish (the major source of omega-3 oil) give an omega-6 to omega-3 ratio of about 15:1. Such a high omega-6 to omega-3 ratio has been associated with cardiovascular disease, cancer, and chronic inflammatory and autoimmune diseases. The ideal omega-6 to omega-3 ratio is about 4:1 (Simopoulos 2002, 2008, 2010).

A polyunsaturated fat (e.g., soybean oil) and a predominantly medium-chain saturated fat (e.g., coconut oil) would be expected to show different metabolic behaviors. Two studies comparing soybean oil and coconut oil show better health outcomes for coconut oil. A 12-week randomized, double-blind clinical trial involving 40 abdominally-obese (waist circumference, WC > 88 cm) women aged 20-40 years was conducted to determine how soybean oil and coconut oil would affect lipid parameters (HDL, LDL:HDL ratio, TC), WC, and BMI. The protocol also included 50 min of walking four days a week. Soybean oil caused an increase in TC and LDL, and a decrease in HDL resulting in an increased LDL:HDL ratio. Coconut oil in comparison gave higher HDL and a lower LDL:HDL ratio. Both oils showed reductions in BMI, but only coconut oil gave a reduction in WC. The study concluded that dietetic supplementation with coconut oil does not cause dyslipidemia and may promote a reduction in abdominal obesity (Assunção *et al. 2009).*

Another study entitled "Soybean oil is more obesogenic and diabetogenic than coconut oil and fructose in mouse: potential role for the liver" reveals why soybean oil is an unhealthy oil when it is a major part of the diet (Deol *et al.* 2015). This study showed that soybean oil caused a general dysregulation of the genes of a major liver enzyme, cytochrome P450. Other genes involved in obesity, diabetes, inflammation, mitochondrial function, and cancer were also upregulated by the soybean oil diet. This study provides a direct causal link between soybean oil and obesity, diabetes, inflammation, and possibly cancer. Coconut oil in comparison did not give such effects.

High Refined Sugar and High PUFA Cause Various Diseases

Carbohydrates make up part of a normal diet. However, industrially refined sugars, especially in high amounts may lead to diabetes, obesity and various inflammatory diseases. It is well known that hyperglycemia, or high blood glucose, increases the risk of diabetes. However, the other common sugar (fructose) may be as harmful as glucose, if not more so. In processed foods, especially in soft drinks and other beverages, fructose is commonly introduced as high-fructose corn syrup (HFCS) because it is cheaper and easier to process than regular sugar (sucrose). Goran and co-workers (2012) found that the prevalence of diabetes was 20% higher in countries where HFCS is readily available as compared to others where HFCS is not as available. Whereas glucose is removed from the bloodstream by insulin, fructose flows through the blood stream until it reaches the liver where it is converted into fat and increases the secretion of very low density lipoprotein (VLDL). Fructose also decreases glucose tolerance, and raises the levels of insulin (hyperinsulinemia) and uric acid (hyperuricemia) (Mayes 1993; Sun & Empie 2012). Fructose has been found to be much more susceptible to autoxidation than glucose or sucrose. This autoxidation is promoted by phosphate and generates free radicals that can in turn oxidize PUFA and LDL (Lawrence *et al.* 2008).

In addition, elevated levels of glucose and fructose in the blood stream are harmful because these compounds react chemically with proteins to form adducts called advanced glycation end-products (AGE) (de Vos *et al.* 2016). On the other hand, when polyunsaturated fatty acids (PUFA) are heated, they are oxidized and form degradation products, such as malondialdehyde, which also react with proteins to form AGE.

AGE-formation alters the structure of proteins which may prevent proteins from functioning properly. If the protein is an enzyme, the reactions that it promotes may be blocked; if the protein is a receptor, this may prevent important processes from occurring. AGE provides a causative link between high sugar and high polyunsaturated fatty acid (PUFA) oils in the diet to various metabolic diseases, such as diabetes (Goldin *et al.* 2006), cardiovascular disease (Hegab *et al.* 2012), and Alzheimer's disease (Ko *et al.* 2015).

Sugar Industry Tries to Hide the Truth, Blames Saturated Fat

Early warnings linking sucrose with coronary heart disease (CHD) began to emerge in the 1950s. John Yudkin, the founding professor of the Department of Nutrition, Queen Elizabeth College, University of London, was a contemporary of Ancel Keys who had a similar interest in determining whether diet had any influence on heart disease. However, Yudkin found the epidemiological link with sugar, not fat and claimed that: "There has never been any direct evidence for the hypothesis that fat consumption has anything to do with causing the disease; indeed, recent evidence points increasingly against it. For example, studies in East Africa have shown that cardiac ischaemia is rare both in the Samburu and in the Masai, who consume very large amounts of fat, almost all of it from meat and milk... On the other hand, there is now quite impressive evidence that a high intake of sugar (sucrose) may be an important factor in producing coronary disease. Firstly, epidemiological studies in which populations are compared show a rather better relationship of the incidence of the disease with sugar consumption than with fat consumption. Secondly, the increasing incidence of the disease that is found in many countries has followed an increasing consumption of sugar rather than of fat" (Yudkin 1965).

Keys (1971) was vigorous in his defense of sugar: "The widely publicized theory that sucrose in the diet is a major factor in the development of coronary heart disease has been examined. The theory is not supported by acceptable clinical, epidemiological, theoretical or experimental evidence."

Keys and other leading American nutritionists maintained their attack on saturated fat. In 1961, Keys co-authored a report of the American Heart Association with Harvard professor Frederick Stare which recommended "reasonable substitution of polyunsaturated for saturated fats as a possible means of preventing atherosclerosis and decreasing the risk of heart attacks and strokes" (Page *et al.* 1961).

In 1967, Stare, along with two other Harvard professors, Robert McGandy and Mark Hegsted, wrote two influential nutrition reviews that blamed saturated fats and cholesterol for heart disease concluding that "on the basis of epidemiologic, experimental and clinical evidence, that a lowering of the proportion of dietary saturated fatty acids, increasing the proportion of polyunsaturated acids and reducing the level of dietary cholesterol are the dietary changes most likely to be of benefit" (McGandy *et al.* 1967b). Intriguingly, they ended the review with this defense: "Since diets low in fat and high in sugar are rarely taken, we conclude that the practical significance of differences in dietary carbohydrate is minimal in comparison to those related to dietary fat and cholesterol." (McGandy *et al.* 1967b). This may have been true in 1967, but is no longer true today when the amount of sugar may be as high as 25 percent of calories.

Recently uncovered industry documents reveal that the attacks on saturated fat and the promotion of sugar were part of a concerted campaign that was funded by the Sugar Research Foundation (SRF). As early as 1954, the SRF had identified a strategic opportunity for the sugar industry to increase market share by promoting a low fat (high sugar) diet and in 1965, it started strategically funding research projects by influential individuals. In 1967, the SRF paid $6,500 for two key review papers by McGandy and colleagues (1967a, 1967b). This campaign continues to the present time with the promulgation of pro-sugar policies by various international agencies (Kearns *et al.* 2016). In all of these policies, the recommendations have been always the same: take a low-fat diet and replace saturated fat with polyunsaturated fat. This is a dietary battle that continues to this day.

The influence that the sugar industry wields over American and global nutrition policy can be partly traced to the experts whom the industry supported. Fredrick Stare was one of the most influential American nutritionists. He founded the Department of Nutrition at the Harvard School of Public Health (HSPH) in 1942 and served as Chairman until he retired in 1976, a period of 34 years. He was the founding editor of Nutrition Reviews, wrote an American nationally syndicated column for many years entitled "Food and Your Health," and published several popular books on nutrition. Stare was also a member of the scientific advisory committee of the SRF (Hegsted 2004; Kearns *et al.* 2016). Mark Hegsted, professor of nutrition at the HSPH, exercised strong influence on the US Food and Nutrition Board and the American Heart Association. He served on the editorial board of the most influential nutrition journals: Journal of Lipid Research, Nutrition Reviews, American Journal of Clinical Nutrition, and Journal of Nutrition and helped draft the first edition of Dietary Guidelines for Americans (Dwyer *et al.* 2010; Scrimshaw 2014). A significant part of American nutrition policy was shaped by Stare and Hegsted, and their students (Hegsted 2004; Dwyer 2010; Scrimshaw 2014).

Correlation is Not Proof

Epidemiological data, such as those obtained from the Seven Countries Study and its follow-up studies, provided correlations between a meat diet (which contains long-chain fat) and serum cholesterol. Serum cholesterol is then used as a surrogate indicator for heart disease. However, there are at least two correlations being applied, both of which do not provide unique proof for cause and effect. For example:

- Meat contains long-chain animal fat, but it contains many other components that are known to be harmful. If meat is fried in polyunsaturated oil, malondialdehyde and other degradation products may be produced which lead to the formation of AGE and free radicals (de Vos *et al.* 2016). The cholesterol present in the meat may oxidize and form oxidized cholesterol which has been shown to be harmful (Ng *et al*. 2008). Red meat has been found to produce trimethylamine (TMA) in the gut through the agency of gut microbiota. TMA in turn is converted into trimethylamine oxide (TMAO) in the liver and TMAO has been shown to cause atherosclerosis, which is linked to heart disease (Liu *et al.* 2015). Thus, the simple correlation between animal fat and heart disease does not prove causation and is not valid.

- Serum cholesterol itself is not a valid indicator of risk of heart disease. Interestingly, this is a result that Keys himself showed in his 1952 paper where he showed that there was a natural tendency in healthy men for cholesterol levels to increase with age. His own data showed that at age 20, healthy males have a serum cholesterol level of around 190 mg/dL, and this increases to over 260 mg/dL at age 70 (Keys 1952). However, he never referred to this work in his later studies. Later, Keys' failed MCS experiment showed that serum cholesterol levels do not predict heart disease.

Unfavorable Results were Withheld from Publication

Proof requires evidence of causality and Keys was aware of this. Since the Seven Countries Study was only an observational study, Keys wanted to do another study where he could carefully control the diet of the test subjects. In 1967, Keys and Ivan Frantz, Jr. undertook a project entitled "Effect of a Dietary Change on Human Cardiovascular Disease," also called the "Minnesota Coronary Survey" (MCS). This study was funded by the US National Heart, Lung and Blood Institute and was undertaken from 1968 to 1973. MCS was meant to be a landmark study because of its experimental design: the large number of subjects (n=9,423, male and female, age 20-97); the length of the feeding study (five years); the high level of dietary control; and the double-blind randomized protocol. MCS used residents in a nursing home and patients in six state mental hospitals in Minnesota. This enabled the study to carefully control and document the food that was actually consumed. The MCS study sought to apply the equation that Keys had first proposed in 1957 that correlated saturated fat with high serum cholesterol and then with heart disease (Keys *et al.* 1957a; Keys & Parlin 1966). Keys' fat diet-cholesterol-heart disease hypothesis had never been causally demonstrated in a randomized controlled trial and the MCS study was meant to prove this hypothesis. This study was conducted at the same time that Keys was coordinating the Seven Countries Study and would have provided powerful validation of the saturated fat-cholesterol-heart disease hypothesis.

Unfortunately, Keys himself did not publish the full results of this study and it remained hidden until Ramsden and co-workers (2016) obtained the raw data from this study over 40 years after it was conducted and subjected it to full analysis (O'Connor 2016). The analysis of MCS data was performed by Ramsden and co-workers (2016) and are summarized as follows:

- The group that consumed the high linoleic acid diet showed a significant reduction in serum cholesterol compared with those on the saturated fat group. However, there was no difference in mortality among the groups.
- There was a higher risk of death in subjects who showed reduction in serum cholesterol level (22% increase in risk for each 30 mg/dL reduction in serum cholesterol).
- The main conclusions were that a high linoleic acid diet effectively lowers serum cholesterol but this increases the risk of CHD.

A partial release of the results of MCS study was made in a 1989 paper in the journal Arteriosclerosis with Frantz as lead author. This paper made the modest conclusion that: "For the entire study population, no differences between the treatment (high linoleic acid group) and control (high saturated fat group) were observed for cardiovascular events, cardiovascular deaths, or total mortality." (Frantz *et al.* 1989).

The results of the MCS study did not give the expected results and directly contradicted the conclusions of the Seven Countries Study which Keys had published a few years earlier in 1986. Although Keys was a co-proponent of the MCS study, his name did not appear as a co-author in the Arteriosclerosis paper; he was not even mentioned in the Acknowledgment. This might also explain why it was published in a journal of more limited circulation which gave it less exposure. It is clear that a wider distribution of the results of the Arteriosclerosis paper, with Keys properly included as co-author, would have been fatal to the saturated fat-cholesterol-heart disease hypothesis.

Influence on WHO Policy

The World Health Organization has adopted the saturated fat-cholesterol-heart disease hypothesis. For example, the WHO Healthy Diet Fact sheet No. 394 reads: "For adults. A healthy diet contains… less than 30% of total energy intake from fats. Unsaturated fats (e.g. found in fish, avocado, nuts, sunflower, canola and olive oils) are preferable to saturated fats (e.g. found in fatty meat, butter, palm and coconut oil, cream, cheese, ghee and lard) …" (WHO 2015).

This WHO report was taken from a publication of the Food and Agriculture Organization, Fats and

Fatty Acids in Human Nutrition Report of an Expert Consultation.

"The Expert Consultation recognizes that grouping of fatty acids into these three broad groups (SFA, MUFA and PUFA) is based on chemical classifications, but it is clear that individual fatty acids within these groups have distinct biological properties. However, most of the epidemiological evidence reviewed by the experts uses broad groupings, which makes it difficult to distinguish and disentangle the effects of individual fatty acids.

"SFA refers to the major SFA in our diet, namely C14, C16, C18, except in the case of milk and coconut oil where SFA range from C4 to C18" (FAO 2008).

The experts ignored the distinction between medium-chain and long-chain fat. This distinction is central to the understanding of the health effects of coconut oil, which is made up of about 63% medium-chain fat. The failure to recognize this difference makes this document's conclusions regarding coconut oil incorrect.

The Role of Coconut in Traditional Healthy Diets

There is abundant evidence that people who abandon their traditional coconut diets in favor of the American diet have become overweight or obese. WHO (2003) reported that Pacific islanders "were 2.2 times more likely to be obese and 2.4 times more likely to be diabetic if they consumed fat from imported foods rather than from traditional fat sources. The most commonly consumed imported foods providing fats were identified as oil, margarine, butter, meat and chicken, tinned meat and tinned fish." Traditional fat sources in the Pacific islands are coconut, fish and pork.

A 1999 study among American Samoans showed that a shift to a modern diet increased their carbohydrate and protein consumption and decreased their overall fat, in particular, saturated fat. This shift was identified as the cause of their increased incidence of obesity and cardiovascular disease (Galanis *et al.* 1999).

Evidence from Polynesia and the Philippines show that there is no link between coconut oil consumption and cardiovascular disease. In the Polynesian islands of Pukapuka and Tokelau, Prior (1981) reported that: "Vascular disease is uncommon in both populations (Pukapuka and Tokelau) and there is no evidence of the high saturated fat intake having a harmful effect in these populations." Likewise, a population-wide study by Florentino & Aguinaldo (1987) in the Philippines showed that: "High coconut oil intake is not consistent with high CVD mortality rate." They then concluded that: "These observations do not seem to corroborate the contention that coconut oil as naturally ingested in the diet together with other fat sources increases the risk of CVD."

Conclusions and the Way Forward

Ancel Keys' landmark Seven Countries Study became the basis for the recommendation of the Dietary Guidelines for Americans to consume a low-fat diet and to replace saturated fat by unsaturated fat. This is currently being put to question. Further, Keys' study covered primarily animal fat which is mainly long-chain fat and is not applicable to a predominantly medium-chain fat, such as coconut oil. Therefore, the basis for Keys' inclusion of coconut oil is incorrect.

Historical documentary evidence of the significant influence of the American sugar industry and a detailed analysis of published and unpublished research on dietary fat show that the current dietary recommendations for a low-fat diet and replacement of saturated fat with polyunsaturated fat are wrong and heavily influenced. Populations that have followed these recommendations have become significantly overweight and obese. Coconut oil has been labeled as unhealthy because of its high saturated fat composition. However, populations that consume significant amounts of coconut do not have high rates of obesity and heart disease. The Keys saturated fat-cholesterol-heart disease hypothesis has been shown to be in error in numerous studies, and significantly, in a study which Keys himself did not publish. This hypothesis should be abandoned. ■

Source: http://coconutresearchcenter.org/hwnl_15-4.htm

World Coconut Day celebrated at Vanavarayar Institute of Agriculture

World Coconut Day celebrations was organised in Vanavarayar Institute of Agriculture, Pollachi on 2nd September 2018 Coconut Development Board, Regional Office, Chennai took part in the programme.

Shri.C.P. Radhakrishnan, Chairman, Coir Board, Kochi. In his presidential address informed that the coir export has risen to Rs.2535 crores now and hoped that this would rise up to Rs.20,000 crores in the near future. He requested the farmers to work hard to double their income by 2020.

Dr.C.Anantharamakrishnan, Director, IIFPT, Thanjavur in his special address spoke on the facilities offered by IIFPT and requested the farmers to make use of the facilities available to improve their income. Dr.M. Jawaharlal, Dean, Horticulture College and Research Institute, TNAU, Mr.R.A. Sakthivel, President, Consortium of Tamil Nadu CPCs, Smt.T. Bala Sudhahari, Deputy Director, CDB, RO, Chennai, Dr.S. Balakrishnan, Professor and Head, Spices and Aromatic Division, TNAU, Dr.K. Venkatesan, HOD, CRS, TNAU, Mr.S.S. Vaseekaran, Development Manager, NABARD, Coimbatore and Dr.K. Kumaravadivel, ICAR, KVK, Karamadai spoke during the ocassion. Smt. T. Bala Sudhahari, Deputy Director, CDB, RO, stressed on 'Coconut for Good Health, Wealth and Wellness' – the theme of World Coconut Day celebrations for the current year and spoke on the need for a change in coconut from oil based economy to other value added products based economy. Dr.N. Balusamy, Dean, Vanavarayar Agriculture College delivered the welcome address and Mr.P.K. Padmanaban, Chairman, Vinayaga CPC proposed vote of thanks.Around 500 farmers took part in the programme.

The programme was followed by a technical session wherein Dr.P. Subramanian, Smt.T. Bala Sudhahari, Dr.S. Balakrishnan, Professor and Head, Spices and Aromatic Plants and and Dr. Venkatesan, HOD, CRS, TNAU, Aliyar spoke on various coconut related topics.

Aahar – 2018 International Food & Hospitality Fair

Coconut Development Board participated in the 12th edition of AAHAR – 2018, International Food & Hospitality Fair held from 23rd to 25th August 2018 at Chennai Trade Centre. Board showcased the wealth and scope of Coconut and coconut based value added products to the participants / visitors of this International event. Shri Kumar Jayanth, IAS., Principal Secretary, Cooperation, Food & Consumer Protection Department, Government of Tamil Nadu inaugurated the programme.

Along with the Board, M/s. Vinayaga Coconut Producer Company, M/s. Pollachi Coconut Producer Company and M/s. Vadakara Coconut Producer company and coconut processing units viz. M/s. Sakthi Coco Products, M/s. VAMA Oil Private Limited and M/s. Shriram Coconut Products showcased various coconut value added products during the fair. The participated CPCs and TMOC assisted units got many reliable trade enquiries for their coconut based value added products viz., Coconut Palm Sugar, Tinned Neera, Virgin Coconut Oil etc.

World Coconut Day Celebrated at ICAR-AICRP on Palms – Coconut Centres

ICAR-AICRP on Palms celebrated World Coconut Day on the theme “Coconut for Good Health, Wealth and Wellness” at Coconut centres of AICRP on Palms, with various functions like interactive discussions among scientists and entrepreneurs, farmers, exhibition, distribution of seedlings, field visit etc. at Arsikere (Karnataka), Ambajipeta (Andhra Pradesh), Aliyarnagar and Veppankulam (Tamil Nadu), Kahikuchi (Assam), CCARI Old Goa, Ratnagiri (Maharashtra), Jagdalpur (Chhattisgarh), Sabour (Bihar), Port Blair (A & N Island), Navsari (Gujarath), Bhubaneswar (Odisha) and Mondouri (West Bengal). The Scientists working in state Agri./ Hort. Universities and ICAR institutes are involved in Technology transfer to coconut farmers in respective states.

Ambajipeta (Andhra Pradesh)

The World coconut day was celebrated on 2nd September 2018 as State programme by Coconut Development Board, State Centre, Vijayawada, Andhra Pradesh in association with Dr.YSR Horticultural University, AICRP on Palms, Horticultural Research Station, Ambajipeta and Department of Horticulture, Govt. of Andhra Pradesh and Chicof Coconut Producer Company, Ichapuram, Srikakulam Dist., at Ichapuram, Srikakulam Dist. World Coconut Day 2018 was also celebrated at Agricultural Market Committee organized by the Department of Horticulture and Krishivala Farmer Producers Company.

Arsikere (Karnataka)

Horticulture Research and Extension centre, Arsikere in collaboration with AICRP on palms, and CDB celebrated World coconut day on 3rd September 2018. Dr. N. Basavaraj, Director of Research, UHS, Bagalkot inaugurated the programme and Dr Vishnuvardan, Associate Director of Research, presided over

Aliyarnagar (T.N.)

The world coconut day was jointly organized by Tamil Nadu Agricultural University, Coconut Research Station, Aliyarnagar, Vanavarayar Institute of Agriculture, Coimbatore coconut producer company limited and Vinayaga coconut producer company on 2nd September 2018 at Vanavarayar Institute of Agriculture, Manakadavu, Pollachi, Coimbatore District.

Veppankulam (TN)

World Coconut Day was celebrated by organizing one day seminar on Coconut cultivation at Avanam village, Peravurani block, Thanjavur Dt. on 3rd September 2018. Dr. K. S.Vijay Selvaraj, Asst. Prof. (Hort) ,Th.V.Mathiyarasan, Asst. Director of Agriculture, Dr.A.Karthikeyan, Professor and Head and progressive farmers Thiru. Manickam Thevar and Th.Balasubramaniam spoke during the occasion. Dr. K. S. Vijay Selvaraj, Assistant Professor (Horticulture), Dr. A. Selvarani, Assistant Professor (Agronomy) and Dr. S. Thangeswari, Assistant Professor (Plant

Pathology) spoke on high yielding coconut varieties, mother palm selection criteria for raising their own nursery, integrated crop management and integrated pest and disease management in coconut. Farmers interacted with the scientists on various issues related to coconut cultivation, value addition and marketing.

ICAR-CCARI Old Goa

World Coconut day was celebrated by ICAR-CCARI, Old Goa with support from ICAR-AICRP on Palms-Goa centre and ICAR-KVK North Goa and coconut farmers and entrepreneurs. An exhibition of coconut varieties, climbing machine and coconut products were displayed at KVK North Goa during the training program on Virgin coconut oil during 30-31 August 2018. On 1st September 2018, an off campus training was organized at Mardol village Panchayat near Ponda to 15 coconut farmers. The program was chaired by Dr EB Chakurkar Director (A) ICAR-CCARI Old Goa. On 2nd Sep 2018, another off campus training was organized at Cotigao village, Canacona Taulk, South Goa. Dr V Arunachalam Principal Scientist (Horticulture) & In-charge ICAR-AICRP on Palms-Goa centre coordinated the activities and briefed the farmers and entrepreneurs during the four days of the event.

Bhatye, Ratnagiri (Maharashtra)

World Coconut Day programme was jointly organized by Regional Coconut Research Station, (AICRPP),Bhatye and ATMA, Ratnagiri. Dr. Shrirang Kadrekar, Ex- Vice Chancellor of Dr. BSKKV, Dapoli was the chief guest on the occasion and highlighted the research need of coconut sector which benefits the farming community. Shri. Sunil Chavhan, Hon'ble Collector, Ratnagiri, Shri. Rajabhau Limaye, former Vice Chairman, Coconut Development Board, Shri. Anil Joshi, President, Coconut Growers Association, Ratnagiri, Shri. Gurudatta Kale, Deputy Director, ATMA, Ratnagiri, Shri. Aarif Shaha, Agriculture Development Officer, Ratnagiri were present on the occasion.

Kahikuchi (Assam)

On the occasion of World Coconut Day on 2nd September, 2018, a day long programme was organized in the Farmers' Field at Sarpara village, Mirza under Kamrup district by All India Coordinated Research Project on Palms, Horticultural Research Station, Kahikuchi Guwahati. Dr. J.C. Nath, Principal Investigator of the All India Coordinated Research Project on Palms, highlighted the status, significance and prospects of coconut in the agrarian scenario of Assam. Dr. A.A. Ahmed, Principal Scientist of the station, stressed upon the industrial uses of coconut in the country as well as health benefit of tender coconut and neera in the region. In the training session, Dr. P. Bora (Sr. scientist), Dr. P. Pathak (Pr. Scientist) of HRS, Kahikuchi deliberated on the scientific production practices, post harvest management, plant protection and product diversification of coconut in order to make its cultivation more remunerative for the farming community. 115 farmers from various localities of Kamrup district actively participated in the programme.

Jagdalpur (Chhattisgarh)

The All India Coordinated Research Project on Palms, Jagdalpur and Coconut Development Board jointly organised and celebrated World Coconut Day on 2nd September 2018 on the theme "Coconut for Good health, wealth and wellness" at Swami Vivekanand Sabhagar, College of Agriculture, Raipur.

Mondouri (WB)

World Coconut Day was observed at AICRP on Palms, Mondouri centre BCKV, Kalyani on 2nd September 2018 at the HRS Mondouri. Prof D D Patra, Vice Chancellor, BCKV presided over the function. Prof. A B Sarangi, HOD, Spices & Plantation Crops, Prof. J Tarafdar, SIC, AICRP Tuber Crops, Prof. R Sadhukhan, SIC, AICRP Floriculture, Dr S Mitra, Director of Farms, Scientists and Staff attended the programme.

Navsari (Gujarath)

One day farmers training programme on "Production Technology of Coconut" was organized by All India Co-ordinated Research Project (Palms), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari on 2nd September 2018). The training programme was inaugurated by Dr. P. P. Bhalerao. Mr. G. B. Desai, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and Mr. Sashikantbhai Patel (farmer).

Sabour (Bihar)

"World Coconut Day Celebration –cum- Training programme" was organised by All India Coordinated Research Project on Palms (Coconut), BAC Sabour in collaboration with Bhola Paswan Shshstri Agricultural College, Purnia " on 11th September, 2018. About 77 farmers from three districts i.e Purnia, Katihar and Araria participated in the programme. Head & Sr.Scientist of KVK, Jalagarh, Dr. Seema Singh and KVK, Katihar, Dr. Nandiat participated in the programme. Dr. Paras Nath, Principal, BPSAC, Purnia, Dr. Ruby Rani, PI, AICRP on Palms (coconut), Dr. Suraj Praksh, Assst Professor (Horticulture), BPSAC, Purnia, and Dr. Paras Nath, Principal, BPSAC, Purnia spoke during the occasion.

Port Blair (Andaman and Nicobar Island)

An Entrepreneurship Development Programme on Coconut on the theme 'Wealth through Value Addition' was organized at ICAR-Central Island Agricultural Research Institute (CIARI), Port Blair in collaboration with ICAR- All India Coordinated Research Project (AICRP) on Palms, ICAR-Central Plantation Crops Research Institute (CPCRI), Kasaragod; Coconut Development Board (CDB), Kochi; National Horticultural Board (NHB), Gurugram; National Bank for Agriculture and Rural Development (NABARD) and Andaman & Nicobar Administration.

Bhubaneswar (Odisha)

AICRP on Palms, Bhubaneswar centre celebrated "World Coconut Day-2018" on 2nd September at KVK, Puri, Sakhigopal. Prof. R.K. Patra, the Dean of Research, O.U.A.T inaugurated the programme as the Chief Guest and addressed the gathering on the very purpose of celebrating the "World Coconut Day". Prof.T.K Mishra, Associate Director of Research (Seeds) and Prof. K.C. Barik, Senior Scientist, Dean of Research wing attended the function as guests and addressed the gathering on the importance of coconut.

Report prepared H. P. Maheswarappa, All India Coordinated Research Project on Palms, ICAR-Central Plantation Crops Research Institute, Kasaragod- 671 124

Coconut Plantations in Srikakulam severely hit by Titli cyclone

Titli, the cyclone that hit the coastal district of Srikakulam in Andhra Pradesh on 11th October 2018 caused severe damage to coconut and other field crops. The state has reported a damage for the horticultural crops to the tune of Rs 1000 crores due to the cyclone.

A team consisting of Shri. R. Jayanath, Deputy Director (i/c), CDB, Shri Johar Khan, Former Board Member,CDB and Chairman of Chicof CPC and its Directors and Shri Kiran Kumar, Field Officer, CDB visited cyclone affected areas.

Srikakulam district of Andhra Pradesh comprises of 38 mandals. Coconut is cultivated in 14,927 ha. in the district and is mainly grown in 9 mandals. As per the preliminary assessment of CDB , the cyclone has affected around 12000.ha of which Kaviti, Kanchili, Vajrapukothuru and Sompeta are severely affected which accounts for 9366 ha (63% of the total coconut area in the district). In Kavitti mandal, the damages to palms on account of uprooting varies from 4 to 45 % of the total palm population. The palms in Kanchili Mandal is more affected than in Kaviti. In the heavily affected Kuttuma village, the percentage of damage is in the range of 50-73% of the total palm population. In Sompeta Mandal, the damage to uprooted palms is also in the similar lines as of Kanchili. In general 26.42% of total palm population is uprooted and 18.68 % of the total palm population is severely affected. There is every possibility of shedding of more nuts due to damage to the existing bunches in the crown. Practically the farmers can't expect a good harvest from the remaining palms in the gardens for at least 6 months from now.

As per the final report of the Department of Horticulture around 4.5 lakh palms are damaged due to the cyclone and the estimated seedling requirement is around 4.5 lakh .

The team has observed that coconut palms were totally destroyed due to uprooting. Stems were broken and the crowns were twisted and broken. Young and adult palms were tilted and inflorescence, leaves,bunches were damaged. The uprooted palms as well as broken palms are completely lost beyond recovery. The adult palm with twisted crowns and broken fronds can be rejuvenated by adopting scientific management practices.

CDB has recommended that the uprooted and completely damaged coconut palms need to be disposed from the field to avoid any outbreak of pest and diseases in the area. The damaged crown portion and left out trunks in the gardens may provide a breeding ground for Rhinoceros beetle and Red palm weevil. Since the climbing and crown cleaning is cumbersome due to the already fallen trees/intercrops in the coconut gardens, there is an urgent need for providing the farmers with necessary equipments to clear the garden. The FPOs in this area can take initiatives in this regard.

A prophylactic spray with copper oxycloride/ Bordeaux mixture may be given to all the coconut gardens of the affected areas in order to avoid the secondary infection and spread of fungal diseases like bud rot, leaf rot etc. To prevent Rhinoceros beetle and Red palm weevil outbreak, all integrated pest management practices shall be adopted.

The continuous cyclones in these areas have resulted in the irregular canopy and layout in majority of the gardens. The under planting of existing gardens with quality seedlings need to be promoted and CDB may consider extending support to underplanting in these areas under the Area Expansion Programme as a special case. Farmers may be strictly advised to undertake planting of coconut seedlings in pits only. Since the soil in the region is sandy, the shallow planting of coconut may result in easy uprooting in the event of cyclones.

The demand for seedlings required for under planting/new planting during the next planting season is estimated around 4.5 lakh seedlings. Some more existing nurseries under Department of Horticulture can be strengthened under the Regional Coconut Nurseries programme. About one lakh seedlings will be available at DSP farm, Vegiwada during the next planting season.

Rejuvenation of the existing coconut gardens in the affected areas by adopting scientific management practices is feasible under CDB programme 'Replanting & Rejuvenation of Coconut Gardens' for which a total of Rs 53,500/- is extended as financial assistance per ha. for implementing the three components for a period of two years. All the aspects of development of garden in the affected areas can be accommodated under this scheme. The scheme has been commenced in the state during 2017-18. If the Department of Horticulture, Govt of AP submits suitable proposal for additional area under R &R for covering the areas affected by cyclone Titli, the same may be considered.

The implementation of Coconut Palm Insurance Scheme (CPIS) need to be strengthened in these areas since coastal regions in the state is prone to cyclones. The farmers may be motivated to take up planting of perennial trees in the border/boundaries of coconut gardens which may act as windbreaks at the time of cyclones. ■

Report prepared by R. Jayanath, Deputy Director, i/c, Coconut Development Board, State Centre, Andhra Pradesh

Cultural practices for coconut

November

Irrigation for seedlings

- Seedlings are to be given irrigation either through drip or basin method. If drip irrigation is adopted provide on an average 10 litres of water per seedling per day. Through other methods like basin irrigation 40 litres of water once in four days is sufficient.

Irrigation for adult palms

- Irrigation can be started in coconut gardens, except in localities which receive rain through north east monsoon. Even in localities where rainfall through north east monsoon is not received in adequate quantity (rainless period extending for more than 10 days) irrigation has to be provided to the palms.
- If basin irrigation method is adopted, provide irrigation once in four days @ 200 litres per palm.
- Drip irrigation is the ideal method of irrigation for coconut. Small pits of 1'x 1' 1' size should be taken 1 m away from the tree trunk at four equidistant points within the basin. The pits are to be filled with coir pith. The drippers/microtubes are to be placed sub surface in these pits through a polythene conduit pipe. The number of dripping points should be six for sandy soils and four for other soil types. 30-45 litres of water per palm per day is to be provided through drip irrigation system.

Drainage

- Ensure adequate drainage facilities in coconut gardens in localities which receive rain through north east monsoon. Depending up on the soil type and water table drainage channels of appropriate size, minimum of 50 cm depth and width, can be taken either manually or mechanically. Drainage channels are to be constructed for every two rows of palms.

Manuring

- Drip fertigation may be started for coconut palms. Water soluble fertilizers like urea and Muriate of potash can be given along with drip irrigation system. For the coconut palms, these fertilizers as per the general recommendation (50% of the recommended dose ie 545 g urea and 1000 g of Muriate of potash per palm per year) can be given in equal splits through monthly fertigation schedule. However, quantity of chemical fertilizers is to be worked out based on soil test results and yield targeted.
- Wherever Boron deficiency is noticed 100 g Borax may be applied in the basin.
- For coconut palms showing yellowing of leaves due to Magnesium deficiency, 0.5 kg of magnesium sulphate can be applied in the basins.

Green manuring

- In regions benefitted by north east monsoon like Tamil Nadu, the green manure plants can be ploughed back in to the interspace of coconut garden if the plants have attained 50 percent flowering. Similarly, green manure plants grown in the coconut basins also can be incorporated into the soil.

Mother palm selection

- Select mother palms for seed nut collection to raise quality planting material.
- In tall varieties, seed nuts should be collected

from mother palms which should have attained an age of 20 years, yielding constantly more than 80 and 120 nuts per palm per year for rain fed and irrigated conditions respectively with nut weight more than 600 g and copra weight of 150 g and above. Further, the palm should have a minimum of 30 leaves and free of any disease. The trees should have short and strong petioles with wide leaf base firmly attached to the stem. The bunch stalk should be short, stout, strong and should not show any tendency to droop down or buckle. Palms which produce barren nuts or those shedding large number of immature nuts should be discarded. Very old age palms i.e., above 60 years may be avoided and growing in very favourable conditions e.g. trees near manure pits are to be avoided. Palms showing alternate bearing tendency also should be avoided. In dwarf varieties seed nuts can be collected from mother palms which have attained an age of 12 years or more and yielding more than 60 and 100 nuts per year for rain fed and irrigated condition, respectively. Further it should have a minimum of 30 leaves with nut weight more than 400 g.

Nursery management

- Weeding should be done in the nursery.
- Five month old ungerminated nuts and dead sprouts should be removed from the nursery.
- Mulching with coconut leaves or dried grass or live mulch by raising green manure crops can be done in the nursery
- Provide irrigation
- Need based plant protection measures against pests and diseases are to be undertaken. Soil drenching of chlorpyriphos @ 2ml/litre is to be done in the nursery, if termite infestation is observed. Spraying of water on the leaves can be done against white fly infestation in the coconut nursery.

Mulching

- Mulching of palm basins can be undertaken if not done earlier. Fallen dried coconut leaves available in the coconut garden can be used for mulching. In the non traditional areas like Bihar, Madhya Pradesh, Chhattisgarh and North Eastern states, ensure thick mulching in the basin to regulate soil temperature. Irrigation can be started to negate the effect of low temperature in such areas.

Plant protection

Currently, a drastic shift in pest damage level on coconut is being experienced in the event of unprecedented weather vagaries. Gradient outbreak of the invasive rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) in Peninsular and North-East India, black headed caterpillar (*Opisina arenosella* Walker) in Karnataka and slug caterpillar (*Darna nararia* Moore) in Andhra Pradesh and Karnataka are classical examples to support this phenomenon. Rhinoceros beetle (*Oryctes rhinoceros* Linn.) and red palm weevil (*Rhynchophorus ferrugineus* Olivier) are cosmopolitan pests recorded predominantly in monsoon and post-monsoon periods in Peninsular India. The most unnoticed and a serious sucking pest observed during North-East monsoon phase is the attack by coreid bug (*Paradasynus rostratus* Distant). At least 2-3 bunches would be affected with complete button shedding leading to barren bunches. Incidence of bud rot disease, nut fall, leaf rot, stem bleeding and Basal Stem Rot/*Ganoderma* wilt also cause damage to coconut. Under the changing weather conditions systematic monitoring is very crucial to suppress outbreaks of pests and diseases in coconut. Regular observation and monitoring should be done in the coconut garden to identify incidence of pests and diseases and need based and appropriate plant protection measures are to be adopted to avoid crop loss. Recommendations for the management of pests and diseases in coconut for the month of November are furnished below.

Integrated Pest Management

Rhinoceros beetle

- Adopt mechanical method of control by extracting beetles with beetle hooks, without causing further injury to the growing point of the palm
- The top most leaf axils may be filled with powdered neem cake/marotti cake (*Hydrocarpus sp/* pongamia) @ 250 g + fine sand (250g) per palm as a prophylactic measure
- Filling the innermost three leaf axils with 4 g each of naphthalene balls covered with sand (12 g/ palm) for juvenile palms
- Placement of two perforated sachets containing chlorantraniliprole a.i. 0.4% (5 g) or fipronil (3 g) or one botanical cake (2 g) developed by ICAR-CPCRI
- Incorporation of the biomass of weed plant *Clerodendron infortunatum* Linn. in the cow dung/ compost pit
- The breeding sites may be treated with green muscardine fungus (*Metarhizium anisopliae*)

Red Palm Weevil

- Avoid causing injury to the palms, as they would attract the weevil to lay eggs. Mechanical injury if any, caused should be treated with coal tar
- While cutting fronds, petiole to a length of 120 cm is to be left on the trunk to prevent the entry of weevils into the trunk
- Removal and burning of palm at advanced stage of infestation would aid in destruction of various stages of the pest harboured in the trunk
- Prophylactic leaf axil filling suggested for rhinoceros beetle is very essential as this pest pave way for red palm weevil
- If damage occurs in the crown, the damaged tissue has to be removed and insecticide suspension, imidacloprid (0.02%) @1 ml/L of water may be poured in. In case of entry of weevil through the trunk, the hole in trunk may be plugged with cement/tar and the top most hole is made slanting with the aid of an auger and the insecticide solution is poured through this hole with funnel

Leaf eating caterpillar

- Cutting and burning the heavily infested and dried outer most 2 - 3 leaves helps to prevent the spread of the pest.
- Improving soil and infested palm health through balanced dose of chemical fertilizers and organic manures.
- Since a very rich natural enemy fauna is associated with the pest in the field, chemicals are generally not encouraged for management of *O. arenosella.* As this pest is subject to parasitism by a good number of indigenous larval and pupal parasitoids, biological suppression is a feasible and viable approach. Augmentative release of stagespecific parasitoids viz., the larval parasitoids *Goniozus nephantidis* (Bethylidae) @ 20 parasitoids/palm, *Bracon brevicornis* (Braconidae) @ 20 parasitoids/ palm, the prepupal parasitoid, *Elasmus nephantidis* (Elasmidae) @49/100 pre-pupae, and the pupal parasitoid *Brachymeria nosatoi* (Chalcididae) @32/100 pupae at the appropriate time was found effective in the sustainable management of the pest. Combined release of the parasitoids is required in multi-stage prevalence of the pest in the field. Conditioning of parasitoids on larval frass before release enhanced the field level parasitism.

Eriophyid mite

- Spraying on the terminal five pollinated coconut bunches with neem oil garlic soap mixture @ 2 per cent concentration (neem oil 200 ml, soap 50 g and garlic 200 g mixed in 10 litres of water)
- or spraying neem formulations containing 1 per cent azadirachtin @ 4 ml per litre of water
- or spraying palm oil (200 ml) and sulphur (5g) emulsion in 800 ml of water
- Root feeding azadirachtin 10,000ppm @ 10 ml + 10 ml water is also effective
- Along with the recommended dose of manures and fertilizers, 5 kg neem cake should be applied

Coreid bug

- Spraying of neem oil-soap emulsion (0.5%) on the pollinated bunches. The emulsion can be prepared by adding 5 ml neem oil and 8 g bar soap in one litre water.

Rugose Spiralling Whitefly

- No chemical insecticide should be sprayed on leaves
- Application of 1% starch solution on leaflets to flake out the sooty moulds.
- In severe case, spray neem oil 0.5% and no insecticide is recommended.
- Installation of yellow sticky traps on the palm trunk to trap adult whiteflies.
- Encourage build up of parasitoids (*Encarsia guadeloupae*) and re-introduce parasitized pupae to emerging zones of whitefly outbreak.
- *In situ* habitat conservation of the sooty mould scavenger beetle, *Leiochrinus. nilgirianus.*

Integrated Disease Management

Bud rot

- Remove the infected tissues of the spindle completely. Two or three healthy leaves adjacent to the spindle may have to be removed, if necessary, for easy removal of all rotten portions and thorough cleaning. After removing the affected tissues apply 10% Bordeaux paste and cover the wound with a polythene sheet to prevent entry of rain water. The protective covering has to be retained till normal shoot emerges.
- Destroy the infected tissues removed by burning or deep burying in the soil
- Spray 1% Bordeaux mixture to the surrounding palms

Stem bleeding

- Avoid burning of trashes near the tree trunk
- Avoid injury to the tree trunk
- The affected tissues should be completely removed using a chisel and smear the wound with 5% hexaconazole (5 ml in 100 ml of water) and drench the basins @ 25 lit. of 0.1% solution
- Smearing paste of talc based formulation of *Trichoderma harzianum* on the bleeding patches on the stem (The paste can be prepared by adding 50 g of *Trichoderma* formulation in 25 ml of water)
- Soil application of *Trichoderma harzianum* enriched neem cake @ 5kg per palm and adopt recommended irrigation/moisture conservation practices.

Leaf rot

- Remove rotten portion of the spindle leaf and 2-3 successive leaves and pour fungicide solution containing 2 ml hexaconazole 5 EC in 300 ml water/ palm or talc based formulation of *Pseudomonas fluorescens* or *Bacillus subtilis* @ 50 g in 500 ml water/palm into the well around the base of the spindle leaf
- Undertake prophylactic measures to prevent rhinoceros beetle attack

Basal Stem Rot/Ganoderma wilt

- Removal of dead palms, palms in advanced stages of the disease and destruction of the bole and root bits of these palms
- Isolation of diseased palms from healthy palms by digging isolation trenches of 2 feet depth and one feet width around the basin
- Avoiding flood irrigation or ploughing in infected gardens to prevent spread of the inoculum.
- Addition of 50 kg of farmyard manure or green leaves per palm per year.
- Application of *Trichoderma harzianum* enriched neem cake@ 5 kg per palm and irrigating the palm once in 4 days and mulching around the basin
- Raising banana as intercrop wherever irrigation is possible
- Root feeding of hexaconazole @ 2% (100 ml solution per palm) or soil drenching with 0.2% hexaconazole / 1 % Bordeaux mixture @ 40 litre solution per palm. ■

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Market review – September 2018

Domestic price

Coconut Oil

During September 2018 the price of coconut oil opened at Rs.17800 per quintal at Kochi and Alappuzha market and Rs.18700 per quintal at Kozhikode market. During the month, price of coconut oil at all three markets expressed an overall downward trend.

The price of coconut oil closed at Rs.15900 per quintal at Kochi and Alappuzha market and Rs.16300 per quintal at Kozhikode market with a net loss of Rs.1900 per quintal at Kochi and Alappuzha market and Rs.2400 per quintal at Kozhikode market.

The price of coconut oil at Kangayam market in Tamilnadu, which opened at Rs.15000 per quintal, expressed a mixed trend and closed at Rs.13667 per quintal with a net loss of Rs.1333 per quintal.

Weekly price of coconut oil at major markets Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
01.09.2018	17800	17800	18700	15000
09.09.2018	17000	17100	18300	14667
16.09.2018	15700	16000	17000	13333
23.09.2018	15700	15700	16400	13733
30.09.2018	15900	15900	16300	13667

Milling copra

During the month, the price of milling copra opened at Rs.11500 per quintal at Kochi, Rs.11450 per quintal at Alappuzha market and Rs.11550 per quintal at Kozhikode market. During the month, price of milling copra at all three markets expressed an overall downward trend.

The prices closed at Rs.10200 at Kochi market, Rs.10100 at Alappuzha and Kozhikode markets with a net loss of Rs.1350 per quintal at Kochi and Alappuzha market and Rs.1450 per quintal at Kozhikode market.

At Kangayam market in Tamilnadu, the prices opened at Rs. 10400 per quintal and closed at Rs.9300 per quintal with a net loss of Rs.1100 per quintal.

Weekly price of Milling Copra at major markets (Rs/Quintal)				
	Kochi	Alappuzha (Rasi Copra)	Kozhikode	Kan-gayam
01.09.2018	11550	11450	11550	10400
09.09.2018	11150	11000	11050	9800
16.09.2018	10200	10300	10200	9000
23.09.2018	10100	10050	10100	9250
30.09.2018	10200	10100	10100	9300

Edible copra

The price of Rajapur copra at Kozhikode market which opened at Rs. 19500 per quintal expressed a fluctuating trend during the month and closed at Rs.19000 per quintal.

Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
01.09.2018	19500
09.09.2018	18800
16.09.2018	18500
23.09.2018	19000
30.09.2018	19000

Ball copra

The price of ball copra at Tiptur market which opened at Rs.16100 per quintal expressed a mixed trend during the month and closed at Rs.16250 per quintal with a net gain of Rs.150 per quintal.

Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal)	
	Tiptur
01.09.2018	16100
09.09.2018	16000
16.09.2018	16500
23.09.2018	16000
30.09.2018	16250

Dry coconut

At Kozhikode market, the price of dry coconut which opened at Rs.9960 per quintal expressed a declining trend during the month and closed at Rs.9450 per quintal.

Weekly price of Dry Coconut at Kozhikode market (Rs/Quintal)	
01.09.2018	9960
09.09.2018	9750
16.09.2018	9650
23.09.2018	9550
30.09.2018	9450

Coconut

At Nedumangad market the price of partially dehusked coconut opened at Rs.17000 per thousand nuts and ruled at the same price throughout the month. At Pollachi market in Tamil Nadu, the price of coconut opened at Rs.13000 per thousand nuts and closed at Rs.12000 per thousand nuts. At Bangalore APMC, the price of partially dehusked coconut opened at Rs. 25000 and ruled at same price throughout the month. At Mangalore APMC market the price of partially dehusked coconut of grade-I quality opened at Rs.24000 per thousand nuts and closed at Rs.20000 per thousand nuts.

Weekly price of coconut at major markets (Rs /1000 coconuts)				
	Neduman-gad	Pollachi	Banglore	Mangalore (Grade-1)
01.09.2018	17000	13000	25000	24000
09.09.2018	17000	12000	25000	24000
16.09.2018	17000	12000	25000	20000
23.09.2018	17000	12000	25000	20000
30.09.2018	17000	12000	25000	20000

International price

Coconut oil

The international price of coconut oil and domestic price of coconut oil in Philippines, Indonesia and India expressed an overall downward trend during the period. The price of coconut oil quoted at different international/ domestic markets is given below.

Weekly price of coconut oil in major coconut oil producing countries				
	International Price(US$/MT)	Domestic Price(US$/MT)		
	Philippines/ Indonesia (CIF Europe)	Philippines	Indonesia	India*
01.09.2018	935	880	885	2081
08.09.2018	910	876	882	2034
15.09.2018	910	860	857	1849
22.09.2018	891	845	840	1905
29.09.2018	881	835	835	1896
				* Kangayam

Copra

The domestic price of copra at Srilanka and Indonesia expressed a downward trend during the month whereas price of copra in India and international price of copra expressed a mixed trend. The price of copra quoted at different domestic markets is given below.

Weekly International price of copra in major copra producing countries				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
01.09.2018	566	462	1214	1443
08.09.2018	568	458	1210	1359
15.09.2018	537	460	1210	1248
22.09.2018	532	452	1108	1283
29.09.2018	521	456	1088	1290
				* Kangayam

Coconut

The price of coconut quoted at different domestic markets in Philippines, Indonesia, Srilanka and India are given below.

Weekly price of dehusked coconut with water				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
01.09.2018	123	136	223	409
08.09.2018	123	135	247	388
15.09.2018	122	135	237	374
22.09.2018	122	135	219	374
29.09.2018	122	134	206	381
				*Pollachi market