Department of Agriculture Development & Farmers' Welfare
Farm Information Bureau

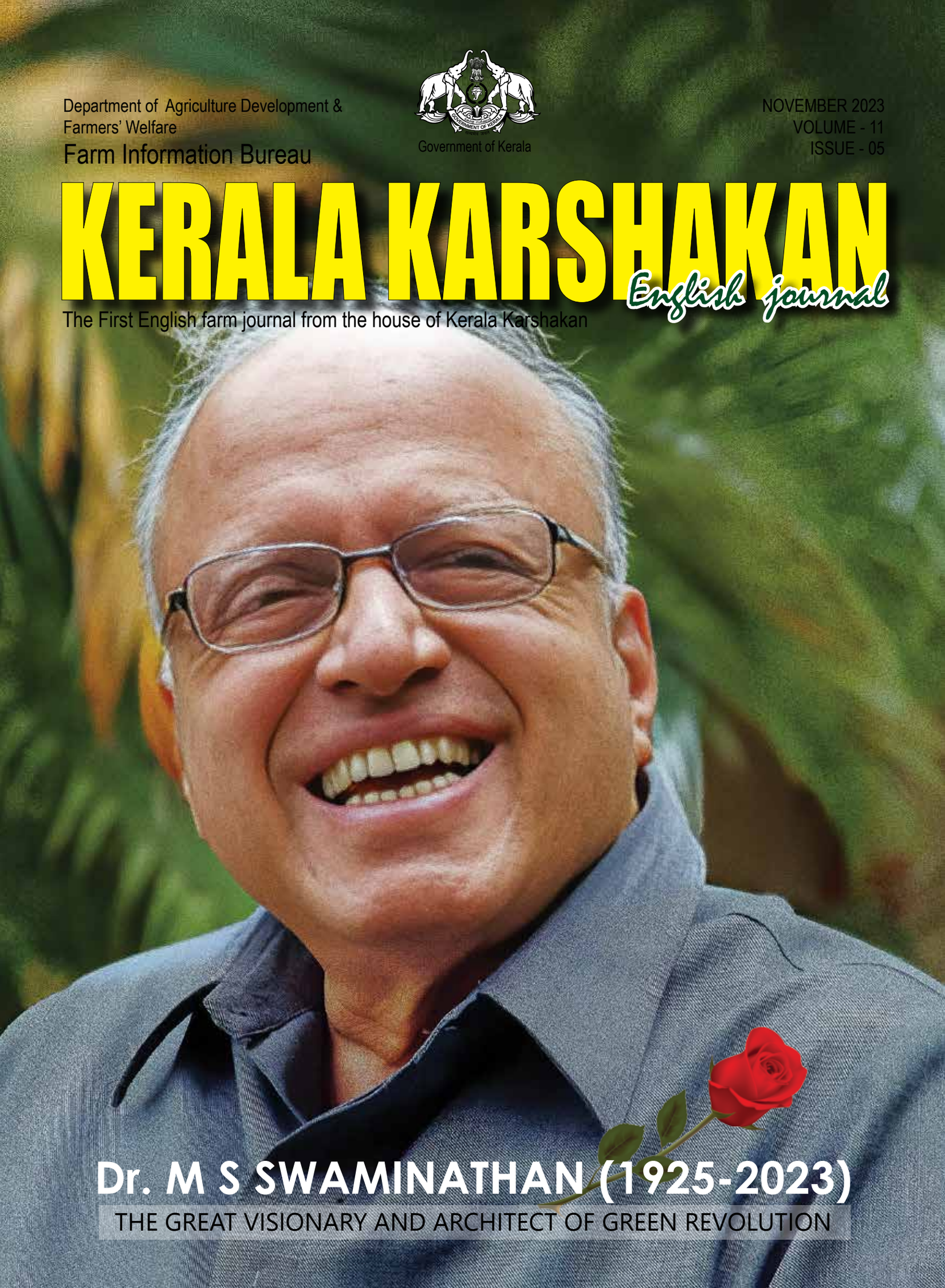
Government of Kerala

NOVEMBER 2023
VOLUME - 11
ISSUE - 05

KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan



Dr. M S SWAMINATHAN (1925-2023)

THE GREAT VISIONARY AND ARCHITECT OF GREEN REVOLUTION

INSIDE

KERALA KARSHAKAN
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NOVEMBER 2023 Volume - 11 Issue - 05 Mail: editorejournalkkfib@gmail.com Log on to http://www.fibkerala.gov.in
Phone: 0471-2314358

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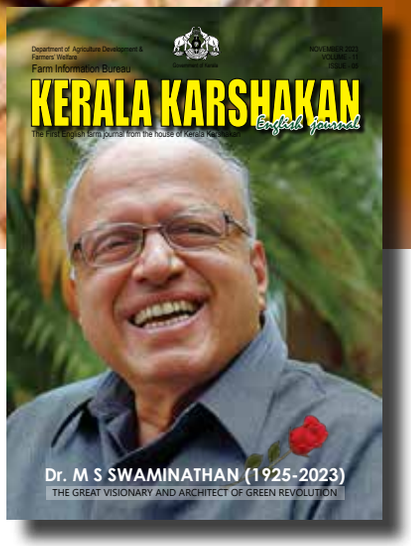

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PROF. M S SWAMINATHAN

Dr. A K Krishnakumar
Former Rubber production commissioner

Remembering the Father of Green Revolution, the legendary Prof. M S Swaminathan of the three most essential needs for mankind, food, clothing and shelter, it is food which is the most critical element for sustenance. The American biologist, Paul Ralph Ehrlich, known for his pessimistic view of population growth and predictions of famine in his book 'Population Bomb' published in 1968 is reported to have mentioned that India be allowed to starve, and the aid be given to countries which are 'not so hopeless'. India at that period was literally on a ship to mouth existence entirely dependent on imported grains. The pioneering

work of Norman Borlaug on dwarf wheat led the food grain revolution, the Green Revolution, at a global level. India with a large population, diverse agro climatic conditions and socio-economic background, smaller farms with limited access to technology offered unsurmountable challenges in achieving quantum leaps in food grain production. A strong political will and relentless scientific efforts made India tide over the food crisis

The First World Food Prize,

Honorary degree of Doctor Science conferred by University of Wisconsin, Madison, 1983

making not only self sufficient but an exporter of food grains. The chief architect of this feat was undoubtably as everyone in the country knows is Prof MS Swaminathan, who is rightly known as the Father of Green Revolution in India. It is not common that the Prime Minister of a country writes an article under his name in a newspaper on a Scientist. The PM has addressed Prof Swaminathan as a 'kissanvygyanik' as opposed to 'Krishi vigyanik' considering his passion and focus on farmers as central to his research work. I had the opportunity to be associated with the legend while serving as a member of the Karshakasri selection panel, courtesy Malayala Manorama. The meetings for Karshakasree award were once in a lifetime experience particularly when both the Prof and Dr. Varghese Kurien, the Father of White Revolution, was also were present. Dr. Swaminathan had a special skill to get the best out of the members also to ensure that the selection is democratic, inclusive and flawless. It is perhaps these factors which puts Karshakasree award several notches above other similar awards. The informal discussions on the sidelines of the meetings were really enriching. I am sure Prof Swaminathan's chairmanship of the committee raised the brandvalue of Karshakasree award of Malayala Manorama.

There were a few more occasions when close interactions were required, particularly when Prof Swaminathan was chairing the Commission on W.T.O concerns in Agriculture in Kerala in 2001. Rubber being a crop of great importance to Kerala I had to provide need-based inputs on behalf of the Rubber Board and the sector. Yet another occasion was during preparation of Kuttanad development plan.

Prof. Swaminathan was the Secretary Agriculture Govt of India when I was a graduate student in Agriculture in early 1970's. He was an internationally renowned scientist and a research administrator on those days itself. The most noteworthy trait of him known to us as a student, shared by our seniors and teachers who worked with him (mostly during his stints as Director IARI) was his outstanding oratory skills, which is rather a rare feature among accomplished Scientists. With his depth in knowledge of agriculture and related disciplines, not only in technical matters but also at policy level, stupendous communication skills with gorgeous display of charm, he was undoubtedly a crowd puller. I was told by one of my seniors that students particularly those pursuing post graduate studies and doctoral research used to travel long distances absenting from classes and other responsibilities to listen to his speech/presentations.

My first glimpse of Prof Swaminathan in person was in 1980 while I was a Junior scientist at the Rubber Research Institute of India (RRII). It was only a few months since I had joined RRII, and it was celebrating its Silver Jubilee in that year. The event was almost a weeklong affair conducted in pomp and style without losing

Meeting with President George Bush on the occasion of the award of the Congressional Gold Medal to Dr. Norman E. Borlaug, 2006

the scientific focus. There was an international conference as a part of it, styled IRCIND '80, which was well attended. I consider that as the probably the best event ever conducted by the Rubber Board. Prof Swaminathan delivered the keynote address, and he was at his best. Though the event had a galaxy of eminent speakers from within and outside the country, Prof. Swaminathan's Keynote eclipsed all others. After the conference the proceedings had to be prepared and he did not circulate any text of the speech. However, the speech was recorded. I was entrusted with the task of deciphering the audio recording to script, of course with stenographic support. The 45 minutes address covered 30 pages while transcribed and it took more than a week if I remember correct. This was a golden opportunity for me which would later helped me immensely on many counts; the way you make a presentation or a speech, the intonations, choice of right vocabulary, command over the language and the technical depth.

Though it is 43 years since he delivered the address the points, he touched remain relevant and still being the focus of research on natural rubber and applicable to other crops too. While I may not go into details, the gist is given here collected from my old notes.

The broad topic was 'perspective and strategy for research and development for the "eighties" in respect of improving natural rubber production. The whole topic was divided into three sections.

1. Basic Research,
2. Applied research,
3 Adaptive research.

Under basic research he explained how to raise the ceiling to experimental yield, through identification of Gibberellic Acid insensitive dwarf genotypes and development of new plant types suitable for high yield management and Gene transfers. He also touched on bioenergetics which aims at increasing conversion of different forms of 'cultural energy' into latex energy. and on total biomass production per unit of time,solar energy and cultural energy. He detailed on partitioning of the biomass into economically beneficial

With Thai Princess during the 36th World Food Day at FAO's Regional Office for Asia and the Pacific in Bangkok, 2016

pathways. Under the applied research he spoke about ecology of rubber cultivation through 'soil breeding', environmental impact studies of NR production and processing systems and identification of suitable areas in NE region for expansion of the rubber cultivation. Other topics under applied research dealt with was energy management (improved fertilizer and water use efficiency and development of NR coated urea for high rainfall area) diversified assured income in rubber-based farming system through 'minimum yield guarantee' programmes and mechanisation.

Under adaptive research the topics covered included size neutrality of technology and identification of constraints causing the gap between the potential yield and actual yield for which he suggested inter-disciplinary constraints analysis under different conditions of farm holdings and management to identify precise set of factors responsible for the prevailing gap between potential and actual yields.

Prof. Swaminathan summed up highlighting the two areas of research i.e. one reducing the gap between potential and actual experimental yields through basic and applied research and the other one aimed at reducing the gap between potential and actual farm yields.The areas which he mentioned needs a revisit and most of these are yet to be addressed completely. Humility was his hallmark and he was approachable by even juniors, and he took care to mentor them. I remember my former colleague at RRII sharing his experience when he visited Sri Lanka in early 1970's as a part of Rubber Board delegation to attend an international conference. The then Director Research of RRII was the head of the delegation. Prof Swaminathan was the chief guest and keynote speaker at the conference in Colombo. The team was travelling by the same flight from Chennai to Colombo in which Prof also was travelling. While they landed, he was escorted from the tarm ac as he was a State Guest. I was told that he waited at the arrival launch till they reached and left only after ensuring that the

team is taken care of. But the most important incident was that when they called on him at his room in the hotel in the evening. When they met him, he was preparing for his talk for next day viewing slides, preparing notes which shows the seriousness and importance he shows to every address. It needs to be mentioned that at that time he was an established and most sought-after speaker globally. Yet he was in all his seriousness and was meticulous, a lesson for young professionals.

The last time I heard him speak was an online address in 2017 made at the World Food Prize award ceremony (The award was instituted by Norman Borlaug). I happened to be in Iowa during that time and had an invitation to attend the ceremony. Prof MS Swaminathan was the first recipient of the award in 1987. The award committee chairman announced that since 1987 Prof Swaminathan had a slot to address the august gathering which he did in person with out fail. In 2017 due to physical indisposition, he could not travel and hence came live on the screen- at 92 he was at his eloquent best and got a rousing applause from the audience. It was proud moment for me and we Indians who were attending the conference.

I had opportunity to interact with him while I was working on food processing after my rubber days. I wanted to seek his guidance in the new sector I started my work and visited the MSSRF at Taramoni. His keenness in gender friendly technologies and nutritional security was evidenced when he advised me that when projects are prepared in the food processing sector do not lose focus on these two aspects too.

He was known for his passion for sustainable development. He always used to emphasize the need for conservation of germplasm, rights of seed etc. His contribution in this area is widely known. He had a penchant for coining new terms such as 'Ever Green Revolution'. Speaking of sustainability in agriculture, his concept of optimum utilisation

With Mina and daughters Soumya, Madhura and Nitya, 1968

of resources, land water, sunlight, using the below ground and above ground space effectively is very relevant. In 1980 while delivering the keynote address at IRCIND'80 he highlighted this and explained it comparing to aquaculture- among fish there are bottom feeders, column feeders and surface feeders each one remaining in their space helping optimum use of water and maximising returns. He always wanted the farmer to be considered as an entrepreneur and a micro farm enterprise model can adopt the suggestions he gave decades ago. (which is being seriously considered to be adopted in agriculture to adapt to climate change and ensuring sustainability).

Professionals like Prof. M S Swaminathan are rare, and his loss is irreplaceable. Though the Nobel Prize eluded him, he would be remembered by many for decades to come. I consider myself lucky and privileged to have received opportunity to interact with him.

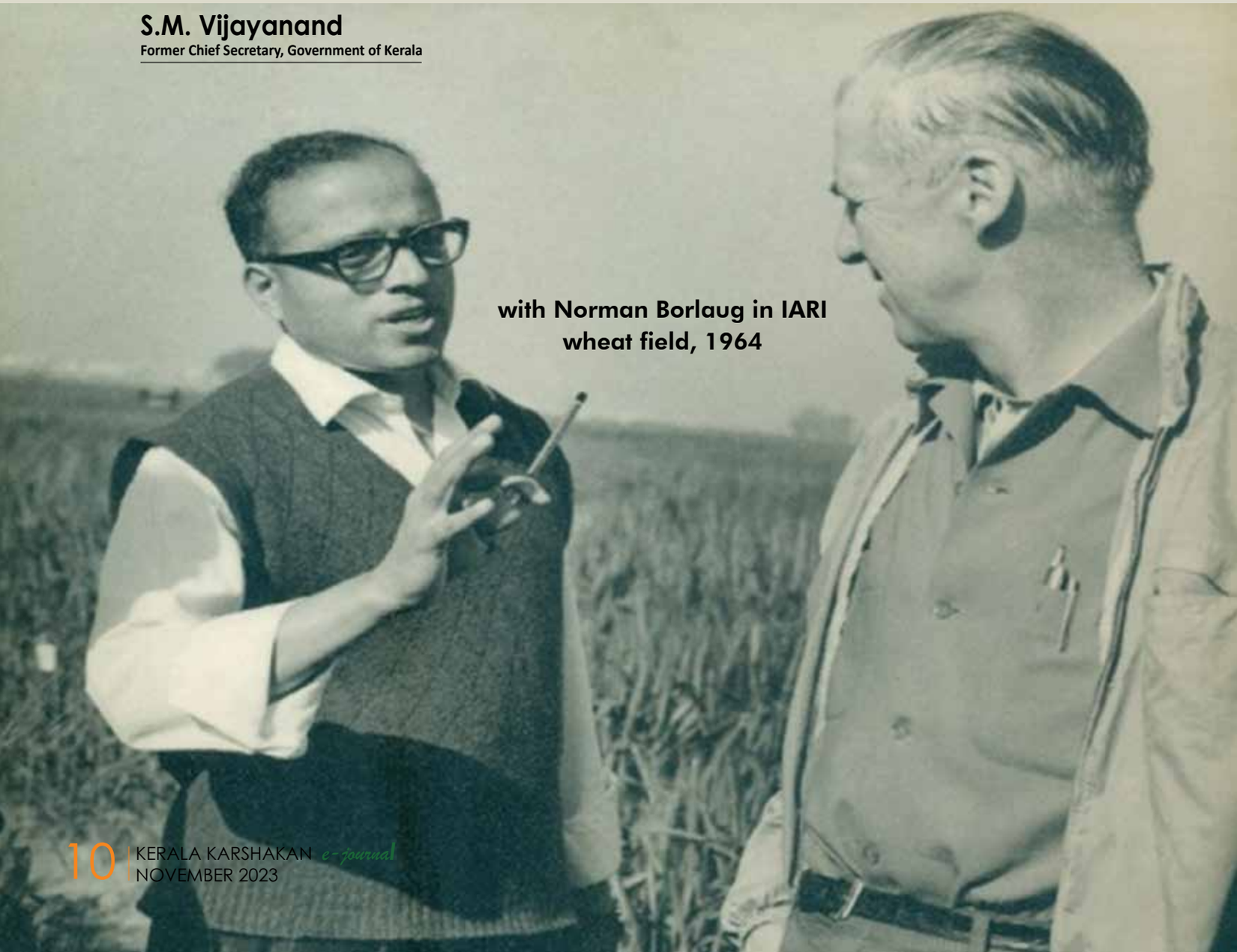
DR. M.S. SWAMINATHAN

A Tribute from an Admirer

S.M. Vijayanand
Former Chief Secretary, Government of Kerala

As a young boy, even before completing ten years, I could sense the dangers the country was in, due to the unpredictability and uncertainty in food production and supply. Dependence on food aid especially from USA was increasing. Several cartoons showed India with a begging bowl. The situation was bleak and depressing. Even though Kerala had an excellent public distribution system, the quality of rice supplied was so poor that one had to wash hands with soap after eating to get rid of the bad odour.

It was in this context that Dr. M.S. Swaminathan started his work. The priority was very clear though the means of achieving it were dauntingly difficult, a challenge which he accepted and overcame in a relatively short period of time. Of course he was an expert in food technology and used his international contacts particularly in getting high yielding variety of wheat from Norman Borlaug. But it needed to be adapted to the Indian situation. This was done very effectively



with Norman Borlaug in IARI wheat field, 1964

and the message from lab to land spread very fast. It must be remembered that most of the farmers were illiterate and held on to their traditional practices with tenacity. For them it was a leap in the dark and for Dr. Swaminathan it was a leap of faith.

Thanks to the vision of the early planners India had developed a reasonably good irrigation system and, more importantly, through the Community Development experiment, an excellent system of extension which essentially meant taking a proven development idea to the people and persuading them to accept it and change the existing practices. In a sense Green Revolution was an outstanding practical example of high quality extension.

Of course such a stupendous task cannot be carried out by one individual; thanks to the commitment of Dr. Swaminathan, he could build a team and reach out to the academic community and the States. Agriculture is a State subject and the Agriculture Universities are under the State. But using ICAR and the central institutions he reached out to them and got them to agree to the new technology and the package of practices associated with it. Such an exercise and co-ordination is unthinkable even at this point of time, even though communication systems have improved manifold. How this was done needs to be studied for lessons for the future.

It is very difficult for a scientist to convince the political leaders to adopt a major policy. Eminent statesmen like Shri C. Subramaniam made this task easier and once the political ownership was obtained things became easier. Here Dr. Swaminathan played a unique role in identifying a technology, adapting it to the Indian situation, converting it into a policy priority and translating the policy into field level action spread across India's villages. Looking back, it looks like a miracle and a lesson to be relearned by everyone in Government.

Of course it is easy to criticize the negative effects of the Green Revolution at this point of time. It is true that, the focus on mono cropping, excess use of water and fertilizers and ignoring traditional varieties and cultivation practices, all produced negative effects later on. But at that point of time if India had not succeeded in achieving self sufficiency in food production, the nation itself could have collapsed through famines and the discontent arising out of starvation and distress migration.

It goes to the credit of Dr. M.S. Swaminathan that he realized the limitations of Green Revolution and openly admitted the need to move on and develop what he called Evergreen Agriculture focusing on sustainability. He invested most of his resources and energies, in the latter part of his career in developing an agriculture system appropriate not only to the farmers but also to the environment. He realized the importance of agriculture to the livelihoods of the rural poor especially the small and marginal farmers, and, women in particular. A lot of work has been done and studies carried out by M.S. Swaminathan Research Foundation (MSSRF) to develop local models. He propagated the importance of biodiversity and sustainability. And importantly, the need to wean away farmers from excessive use of chemicals which destroy the soil and reckless use of water which dry up localities irrecoverably.

Dr. Swaminathan through his MSSRF focused on research required for the local situation and in these research activities he involved the farmers and workers and understood their requirements and imbibed their wisdom.

Dr. Swaminathan has left us a great task to carry forward - the agenda of sustainable agriculture to improve the livelihoods of the poorest farmer and regain the health of the soil and the variety in food. Soil biology becomes equally if not more important than soil physics and soil chemistry; the quality of food is as relevant as quantity. Agriculture research has to be 'for the people and by the people' so that it can become 'of the people.' At this point of time, a State like Kerala has to look at options like natural farming and learning lessons from nature and regaining the lost qualities to address the need of the time. Let's pay our homage to this great son of Kerala, by seriously trying this out in the State.

Dr. M. S. Swaminathan

Earthy wisdom coupled with scientific knowledge

K. Jayakumar
Former Chief Secretary, Govt of Kerala

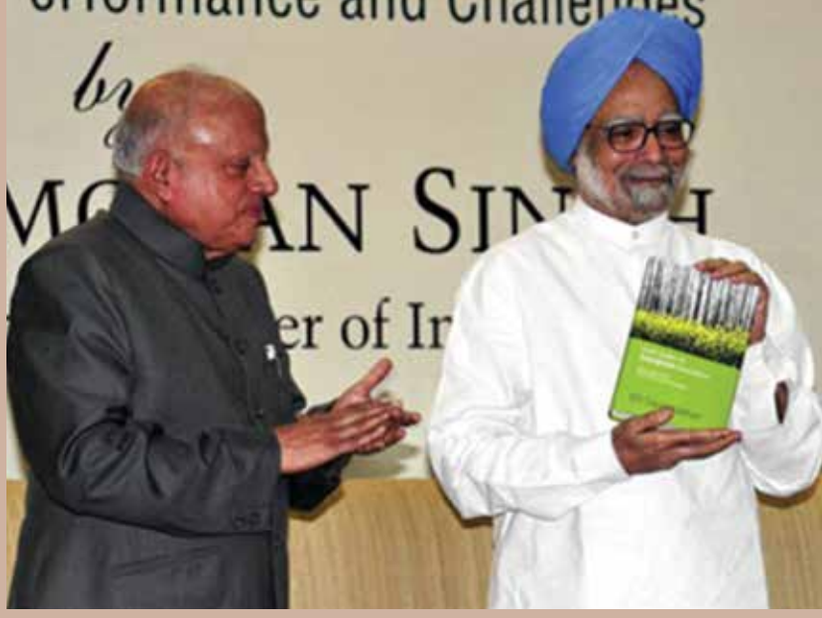
It was my great fortune that I could meet and interact with the legendary scientist, Dr. M. S. Swaminathan. Ordinarily, such an opportunity is unlikely as he had already touched ethereal heights of glory and global recognition by the time I became senior enough in bureaucracy. At best, one could have spotted him at some the airport or at a conference but beyond that an occasion for developing familiarity is quite unlikely in ordinary circumstances. That was possible by a fortuitous coming together of a few events. Dr. M. S. Swaminathan Foundation was asked by the then Government of Kerala to study the causes of the recurrent agricultural distress in Kuttanad and suggest remedial measures. That was sometime in 2005 or 2006. By the time I returned to Kerala in 2007, after my Central deputation, the Kuttanad Special Package Report was ready. I was by then posted as Agricultural Production Commissioner. It was a matter of considerable excitement for me that Dr. Swaminathan himself was going to be grace the occasion when the Report was presented.

The Report on Kuttanad, popularly called Kuttanad Package, is a wonderful document designed with a deep understanding of the unusual ecosystem and geographical features of Kuttanad and keeping the interests and welfare of the farmer in constant focus. This may not be

M.S. Swaminathan on his field observationsin a Maize field, IARI, 1966

the right place to elaborately discuss the details of the much talked about Kuttanad Package. The gist of the recommendations is quite simple. Recurrent instances of the ripe paddy fields getting inundated by the breach of bunds have to be addressed by de-silting and deepening of the canals including the AC canal, and strengthening bunds of these canals and paddy blocks using natural materials. The Report pointed out that while the Thanneermukkam bund and barrage constructed in 1976 to prevent salt water intrusion into the Vembanad Lake succeeded in the short term, has also created unintended new problems. This was sought to be corrected by a scientific restructuring of the barrage which will close and open automatically depending on the recorded salinity. The Report further advocated a Crop Plan for Kuttanad and urged mechanization wherever possible to prevent crop loss. The Report suggested enhancing temporary storage facilities in Kuttanad. In order to enhance the profitability of farmers, the Report suggested establishment of modern rice mills in Kuttanad and branding and marketing of Kuttanad rice.

The most distinguishing feature of the Kuttanad Report was its great concern for ensuring profitability of the farmers and the realization of the ecological sensitivity of the region. The fact that Vembanad Lake is a Ramsar site also has received due attention in the Report. In short, the Kuttanad Package beautifully blends the development aspirations with ecological concerns. What was even more surprising for me was the humility and intellectual clarity of this great scientist. In fact, I came to the conclusion that the hallmark of greatness is one's patience to listen (even when what is said is wide off the main issue and often trash.) He would listen patiently, react politely but never dilute scientific facts and truth. He would not rebuff a misguided enthusiast with a meaningless question. Yet he would never fail to convey the facts softly but firmly; unwaveringly and convincingly. There was always a scientific



With Prime Minister Manmohan Singh at the release of his book FromGreen to Evergreen Revolution – Indian Agriculture: Performance and Challenge, September

precision to his words. Emotions did not overtake his rationality and scientific convictions.

Humility comes from deep conviction and confidence. Dr. M. S. Swaminathan, the world renowned agricultural scientist could listen intently to the woes of a Kuttanad farmer. That is not surprising as M. S. Swaminathan is essentially Mankompu Sambasivan Swaminathan. He loved the Mankopu tag on his name. That sensitivity is what made him a great scientist deeply rooted in the soil. It is this earthy wisdom coupled with scientific knowledge that made him the architect of India's fabled Green Revolution. He is no more amongst us in his physical form but Dr. M. S. Swaminathan will never cease to be a presence in the lives of those for whom agriculture matters. I feel honoured to have met him, chatted with him and spent quite some priceless time with him in the initial yeas of assimilating the Kuttanad Package. If the Package did not fully achieve its desired objectives, Dr. M. S. Swaminathan is the one person who shall bear no guilt for its non-completion. It lies entirely in the executive domain. The only hope that remains is that the Swaminathan Package for Kuttanad is still relevant and needs to be revisited. That will be an act of great honour to this great son of Kuttanad.

M S SWAMINATHAN

THE GREAT VISIONARY AND ARCHITECT OF GREEN REVOLUTION

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Professor (Dr.) Mankombu Sambasivan Swaminathan,a legendary agricultural scientist, plant geneticist, administrator and humanitarian hailed as the Father of India's Green Revolution was instrumental in pulling the country out from a "ship-to-mouth" existence when food would arrive in ships to feed the hungry population to emerge as food self-sufficient and even a food-surplus nation. Ships that have once brought grains to India are now taking them back to other countries across the world. Now, our constitution makes the 'Right to Food' a guaranteed fundamental right that is enforceable by virtue of the constitutional remedy provided under Article 32.All this was possible due tothe relentless efforts and dedication of Dr. Swaminathan led team of officials, scientists and farmers. Just before receiving his Nobel Prize in 1970, Norman Borlaug wrote to Swaminathan:

"The Green Revolution has been a team effort and much of the credit for its spectacular development must go to the Indian officials, organizations, scientists, and farmers. However, to you, Dr. Swaminathan, a great deal of the credit must go for first recognizing the potential value of the Mexican dwarfs. Had this not occurred, it

MSS in his laboratory, IARI, 1961

is quite possible that there would not have been a Green Revolution in Asia".

The Government declared India as self-sufficient in food production in the year 1971.No wonder Dr. Swaminathan was acclaimed by TIME magazine as one of the twenty most influential Asians of the 20th century, the other Indians being Mahatma Gandhi and 1913 Nobel Peace Prize Winner Rabindranath Tagore.Even after achieving food security, he kept on talking about the need to lead the country to nutritional security. He said that somehow malnutrition was considered a health issue, to be handled by the Ministry of Health, rather than seeing it as a broader issue involving food and livelihoods. There is a need to combine agriculture, nutrition and health because as long as we do not bring all these three together malnutrition will remain a challenge. He always reminded us that while the big dream of India's food security was realized through the green revolution, sustainable development in the agricultural sector should be our ultimate goal. He had cautioned about ecological concerns relating to the practice of intensive agriculture as early as 1968 in his address to the Indian Science Congress. He proposed the concept of an "Evergreen Revolution" as an alternative to the Green Revolution in 1990. He had this to say on the concept of the 'evergreen revolution', more than three decades ago:

"What nations with small farms and resource-poor farmers need is the enhancement of productivity in perpetuity, without associated ecological or social harm. The green revolution should become an ever-green revolution rooted in the principles of ecology, economics, and social and gender equity."

He established several research institutes to implement his idea of sustainable development across the country. In all these institutes, he encouraged projects that were pro-poor, pro-women, pro-nature and pro-livelihood, emphasizing job-driven economic growth. He firmly believed that only such projects could

During a visit to Koraput tribal villages in Odisha, 1998

eradicate poverty in rural areas and conserve natural resources. He insisted that his research institutes should become the voice of the voiceless. Most of the programs were planned and implemented for the benefit of marginalized communities and farmers. Dr. M.S.Swaminathan made enormous contributions to scientific advances in agriculture and policymaking.

He was born on August 7, 1925, in Kumbakonam, Thanjavur, as the second son of General Surgeon M.K.Sambasivan and Parvathi Thankammal. His father hailed from a well-known agricultural family of 'KottarathuMadom' of Kuttanad in Alleppey District of Kerala. Sambasivan was a well-known surgeon in Kumbakonam. He also served the community as an elected Chairman of the town's municipal corporation. Most importantly, he was held in great affection and esteem for a successful campaign toward the eradication of diseases caused by mosquitoes. His mother Parvathy Thangammal was a simple and spiritual person who enabled her three sons and a daughter to develop their full mental and spiritual potential. His father died at a very young age and

Swaminathan was only eleven years old then. Being a joint family, his uncle, Narayanaswami took care of the family. His parents wanted Swaminathan to become a doctor as he belonged to a family with a tradition of medicine.Therefore, he completed his education at the Catholic Little Flower High School in Kumbakonam and graduated in Zoology from Maharaja's College (now University College), Thiruvananthapuram. Despite his family background, and belonging to an era where medicine and engineering were considered much more prestigious, he chose agriculture.

The famine in Bengal in 1943 during the Second World War and the plight of farmers prompted him to pursue a degree in agriculture from the Tamil Nadu Agricultural University. He also completed his Masters in Plant Breeding and Genetics from the Indian Agricultural Research Institute, Delhi. In 1949, he received a UNESCO fellowship for the study of potato genetics at the Genetics Institute in the Netherlands. He was awarded IPS during this period, but the visionary scientist decided to remain in agriculture after accepting the UNESCO fellowship. In 1950, he moved to study at the Plant Breeding Institute of the University of Cambridge, School of Agriculture. He earned a Doctor of Philosophy degree in 1952 for his thesis "Species Differentiation, and the Nature of Polyploidy in certain species of the genus Solanum ".Dr.M.S.Swaminathan then spent 15 months in the United States. He accepted a post-doctoral research associateship at the University of Wisconsin's Laboratory of Genetics to help set up a Potato Research Station under the United States Department of Agriculture. He returned to India in early 1954.Swaminathan got married in 1955 to Mina Boothalingam, whom he had met in 1951 at Cambridge University (UK) where she was pursuing her M A degree in Economics.

After his return, initially, he worked as an assistant botanist at the Central Rice Research Institute, Cuttack. Later he got an appointment as Assistant Geneticist in Indian Agricultural Research Institute. During this period, he learned about Dr. Norman Borlaug's newly developed Mexican dwarf wheat variety and began efforts to produce improved varieties in India. During this period he conducted research on soil and plant-compatible fertilizers, different high-yielding wheat varieties and efficient farming practices to empower Indian farmers with advanced agricultural technology. Continuing his research with Dr. Borlaug, he developed high-yielding, pest-resistant varieties suitable for our soil. There was hesitation by farmers to adopt the new variety whose high yields were unnerving. In 1964, following repeated requests by Dr.M.S.Swaminathan to demonstrate the new variety, he was given funding for small demonstration plots. Trial plots and demonstration plots were started in Punjab, Haryana and Uttar Pradesh with the help of farmers to cultivate these varieties of wheat. A total of 150 demonstration plots on one hectare were planted. The results were promising and the anxieties of the farmers were reduced. More modifications were made to the grain in the laboratory to better suit Indian conditions. The new wheat varieties were sown and in 1968 production went to 17 million tonnes, 5 million tonnes more than the last harvest. The wheat harvest tripled in the first year. Wheat yield increased from 12 million tonnes to 23 million tonnes over four crop seasons. He thus ushered in a golden age for India in agricultural technology. As a result, farmers across the country increased production by using improved irrigation methods, cross-breeding varieties and quality fertilizers, leading India to become self-sufficient.

He worked till 1972 as a teacher, researcher, head of the department and Director of the Indian Agricultural Research Institute. Swaminathan taught cytogenetics-I and radiation genetics at the Post-Graduate School of IARI during late 1950s through the 1960s. Without exception, every student looked forward with great interest and enthusiasm to listen to his lectures. During his tenure, the Nuclear Research Laboratory and its Genetics Division were established. In the

1960s, the International Rice Research Institute developed a highly productive rice variety, IR 8, from a dwarf rice variety called Tai Chung Native One. These genes were later successfully tested in Basmati varieties under Dr.Swaminathan's leadership. In 1972, he was appointed as Director General of the Indian Council of Agricultural Research and in1979-80 as Principal Secretary, Ministry of Agriculture with an intention to formulate agricultural policies to maintain India's long-term food self-sufficiency under the Indira Gandhi government. From 1980 to 1982, he was given charge of Agriculture and Rural Development in the Planning Commission, during which he emphasized women's development and environmental protection in India's Five Year Plan. In 1982, he was appointed Director General of the International Rice Research Institute, Philippines. He also has the rare distinction of being the first Asian to hold the position. One of the contributions he made during his tenure here was conducting an international conference on "Women in Rice Farming Systems".He served in this position until 1988. For this, the United States-based Association for Women in Development gave Dr.Swaminathan their first award for "outstanding contributions to the integration of women in development".

Very few geneticists involved in crop improvement are known to have become deeply involved in the conservation of biodiversity, particularly agro-biodiversity. Professor was one among those rare kinds. His inspiration was the driving force for the Norwegian Government to create a Noah's ark in the form of the Svalbard Global Seed Vault serving as a safety net for food security in an era of global warming and climate change. He emphasized that Cryogenic preservation is just a 'safety net' and what is ideally required is 'in-situ on-farm' conservation and maintenance of ecological integrity in primary, secondary and tertiary centres of origin and divergence of crop plants.

His leadership at IRRI was instrumental in the first World Food Prize being awarded to him. In 1984 he became the president and vice-president of the International Union for Conservation of Nature and World Wildlife Fund respectively.He was awarded the first World Food Prize for his contributions to agriculture and food security in 1987. Accepting the award, Swaminathan spoke of the growing hunger despite the increase in food production. He spoke of the fear of sharing "power and resources", and that the goal of a world without hunger remains unfinished.With the prize money, he laid the foundation for M.S.Swaminathan Research Foundation (MSSRF) in 1988, in Chennai. Its activities are being carried out in different areas of the country with the aim of food security and agricultural biodiversity conservation.Community Agrobiodiversity Centre (CAbC) was established in 1997 at Puthurvayal, Wayanad district of Kerala, as one of the regional centres of MSSRF. The Centre was established to promote community conservation systems of rural and tribal people through research, extension and advocacy.Other field stations of MSSRF promoting community conservation were started in Kolli Hills (Tamil Nadu) and Koraput (Odisha). These centres not only revitalized the conservation traditions of tribal women, in particular but also provided recognition and economic benefits.

In 2001, Dr. M.S.Swaminathan was instrumental in introducing the Protection of Plant Varieties and Farmers' Rights Act. This led to the formation of the Protection of Plant Varieties and Farmers' Rights Authority. In 1994, the M S Swaminathan Research Foundation (MSSRF) submitted to the Government of India a draft Act for plant variety protection, incorporating provisions for recognizing the role of farm women and men in conservation, cultivation and breeding. The Act titled, "Protection of Plant Varieties and Farmers' Rights Act" was passed by both Houses of Parliament in 2001. In 2002 MSSRF had submitted a draft implementation rules to the government incorporating provisions for recognizing and strengthening the role of

women and elected local bodies (Panchayati Raj institutions) in the implementation of the Farmers' Rights component of the Act. Both the Protection of Plant Varieties and Farmers' Rights Act (2001) and the Biological Diversity Act (2002) provided for the setting up of National Gene and Biodiversity Funds for recognizing and rewarding the invaluable contributions of tribal and rural families to the conservation and enhancement of biodiversity in general, and agrobiodiversity in particular. The Act lays down detailed provisions for storage, transfer and benefit sharing of seeds to farmers.

In 2004, he was appointed as the chairman of the National Farmers Commission, which was formed to address the issue of increasing farmer suicides. Under his leadership, four reports were published recommending a review of the National Policy for Farmers. These reports recommended several reforms such as increasing credit to farmers, increasing investment in research, taking measures to attract and retain youth in agriculture, and ensuring farmers' incomes including agricultural marketing and value addition. One of the major recommendations of the commission was that 50 percent of the cost of cultivation should be paid as the minimum support price for farmers' produce.

In 2005, he joined the United Nations Millennium Project's Hunger Task Force to set goals for reducing poverty, hunger, disease, illiteracy, environmental problems and gender discrimination over the next decade. In 2007, he was nominated to the Rajya Sabha by the then President Dr A.P.J. Abdul Kalam. In 2011, he introduced the Women Farmers'Entitlement Bill to address the concerns of women farmers related to land ownership, credit, insurance, technology and consumer markets. The bill says that every woman farmer should have equal ownership of, and inheritance rights over land acquired by her husband; his share of the family property; or his share of land transferred through a government land reform or resettlement scheme. But it was introduced as a private member's bill in 2012 and got lapsed in 2013.

Kuttanad package and Idukki package were formulated by Dr. M.S. Swaminathan for Kerala. Its recommendations focused on sustainable and integrated development, reviving agriculture and restoring the environment.The Centre had entrusted M.S.Swaminathan Research Foundation to conduct a scientific study of the region and the foundation had recommended 15 tasks with a total cost of Rs 1840 crore for the project. In the preface to the 2007 study report 'Measures to Mitigate Agrarian Distress in Alappuzha and Kuttanad Wetland Ecosystem,' Dr. M.S. Swaminathan wrote: "We must create a Kuttanad Regeneration Symphony with all the actors playing their part in harmony with each other. Saving the Kuttanad ecosystem and the regeneration of the agriculture of this area has to be a joint Centre-State responsibility". He believed that the package would help not just achieve eco-restoration but ensure livelihood rehabilitation, economic prosperity and ecological security of the residents of Alappuzha district and the adjoining areas that fall under the Kuttanad ecosystem. To ensure the effective implementation of the package, he also called for active people's participation and a synergy of political will professional skills, and farmers' wisdom. Being a people's plan, Dr. Swaminathan insisted on a "bottom-up" approach during implementation. In 2008, a committee chaired by him submitted its report on Kuttanad Package before the union government. The report was approved and in 2010, the then Chief Minister V.S.Achuthanandan inaugurated the package in Kuttanad. Despite extensive studies and surveys, the lack of effective coordination among the 12 departments that were assigned to implement the project, Kuttanad package still continues to remain an unfulfilled dream for natives of Kuttanad.

In 2013, the Food and Agriculture Organization (FAO) of the World declared the Kuttanad Farming System as a Globally Important

Dr. M.S. Swaminathan with pioneers of Agricultural Journalism, Sri. R Heli & Sri Muraleedharan Thazhakara

Agricultural Heritage System (GIAHS) due to the efforts of Dr. M.S.Swaminathan.

On 29th September, 2006, the Union Cabinet along with the Rehabilitation Package for 31 identified districts also decided to have a special plan of action for the Idukki district of Kerala. The M.S.Swaminathan Research Foundation (MSSRF), was assigned the study to suggest measures to mitigate agrarian distress in Idukki district of Kerala. The main components of the measures to mitigate agrarian distress in Idukki district of Kerala included action for reviving ecological security and strengthening common facilities, strengthening of livelihood security of the farmers with crop specific programmes and integrating animal husbandry components for income enhancement, creating rural road connectivity with remote villages, to promote agricultural marketing and improve technology and input servicing etc. Research and development component was also included for development, refinement and transfer of technology in the major plantation and food crops of the district. He also did not forget to warn the government about the irregularities in the administration of these packages and had constant interaction with the government in this matter.

Professor MS Swaminathan firmly believed that sustainable development is possible only by connecting science and society. Professor also advocated an approach that combines traditional knowledge systems with advanced technology to achieve development. He emphasized food, agriculture and nutrition security at the individual, household and community levels and promoted environmental sustainability and gender equality in all the development programmes. He encouraged the formation of grassroots organizations to

ensure sustainability of projects and programmes over time. Dr. M.S.Swaminathan was not only a good scientist but a social activist and a humanitarian. He had no hesitation in working among people, understanding their problems, respecting and praising their knowledge. In many international forums he has spoken about the knowledge possessed by tribal groups, women and farmers on local biodiversity and the need to conserve it for a sustainable future. This became a mission for MSSRF ; to achieve social prosperity through conservation, enhancement and sustainable & equitable use of biodiversity by adopting economically viable, ecologically sensitive, socially inclusive and equity approaches and process in development, research and technology dissemination. He has often said that biodiversity conservation can only be achieved through a 4C paradigm giving emphasis on mutually interlinked aspects like Conservation, Cultivation, Consumption and Commerce. As these 4 C's are interrelated, progress in one 'C' can only be achieved through progress in the other three 'C's. MSSRF under Professor concentrated on agrobiodiversity conservation, popularization and promotion of millets, from 1997 itself in the Kolli Hills of Tamil Nadu. Attempts were made to conserve the nutritious millets which had been neglected for several decades, that was doing immense good to the health of urban consumers and to the resource-poor marginal and small farmers from the point of view of income generation, poverty reduction and enhancing food security.

With Pope John Paul II during discussion on the Sahelian drought, 1985

Dr. Swaminathan's interventions to strengthen the conservation ethos of the tribal women in Koraput led to the tribal women winning the prestigious Equator Initiative Award at the UN Conference on Sustainable Development in Johannesburg, South Africa in 2002 and the Genome Saviour Award of the Protection of Plant Varieties and Farmers' Rights Authority of India. The Kuruma and Kurichiya communities of Wayanad too won this accolade facilitated by MSSRF.

Another important milestone in Kerala's biodiversity conservation dogma was the 'Swaminathan Report' that recommended developing Silent Valley as a 'National Rainforest Biosphere Reserve'. The report explicitly suggested alternate avenues to generate energy. In 1979 the Government of Kerala passed legislation regarding the Silent Valley Protection Area (Protection of Ecological balance Act of 1979) and issued a notification declaring the exclusion of the hydroelectric project area from the proposed national park that saved this treasure trove of biodiversity. When Dr.M.S.Swaminathan was the President of the International Union for Conservation of Nature and Natural Resources (IUCN) during 1984–1990, one of the several things he did was to establish a Global Network of Mangrove Genetic Resources Conservation Centre (MGRCC) to arrest degradation of mangrove forest ecosystem and to restore it. During the signing of the Global Biodiversity Protocol at the UN Conference on Environment and Development in June 1992 at Rio-deJaneiro, the International Society of Mangrove Ecosystem

(ISME) was established in Okinawa (Japan) with Dr.Swaminathan as the Founder-President, who prepared and presented the charter for mangroves conservation and their sustainable use. Under his supervision, MSSRF undertook a massive programme of restoring the degraded mangrove forests along the east coast of India comprising West Bengal, Odisha, Andhra Pradesh and Tamil Nadu. The 2004 tsunami was quite devastating to the coastal regions of Tamil Nadu. Yet, the magnitude of loss of lives and livelihood resources was substantially reduced wherever mangrove restoration programme had taken place.

He was involved in promoting sustainable agriculture and rural development using several innovative paradigms, major one being modern information and communication-based Village Knowledge Centres (VKCs). In October 2006, the then Indian Prime Minister Dr. Manmohan Singh started 'Village Resource Centre'. emphasizing the importance of modern science and technology in eradicating poverty, the 'Village Resource Centres' were envisioned as a one-stop facility for providing a range of services to the rural population. These Village Resource Centres were jointly established by Indian Space Research Organization (ISRO) and Dr M.S.Swaminathan Research Foundation. It provided many facilities for the development of the rural people through a single window. He envisioned that Village Knowledge Centers and Village Resource Centers should work like a "spokes and hub model" catering to the information requirement of every remote village in India.

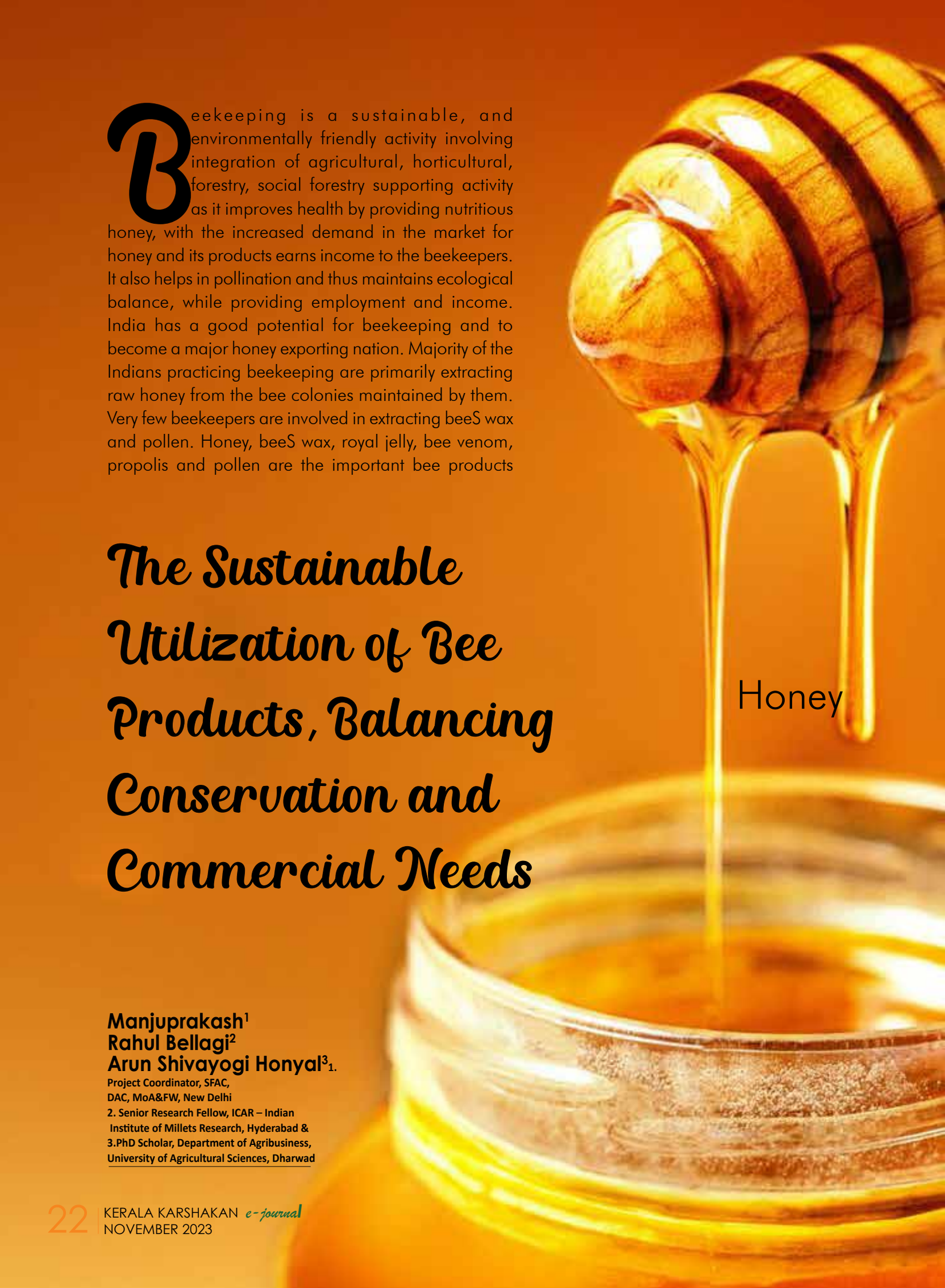
All the programs like Ecotechnology-based biovillages, Fisher Friend Mobile Application, Every Child a Scientist, Mangrove Restoration Programme, Coastal Research, Information Village,etc envisioned by Dr.M.S.Swaminathan were way ahead of their time. As a yogi, he could foresee the future, 20-25 years ahead of his time and formulate plans and programs that could cater to the future needs of humanity. He was also an exceptional leader. He would memorize the names of every colleague, even the farmers and their families. Under his leadership, all decisions were taken democratically. He always ensured that everyone's opinion was sought before making important decisions. He had an incredible ability to draw people to him lovingly. His warm smile and consideration for everyone made him popular. His firm belief was that unless the benefits of modern science and technology are brought to our villages, we cannot get rid of the poverty that afflicts millions of people.

He has also been instrumental in establishing many agricultural institutions in China, Vietnam, Myanmar, Thailand, Sri Lanka, Pakistan, Iran, Cambodia, etc. Ramon Magsaysay Award in 1971, Albert Einstein World Science Award in 1986, UNEP Sasakawa Environment Award in 1994, UNESCO Gandhi Gold Medal in 1999, Indira Gandhi Peace Prize in 2000, Franklin D. Roosevelt Award for Freedoms are just some of the international awards he has received. In India, he was awarded the Lal Bahadur Shastri National Award, Shantiswarup Bhatnagar Award, Lokmanyatilak Award, Indira Gandhi Award and the highest civilian awards Padma Shri (1967), Padma Bhushan (1972) and Padma Vibhushan (1989). He received more than 80 honorary doctorates from various universities around the world and civilian awards from the Philippines, France, Cambodia and China.

Dr. Swaminathan's demise marks the end of an era of agricultural research, education, and extension marked by disruptive innovations. Democratic movements, marginalized communities, farmers and women's organizations have lost a great advocate who stood by them and voiced for their rights. He may have passed away on September 28, 2023, but he will live on forever through the countless lives he has touched and the agricultural revolution he ignited. His commitment to alleviating hunger and poverty through science and innovation will continue to drive the future of agriculture, ensuring a sustainable and prosperous world for future generations.

The Sustainable Utilization of Bee Products, Balancing Conservation and Commercial Needs

Beekeeping is a sustainable, and environmentally friendly activity involving integration of agricultural, horticultural, forestry, social forestry supporting activity as it improves health by providing nutritious honey, with the increased demand in the market for honey and its products earns income to the beekeepers. It also helps in pollination and thus maintains ecological balance, while providing employment and income. India has a good potential for beekeeping and to become a major honey exporting nation. Majority of the Indians practicing beekeeping are primarily extracting raw honey from the bee colonies maintained by them. Very few beekeepers are involved in extracting beeS wax and pollen. Honey, beeS wax, royal jelly, bee venom, propolis and pollen are the important bee products



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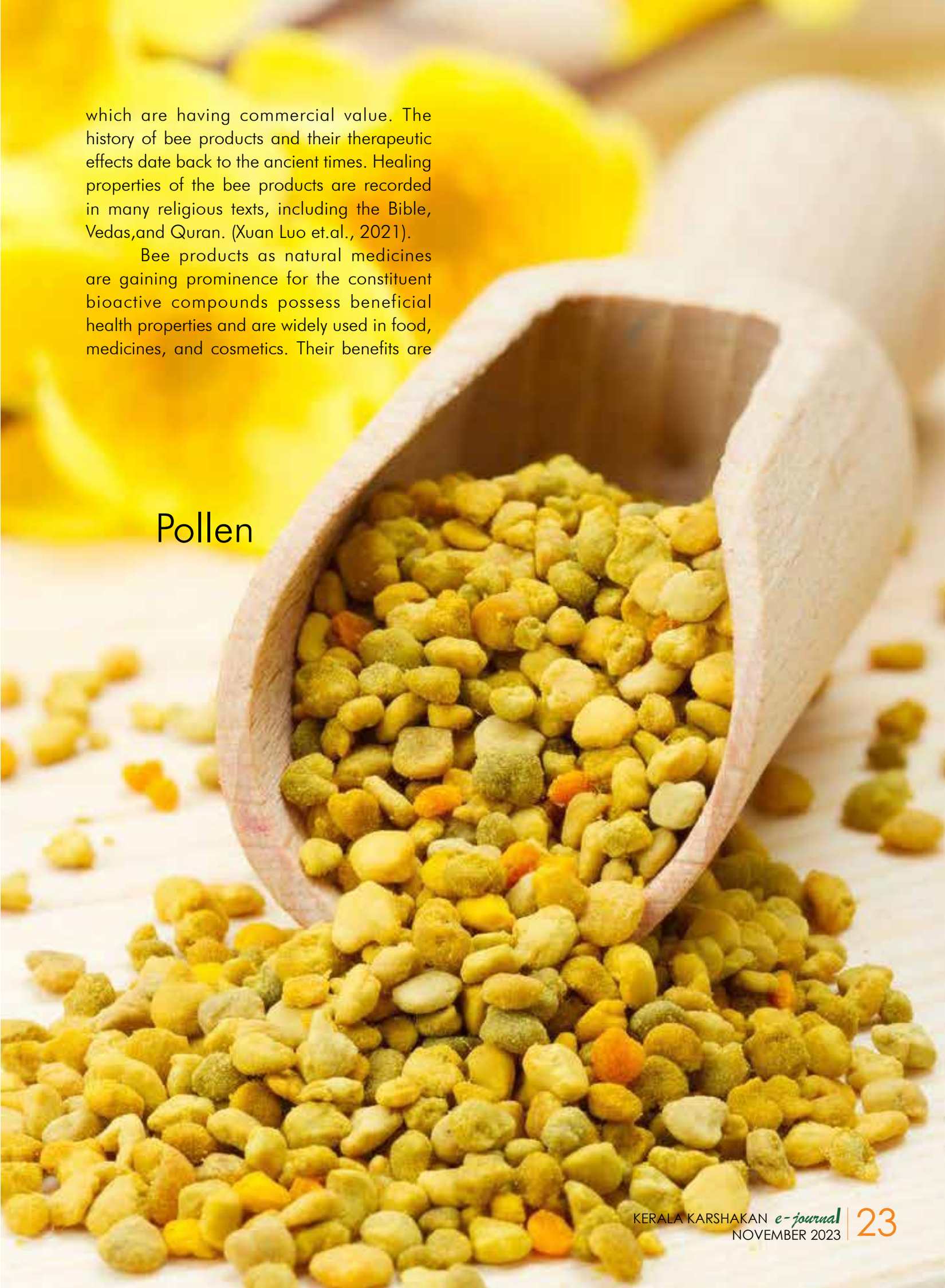
which are having commercial value. The history of bee products and their therapeutic effects date back to the ancient times. Healing properties of the bee products are recorded in many religious texts, including the Bible, Vedas,and Quran. (Xuan Luo et.al., 2021).

Bee products as natural medicines are gaining prominence for the constituent bioactive compounds possess beneficial health properties and are widely used in food, medicines, and cosmetics. Their benefits are

Pollen



mentioned in many religious texts, including the Vedas, the Bible, and the Koran. (Ahangari et. al., 2018).

1. Honey

The most widely used bee product is undoubtedly honey. It is produced by Honey bees from the nectar of plants, the secretions of living parts of plants, or the secretions of insects sucking the living parts of plants. (Papa et. al., 2022).

Honey is made and stored to nourish bee colonies. It is produced by honey bee by collecting nector stored in special sacs in their bodies. The collected nectar

Beeswax

they bring back is eaten by house bees, which add enzymes from their bodies to the nectar that turns the nectar into honey. Bees also collect nectar secreted by plant parts, other than flowers (floral nectaries).

Honey has multipurpose usage

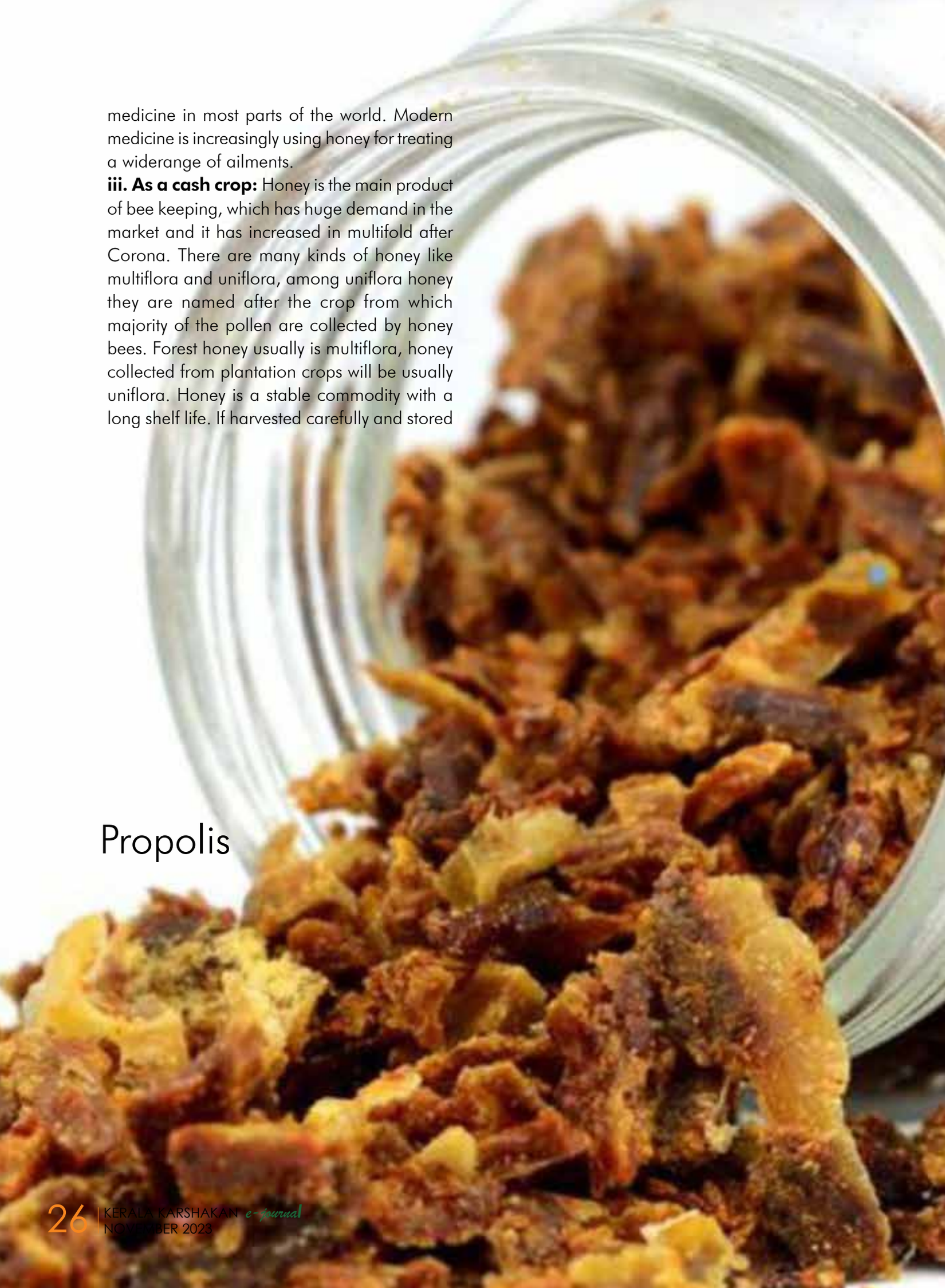
i. As a food: Honey is often regarded as an important ingredient in traditional food and in religious rituals. Honey is valued everywhere as a sweet tasty and energy-rich food. At times of food shortage, it is a useful source of carbohydrate that contains trace elements and adds nutritional diversity to poor diets.

ii. As a medicine or tonic: Due to the medicinal and therapeutic characteristics of honey, it is used as medicine or along with the

Bee venom

medicine in most parts of the world. Modern medicine is increasingly using honey for treating a widerange of ailments.

iii. As a cash crop: Honey is the main product of bee keeping, which has huge demand in the market and it has increased in multifold after Corona. There are many kinds of honey like multiflora and uniflora, among uniflora honey they are named after the crop from which majority of the pollen are collected by honey bees. Forest honey usually is multiflora, honey collected from plantation crops will be usually uniflora. Honey is a stable commodity with a long shelf life. If harvested carefully and stored



Propolis

in dry containers, it will remain wholesome for many years.

iv. As an export crop: There is a huge demand in international market for honey because of the health consciousness. India exports most of its honey to United States, United Arab Emirates and Singapore.

2. Pollen

Pollen is a rich source of protein required for human diet. It is collected by pollen trap from ingoing pollen foragers. The composition of the pollen, including the content of fatty acids, nucleic acids, nucleosides, phenolic compounds, vitamins and bioelements, determines its therapeutic properties. (Kurek-Górecka et. al., 2020). Pollen has also been reported to have beneficial effects on the cardiovascular, respiratory, and nervous systems, treatment of wounds and inflammation. (Mărgăoan

Propolis

et. al., 2018).

3. Beeswax

Honey bees build their nest using beeS wax produced by young honeybees being secreted by special wax glands, when they are 14 to 18 days old. On contact with air, the wax hardens and forms scales, which appear as small flakes of wax on the underside of the bee. About one million wax scales make 1 kg of wax. Bees use the wax to build the well-known hexagonal cells that make up their comb, a very strong and efficient structure. Bees use the comb cells to store honey and pollen; the queen lays her eggs in them, and young bees develop in them. BeeSwax is produced by all species of honeybees, although the waxes produced by different species have slightly different physico-chemical properties. Upon processing the wax, it can be used in manufacture of a variety of commodities like beauty lotions and creams, lipsticks, ointments and pomades and polishes for footwear, floor and furniture,automobile lubricants, paints and varnishes, inks, electrical insulating apparatus and candles.

4. Bee venom

Sting of worker bee is attached to a poison sac where venom is stored. Newly emerged bee is unable to sting because she cannot insert the sting which is not fully chitinized. Also, little amount of venom is stored in the venom sac. A worker bee, when two weeks old has maximum venom in her poison sac. Bee sting therapy is now an emerging treatment to treat inflammation and central nervous system diseases, such as Parkinson's disease, Alzheimer's disease and amyotrophic lateral sclerosis.

Bee venom is commercially obtained by the use of electric shock. An electric current is passed through copper wires at 12 volts. The bees get shock are irritated and release venom by inserting the sting into a thin nylon cloth below the copper wires. Venom is deposited on a glass plate placed below the nylon sheet. The venom on drying is scrapped from the glass plate. One *Apis mellifera* colony yields about 50mg of venom.

5. Propolis

Propolis is generally gathered by bees from resinous exudates of tree. It contains resins and balsams 55 per cent, ethanol and scented oils 10 per cent and pollen 5 per cent. In the bee colony, propolis is used for sticking frames, sealing cracks and crevices but it is a contaminant of comb wax. Propolis is obtained by scrapping it from the frames. Propolis are used in preparation of ointments for treating cuts, wounds and abscesses in cattle. Mixed with vaseline to soothen burn injuries.Propolis is effective against bacteria and purifies or disinfects. Its use is recommended for the treatment of cuts wounds, or ulcers, and diseases affecting the joints. (Durazzo et. al., 2021).

6. Royal jelly

Royal jelly is secreted by a gland of the nurse bees of the age of 6 to 12 days, when the glands are fully active. It is very nutritious food and is fed to the young worker larvae and the queen larva and adult. Royal jelly is milky or light pale in colour. It is responsible for determination of queen bee and is a nutritious food for human being.

Conclusion

Apart from the byproducts such as honey, pollen, beeS wax, propolis, bee venom and royal jelly,the honey bees are also useful for mankind in aiding in pollination of the crops cultivated, thus providing indirect yet a significant benefit. In fact, it has been claimed that the value of bees in pollination of crops is ten to twenty times the value of honey and wax they produce. Certain crops like apples, alfalfa and clover almost entirely depend upon bees for their pollination. Even among some regularly self-pollinated crops, the yield is considerably increased after bee visit.

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Smart Snacking

Healthy Snacks from Tropical Tuber Crops

Snacks are increasingly considered as 'mini-meals' packed with essential minerals and to satisfy sweet, spicy, savory, or salty cravings in between regular meals. In today's world round-the-clock snacking is preferred wherever and whenever hunger strikes. Moreover, consumers are looking for healthier, natural and more convenient

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sweet potato pickles

forms of snack products all around the time. Changing lifestyles, shifting preferences, more importantly the COVID-19 pandemic created the desire for healthy snacks by focusing on health and wellness. During the COVID-19 pandemic snack product consumption shot up worldwide. The reasons for this trend include an increased sense of comfort, boosting mood, and relaxed feeling (Statista Research Department, 2023). According to SNAC International, the international trade association of the snack food industry representing more than 400 companies worldwide revealed top trends in snack which includes natural colors, flavors, low-sugar, sustainable products free of additives. Revenue of the

Sweet potato Biscuits

snack food market worldwide is reported US$539.30 billion in 2023 and is expected to grow annually by 6.34 % (CAGR 2023 to 2028). As per the reports, revenue of the snack food market in India amounts to US$66.9 billion in 2023 and is expected to grow annually by 9.01 % (CAGR 2023 to 2028). Ready-to-eat snacks are classified into three different classes, first-generation snacks (all-natural products used as snacks such as potato chips, nuts, and popped popcorn), second-generation snacks (single ingredient snacks such as tortilla and corn chips), and third-generation snacks (snacks prepared using multi-ingredients) (IIFPT, 2023). Many food companies are inventing different

Sweet potato pista

snack products to pump up the taste profile as well as to increase their market. However, substantial alteration in bioactivity can occur during various processing steps in the food-making process, which often results in products with lower nutritional profiles compared to raw food. Therefore, it is necessary to optimize the processing variables (cooking temperature, time, pressure, and sample size) to minimize nutrient loss and provide a nutritional profile in the final product to produce healthy snacks.

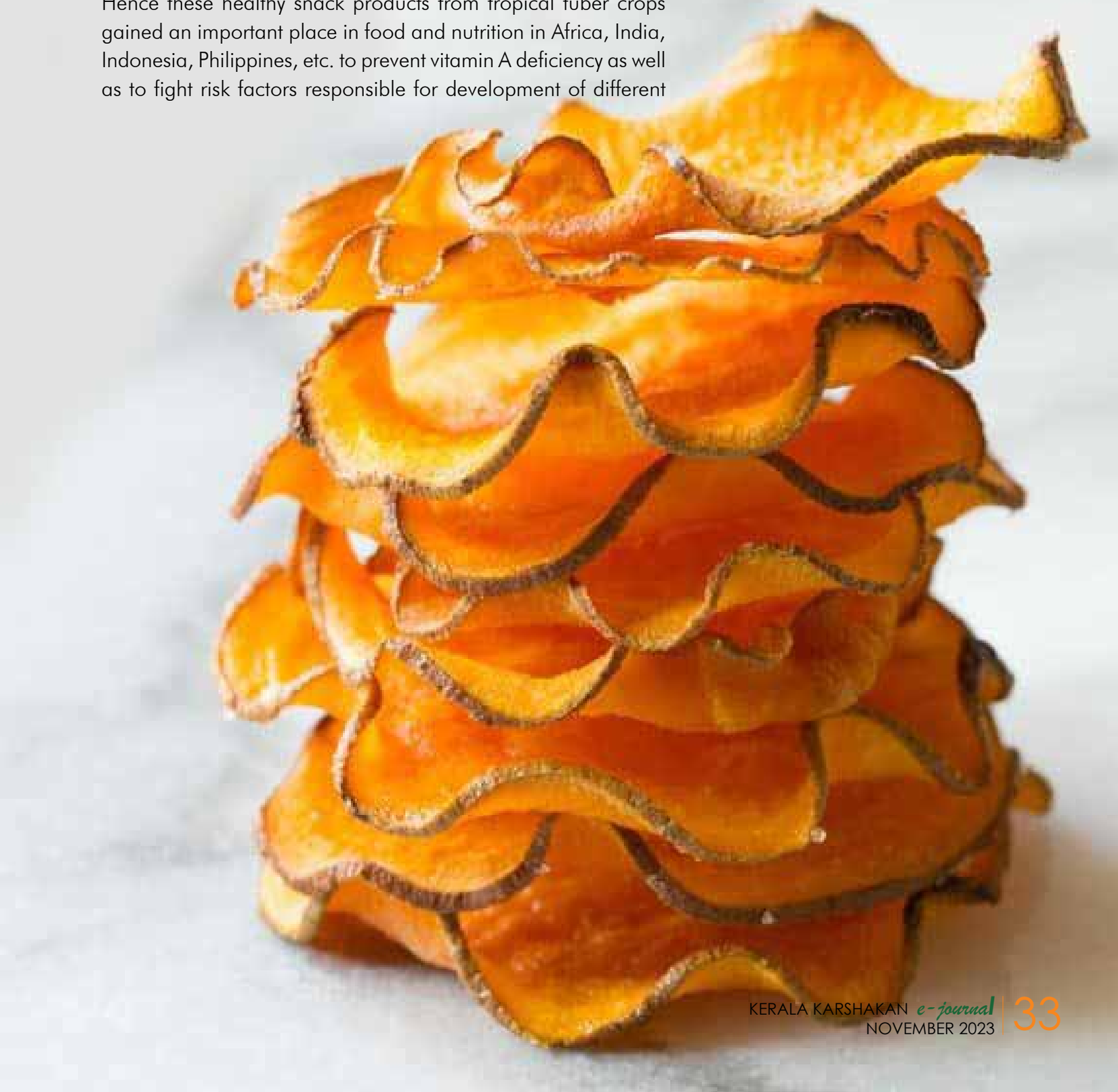
Healthy Indulgence

Even before onset of COVID-19, consumers have been looking for healthy snacking choices which improves digestive health, weight management, controls blood glucose levels. Especially snack foods rich in dietary fiber increases its functionality by maintaining healthy gut with improved health benefits. In addition, plant protein plays an important role in developing snack foods such as fortified protein snacks by contributing food functionality. According to Harvard Health Publishing, paying close attention to

Sweet potato Cake

snack selection would be critical for heart health by controlling body weight and blood sugar. In this context snack food rich in functional components like beta carotene (pro-vitamin A) and anthocaynins are gaining interest among health conscious consumers. Various nutritive snack products developed from tropical tuber crops such as cassava, sweet potato, elephant foot yam, yams, arrowroot, etc. by careful optimization of cooking parameters to stabilize the health promoting components plays a critical role in designing snack foods with increased functionality. Hence these healthy snack products from tropical tuber crops gained an important place in food and nutrition in Africa, India, Indonesia, Philippines, etc. to prevent vitamin A deficiency as well as to fight risk factors responsible for development of different

Cassava Nutri chips



disease development.

Nutritious Snacks from Tropical Tuber Crops

Among different tropical tuber crops sweet potatoes are increasingly recognized as a superfood due to their wider diversity in flesh color (white, off-white, cream, orange, and purple) and high level of nutritional components that can provide several human health benefits like antioxidant, antidiabetic, and antihypertensive properties (Chintha et al., 2021). In addition, the literature indicates that sweet potato is a lower to medium glycemic index crop with one of the best natural sources of beta carotene. Hence in Sub-Saharan Africa,several studies were carried out to evaluate the influences of rich- β-carotene sweet potatoes on the vitamin A situation by simply replacing the white-fleshed sweet potato. Therefore, processing technologies are standardized

Yam Cookies

to produce sweet potato puree and powder with enhanced nutritional values and extended storage. Besides orange-fleshed sweet potatoes, purple flesh sweet potatoes (PSP) are the most abundant sources of natural flavonoids such as anthocyanins with several nutraceuticals and pharmaceutical functionalities followed by orange and white-fleshed sweet potato tubers (Steed & Truong, 2008). Hence, much attention is paid to PSP for the development of a variety of food and beverages globally such as fried chips, crisps, French fries, noodles, bread, biscuits, juices, and several confectionary items (Giri et al., 2019; Toan& Anh, 2018). In addition, a major

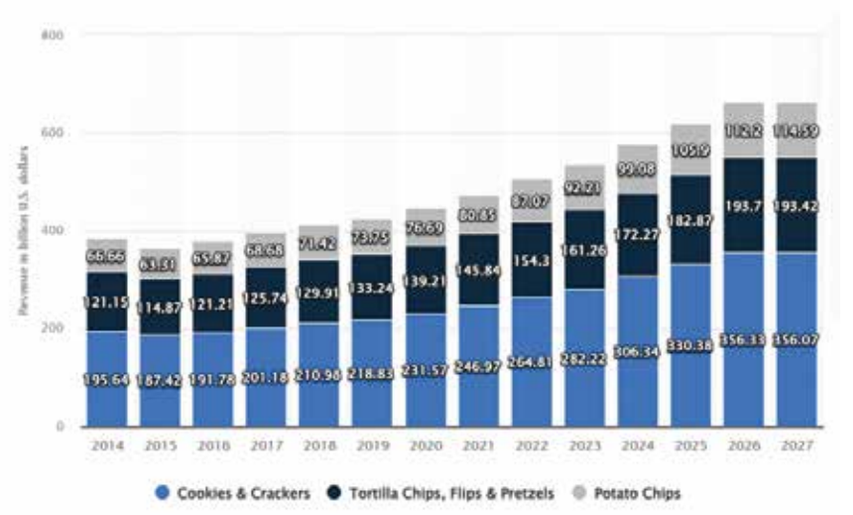


Figure 1: Revenue of the snack food market worldwide from 2014 to 2027, by segment(in billion U.S. dollars) (source: Statista Research Department, 2023)

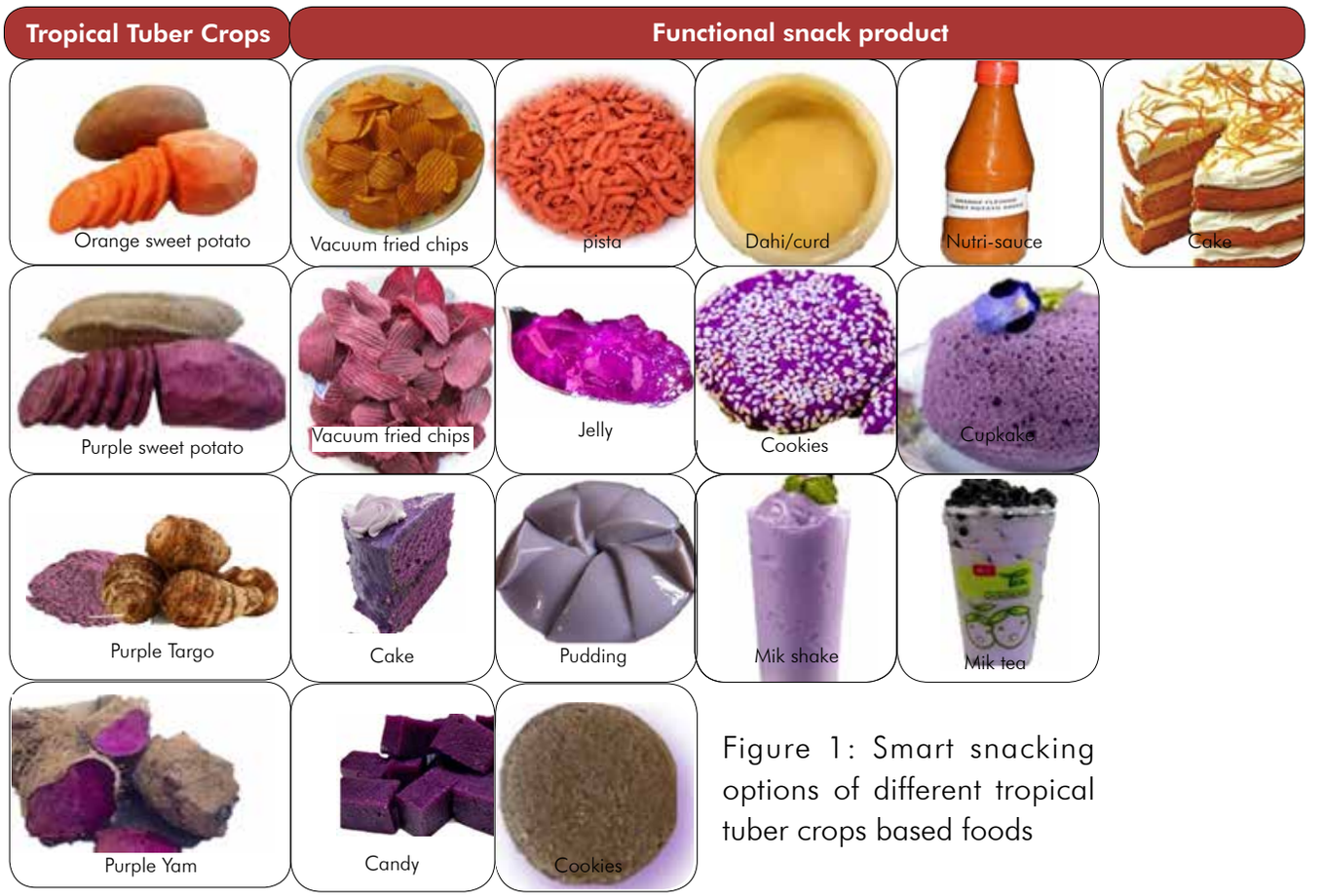


Figure 1: Smart snacking options of different tropical tuber crops based foods

Table 1: Nutritive snacks from tropical tuber crops developed by ICAR-Central Tuber Crops Research Institute, India

Crop	Product	Nutritive value (per /100g)
Sweet potato	Purple colored vacuum	57.44 mg of anthocyanin content fried chips
	Orange colored vacuum fried chips	6.32 mg of anthocyanin content
	Anthocyanin rich cake	39 mg of anthocyanin content
	Beta carotene rich cake	6.30 mg of beta-carotene content
	Anthocyanin Rich Jelly	21.10 mg of anthocyanin content
	Beta-Carotene Rich Jelly	5.42 mg of beta-carotene content
	Beta Carotene Rich Dahi (yogurt)	4.52 mg of beta-carotene content
	Nutri Sauce	5.75 mg of □-carotene content
	Low Glycemic Spaghetti	Low starch digestibility and excellent cooking quality
	Pasta	7.5 to 15.10 g of Protein
	Jam	1.30 g of Protein
	Squash	0.25 g of Protein
	Pickles	3.70 g of Protein
	Sukhiyan	11.30 g of Protein
	Pakodas	22.00 g of Protein
	Sugary Balls	11.20 g of Protein
	Gulab Jamuns	12.70 g of Protein
	Croquettes	8.60 g of Protein
	Fritters	16.80 g of Protein
	Nutria-meals Fiber	2.05 g and Protein 1.50 g
	Gluten free cookies	Zero gluten and high protein content of 12.38 g
	Laddu	Good source of anthocyanin
	Functional sago	Total phenolic content (0.03 g g-1) and antioxidant activity (IC50) (39.13 mg)
Cassava	Protein and fiber enriched mini-papads	Protein content (7-15%)
	Protein Enriched Pasta	4.60 g of Protein
	Fibre-Enriched Pasta	3.60 g of Fiber
	Nutrichips	1.04 g of Protein
	Wafers	Protein enrichment range: 8.3-16.8%
	Popups	High energy value: 536 Kcal/100g
	Rusk	7.50 to 8.30 g of Protein
Yam	Pasta	Betanin-enriched pasta from yam
	Candy from purple yam	Anthocyanin rich
	Protein Enriched Pasta	3.50 g of Protein
	Fibre-Enriched Pasta	2.07g of Fiber
	Cookies	7.35 g of Protein
	Biscuits	8.58 g of Protein
Elephant Foot Yam	Nutri-shreds	Rich in omega-3 fatty acids, and micronutrients.
	Ready to fry papad	Good amounts of micronutrients
	Ready to cook healthy pasta	Protein (14.63 g), iron (3.45 mg) and calcium (336 mg)

tropical tuber crop, cassava grown in southern and northeastern parts of India has been utilized for the development of nutritious snack foods as shown in Table 1 supplementing with protein and fiber sources. Moreover,fortification of yam flour with fiber sources such as oat bran, wheat bran, and rice bran resulted in products having slow and progressive starch digestibility and a very high percentage of starch remained undigested (resistant starch) after 2 hour of digestion under in-vitro conditions. Increasing the level of fiber from 10 to 20% decreased the swelling index and cooking loss, resulting possibly from the high-protein levels in the 20% fortified pasta, which could form a firmer protein–starch network. The slow digestibility of the fiber-enriched yam pasta coupled with the high level of residual undigested starch makes these pasta ideal foods for diabetic and obese people (Krishnan et al., 2012). Furthermore,the low glycemic index of arrowroot and taro flour opened avenues for the development of snack products especially targeting diabetic patients. Priatama and Nuraeni (2019) designed a snack bar using banana bud flour supplemented with arrowroot and taro flour for diabetic patients. Similarly, Salvador-Membreve et al. (2018) observed decreased steatosis and the absence of portal inflammation in the liver due to hypolipidemic activity of consumed arrowroot starch and starch-based cookies in a mice model study. In general arrowroot starch has been playing a pivotal role in food product development such as biscuits, candy, ice cream, soup, cake, pudding, porridge, as well as pie filling. In addition,arrowroot starch is used as a thickener and/or stabilizer and for therapeutic purposes. Another important tropical tuber crop is taro, taro flour is used in the preparation of bakery products in the tropics like Asia and, the Pacific Islands. Up to 15 % of taro flour can be used for the preparation of bread and 60 % can be used for cookie making. In addition, taro flour is used in various products like noodles, pasta, meat analogs, and puffed snacks.Elephant foot yam (EFY), another important tropical tuber crop gown in tropical regions of the world can offer scope for the development of snack products like cake, gulab jamun, Kheer, pakoda, pasta, shreds, extruder products, and ready to fry papads. Konjac glucomannan is a neutral polysaccharide produced from the flour of EFY tubers which is high in dietary fiber which is essential for human health. Hence Konjac flour has been important food ingredients for the preparation of functional foods in Asia.

Consumption of snacks made of konjac flour showed reduced serum cholesterol and low-density lipoprotein cholesterol, and regulation of low blood sugar levels in Type 2 diabetes (Ray, 2015). As eating preferences evolve and tastes change,different healthy snack products developed from tropical tuber crops can satisfy sweet or salty cravings throughout the day. Moreover, these snack products developed from tropical tuber crops can address the bad reputation of snacks as'junk foods' given by critics due to their high nutrition values. In addition, new snack trends such as probiotic coated energy bars, low-calorie high protein ice cream, vitamin C and zinc rich gummies, vitamin D enhanced snacks (mushroom powder vitamin D), keto snacks are getting popular among healthy conscious consumers which can provide essential nutrients like vitamins and minerals between the meals. In the conclusion,preferring snack products from tropical tuber crops which are good source of dietary fiber and health protective compounds (beta carotene and anthocyanins, phenolic acids) which offers protection against chronic oxidative stress commonly associated with non-communicable chronic diseases development in human body would be a smart snacking choice.

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Exotic Rugose Spiralling Whitefly (RSW) *Aleurodicus rugioperculatus* Martin incidence conventional management practices

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Aleurodicus rugioperculatus

RSW nymph and adultinfested with I. fumosorosea NBAIR pfu-5

Introduction

Coconut (Cocos nucifera L.) is the most important plantation crops in India and several South East Asian countries. After Indonesia and the Philippines, India is the third-largest producer of coconut, cultivating roughly 2,150.00 hectares of the crop. With a productivity of 9,901 nuts/ha, the annual production can reach 21,288 million nuts (APCC, 2019). However, the prevalence of several pests and diseases frequently limits the output and productivity of coconut palms (Chowdappa et al., 2018; Neeraja et al., 2020). In native horticultural ecosystems, exotic pests cost billions of dollars in damage and significant ecological changes (Simberloff et al., 2013). Rugose Spiraling Whitefly (RSW), Aleurodicus rugioperculatus Martin, a highly polyphagous and invasive pest that was first discovered in India in Tamil Nadu on coconut plantations in 2016 (Selvaraj et al., 2016), has since been found in Kerala, Karnataka, and Andhra Pradesh, among other coconut-growing regions of the country. Insect pests are specifically targeted by bio-pesticides made from plants and pathogenic microbes, which are both effective and environmentally friendly (Gupta & Dikshit, 2010). Chemical pesticides may be efficient against crop pests, but prolonged use has negative effects on the number of natural enemies, the emergence of insect resistance, and environmental contamination. *Isaria fumosorosea*, an entomopathogenic fungus, was used as a potential biocontrol agent against RSW in Florida (USA) in natural field conditions (Kumar et al., 2018). It was discovered to be more effective against whiteflies (Luangsa-Ard et al., 2005). Bio-control agents such entomo-fungal pathogens and botanical pesticides were tested in the field against the invasive RSW in order to achieve long-term pest suppression of RSW in a sustainable way. Bio-pesticides would lessen the need for synthetic insecticides, postpone the establishment of resistance in pest populations, and provide safer environment for pollinators and natural adversaries (Ali et al., 2015).

Field Evaluation of Bio pesticides against rugose spiraling whitefly (RSW)

According to the damage rating scale created by Srinivasan et al. (2016), the efficacy of various bio-pesticides was tested in the field on East Coast Tall (ECT) variety 7-year-old palms with RSW incidence (> 10 spirals per leaflet)

RSW adult infested with M anisopliae

RSW nymph and adult infested with B. bassiana

between December 2021 and February 2022 at Dr. YSR HU - HRS, Ambajipeta (16°59'38" NL and 81°95'36" EL). In December through February (four cycles) at an interval of 15 days (T1, T2, T3, and T4), talc formulations containing the entomo-fungal pathogens were sprayed onto the coconut fronds. Both Soapnut powder at 0.3 percent (T6) and Azadiracthin 10,000 ppm (T5) at the concentration were sprayed. Jet water spray was also administered during the experiment. Each treatment is replicated three times, with each repetition using two palms. Palms that had not been treated were used as the control group. In accordance with the palm's canopy, 5–10 l of spray fluid was applied for spraying.

Beginning seven days after the imposition of the treatments and continuing for a total of 28 days, observations on the incidence of RSW were made at weekly intervals. The data on the number of RSW nymphs and adults was calculated and expressed as the mean number of leaflets/frond/palm (total of 4 leaflets/frond) (16 leaflets/palm) on four randomly selected infested leaflets per frond per palm from the top, middle, and lower whorls representing four directions.

RSW incidence and intensity (%) were also calculated using the following formulae:

RSW Incidence (%) = (Number of fronds infested by RSW)/(Total number of fronds per palm)×100

RSW Intensity (%) = (Number of leaflets infested by RSW)/(Total number of leaflets per leaf)×100 Evaluation of bio pesticides viz., *Beauveria bassiana*, I. fumosorosea NBAIR pfu-5, *Metarhizium anisopliae*, *Lecanicillim lecanii*, Azadirachtin 10000 ppm, soapnut powder and Jet water spray were underatken against coconut

Rugose infested coconut palm

Power Sprayer for plantation crops

palms with RSW incidence during 2021-22.

Efficacy of bio pesticides against

a. Incidence and intensity of RSW, *A. rugioperculatus*

The combined analysis of the results from the two years showed that, compared to the untreated control palms, all treatments with biopesticides and jet water spray had much decreased incidence and intensity of RSW after the second spray. In contrast to the incidence (48.23, 51.35, and 52.96%) and intensity of untreated control palms (50.89, 51.99, 54.86, and 55.73) of RSW, I. fumosorosea NBAIR pfu-5 spray produced the lowest incidence of RSW (37.98, 33.28, and 29.44 percent at 14, 21 and 28 DAS) and RSW intensity (45.94, 41.71, 36.58, and 30.

b. **Nymphs of RSW, *A. rugioperculatus***

The combined analysis of the data showed that beginning on the seventh day after spraying and continuing through the 28th day, a substantial difference was seen between the various treatments used to control RSW nymphs. Treatment (T5) Azadirachtin 10000 ppm @ 1 ml/l recorded least number (25.74, 22.14, 17.67 and 15.82 nymphs) with 27.27% reduction after spraying, 45.86% reduction over control and demonstrated to be superior to other treatments. The maximum population of 33.47, 35.23, 38.81, and 42.76 nymphs per leaflet was observed in the control treatment (T8).

Spraying intervention of biopesticides

East Coast Tall (ECT) plantation at HRS, Ambajipeta

c. Adults of RSW, *A. rugioperculatus*

The combined analysis of the results showed that there were noticeable differences between the different treatments for RSW adults. With the lowest number (19.57, 17.39, 15.84, and 14.81 adults) and a reduction of 24.99% after spraying and 29.44% above the control, I. fumosorosea NBAIR pfu-5 @ 5 g/l (T2) shown superiority over other treatments. The greatest population for the control palms (T8) was observed at 22.01, 24.27, 24.44, and 25.08 adults per leaflet.

In light of all the factors in the study, azadiracthin 10,000 ppm significantly decreased the nymphal population of RSW, and I. fumosorosea NBAIR pfu-5 spray was significantly superior to other treatments against RSW adult population, pest incidence, and pest intensity. For the efficient management of coconut RSW, additional investigations on the combination of Azadiracthin, soapnut and I. fumosorosea will be useful.

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Oncidium Twinkle white

'Dancing' Blooms in Garden

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'Dancing lady' orchids or 'Golden showers', botanically Oncidium orchids are a popular choice among flower enthusiasts due to their stunning beauty and unique appearance mimicking a dancing lady. Oncidiums are a great choice for those who wish to add a touch of colour to their home or garden. These orchids exhibit a wide range of physical features and have large number of attractive blossoms with variety of flower colours, shapes, and sizes.Oncidiums have diverse hues including shades of yellow, white, pink and purple.

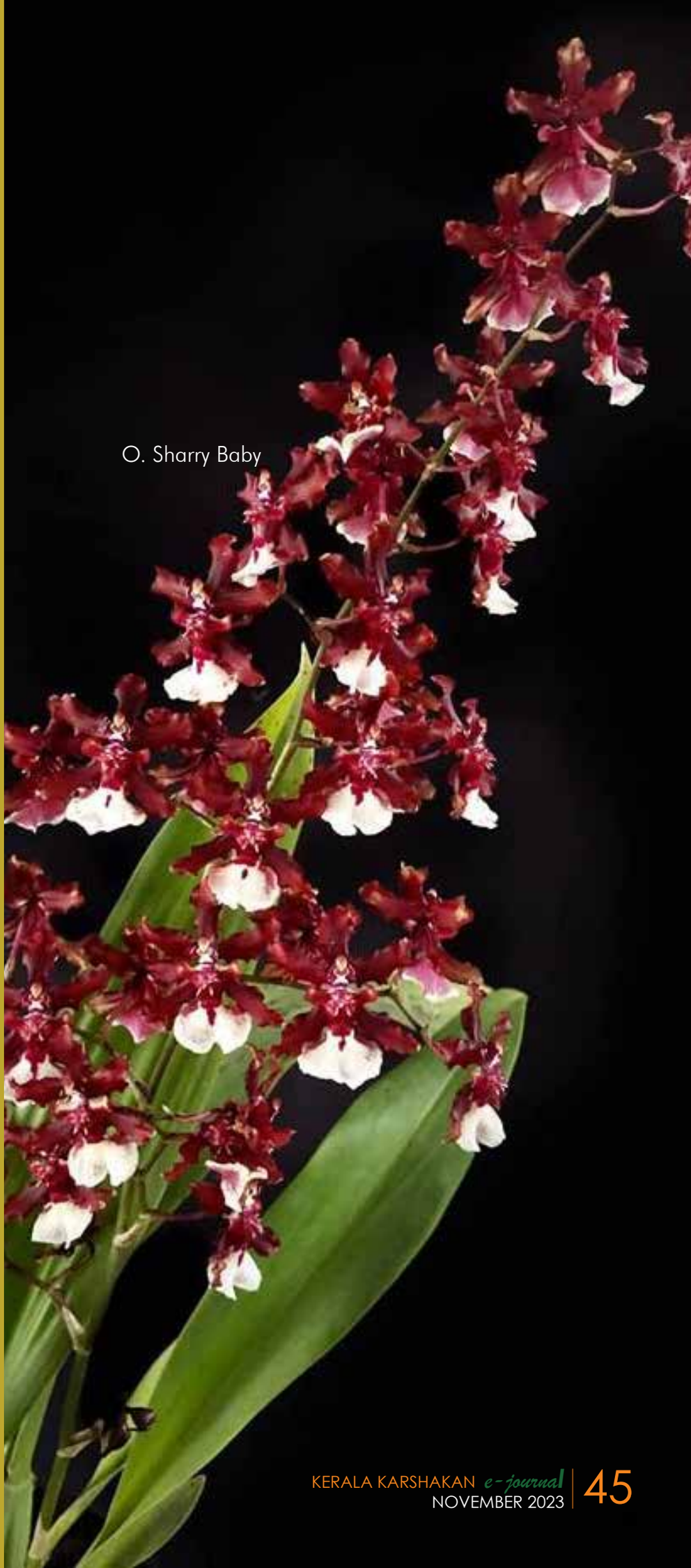
Either pseudobulbs or a fan of razor-thin leaves are present on the plants. One or more small, delicate, pencil-like or extremely massive, leathery, and thick leaves are placed on the pseudobulbs. Usually, only one inflorescence or, rarely, two inflorescences, are generated from a single growth. Inflorescences originate from bases of pseudobulb or axils of leaves. The diameter of flower diameter varies from 1 cm to

12.5 cm in general.

The vibrant hues of Oncidium orchids add a touch of elegance and beauty to any space. Moreover, the shapes and sizes of these flowers vary greatly, with some blooms resembling small stars, while others have larger and round petals. Some species even feature spots, stripes, or intricate designs that resemble faces or animals. The unique petal patterns and textures further contribute to the allure of these orchids. Some Oncidium varieties have ruffled petals, while others have smooth and glossy surfaces. These distinctive features make Oncidium orchids one of the favourite among floriculturists and enthusiasts, as each variety offers its own visual appeal.

Habitat and Distribution

Natural habitat and cultivation of Oncidium orchids are native to the tropical regions of Central and South America, where they thrive in warm and humid environments. These orchids are often found growing on trees or rocks, taking advantage of the high humidity and filtered sunlight in their natural habitats. These orchids require moderate humidity of at least 40% to the maximum upto 70%. Humidity can be elevated around the orchid by placing a tray or saucer filled with pebbles and water under the plantor by using a humidifier. Proper air circulation provided by an overhead fan can overcome problems caused by high humidity.



O. Sharry Baby

Blooming

Oncidium orchids display stunning beauty when they are in full bloom. Many hybrids can bloom 2-3 times per year. In order to initiate the flower spikes, it is important to grow the plant in an area where the night temperatures fall below 18° C. A large, well-grown plant may yield six or seven- branched sprays of yellow flowers. The whole inflorescence resembles a cloud of butterflies. The most popular species include *O. spacelatum, O. varicosum, O. sarcodes* and *O. flexosum, as well as many hybrids. viz., O. Sharry Baby, O.Whitefairy, O. Twinkle white,*

O. varicosum

O. Jirak Fragrant etc. For its sprays of brownish blooms with a strong cocoa aroma, the *O. Sharry Baby* is also known as the chocolate orchid.Miltonia, Brassia, Tolumnia etc. are the some of the related genus of Oncidium.In gardens across Kerala, we can find a wide variety of Oncidium orchids, with prices ranging from as low as 50 Rupees to 2000 Rupees. Oncidium growers can achieve an additional income source to the care takers and financial security to the home makers. A wide variety of inter-varietal and inter-specific hybrids are available now.

Care and Maintenance

For ensuring the health

and longevity of Oncidium plants, it is essential to provide them with proper care and maintenance. They are typically grown in greenhouses or as house-plants in temperate regions. Greenhouses offer the essential conditions of temperature and humidity regulation, creating an environment that replicates the natural habitat of orchids, thus enabling their thriving growth. However, with proper care and attention, it is possible to cultivate Oncidium orchids as houseplants, provided they are kept in a location that receives bright morning and evening; but indirect sunlight. This ensures that the orchids receive adequate light without being exposed to direct sunlight, which can scorch their delicate petals. In addition, placing them near windows with a sheer curtain or providing them with artificial grow lights can help meet their light requirements. Shade requirements also vary for genotypes.

When it comes to watering, they prefer regular watering with good drainage. The need for water can vary widely for different varieties. Excess water may cause fungal infections. Coir, coconut husks and sphagnum moss are the preferable potting materials during summer; charcoal and brick pieces are for rainy season. It is necessary to allow the potting media to dry out slightly between waterings to prevent root rot. Moreover, maintaining moderate to high levels of humidity is crucial for the well-being of these orchids. Placing a tray of water near the plants or using a humidifier can help create the ideal environment for them to thrive.

Plant Care and Protection

Seedling plants need more nitrogen to grow and phosphorus-rich fertilizers should not be used during that stage but can be used for ready to flower plants. The recommended fertilizer quantity for Oncidium orchids can differ based on the fertilizer type, growth stage of plants and specific composition of the fertilizer. However, here are some suggestions for applying fertilizers to Oncidium orchids.

1.Fertilizer Type: Utilize a balanced orchid fertilizer such as 20-20-20 or 19-19-19, denoting the percentages of nitrogen (N), phosphorus (P) and potassium (K) in the fertilizer, respectively.

2.Frequency of application: During the active growth season, administer fertilizer weekly once. Reduce or cease fertilization when the orchid's growth slows down in the dormant phase.

3.Dilution: Dilute 'ready-to-use' fertilizers as per the recommendations provided on the packet or bottle.

4. Application: Apply the diluted fertilizer solution to the roots when the potting medium is already moist. Be cautious to avoid fertilizer spray on the leaves or pseudobulbs, as this can result in leaf burns.

5. Flush with Water: Perio dically, every few months, flush the potting medium with plain water to prevent the accumulation of excess salts from fertilizers. This can be accomplished by thoroughly watering the orchid with plain water.

6. Monitor and Adjust: Observe the response of Oncidium plants to the fertilizer. If any indications of over application are noticed, such as leaf discolouration or salt buildup on the surface of potting medium, decrease the frequency or concentration of fertilizers.

It is essential to keep in mind that these are general guidelines and the specific fertilizer and dosage may differ based on the brand and composition of the product selected. Always adhere to the fertilizer manufacturer's instructions and consider the unique requirements of the particular variety.

If snail attack occurs, collect and destroy them immediately.Leaf blight, leaf spot,root rot etc. are some of the fungal diseases which usually affects Oncidium plants. Mancozeb 63% + Carbendazim 12% WP combination fungicide, 3g per litre of water is recommended to treat fungal infections. The potting materials should be properly sanitised before planting.

Conclusion

Caringand safeguarding of Oncidium orchids with proper attention, will lead to fascinating blossoms. If appropriate levels of light, temperature, humidity, water and protection from pests and diseases are ensured, these stunning orchids will persist in gracing your home garden with their elegance.

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