VIGYAN PRASAR

DREAM 2047

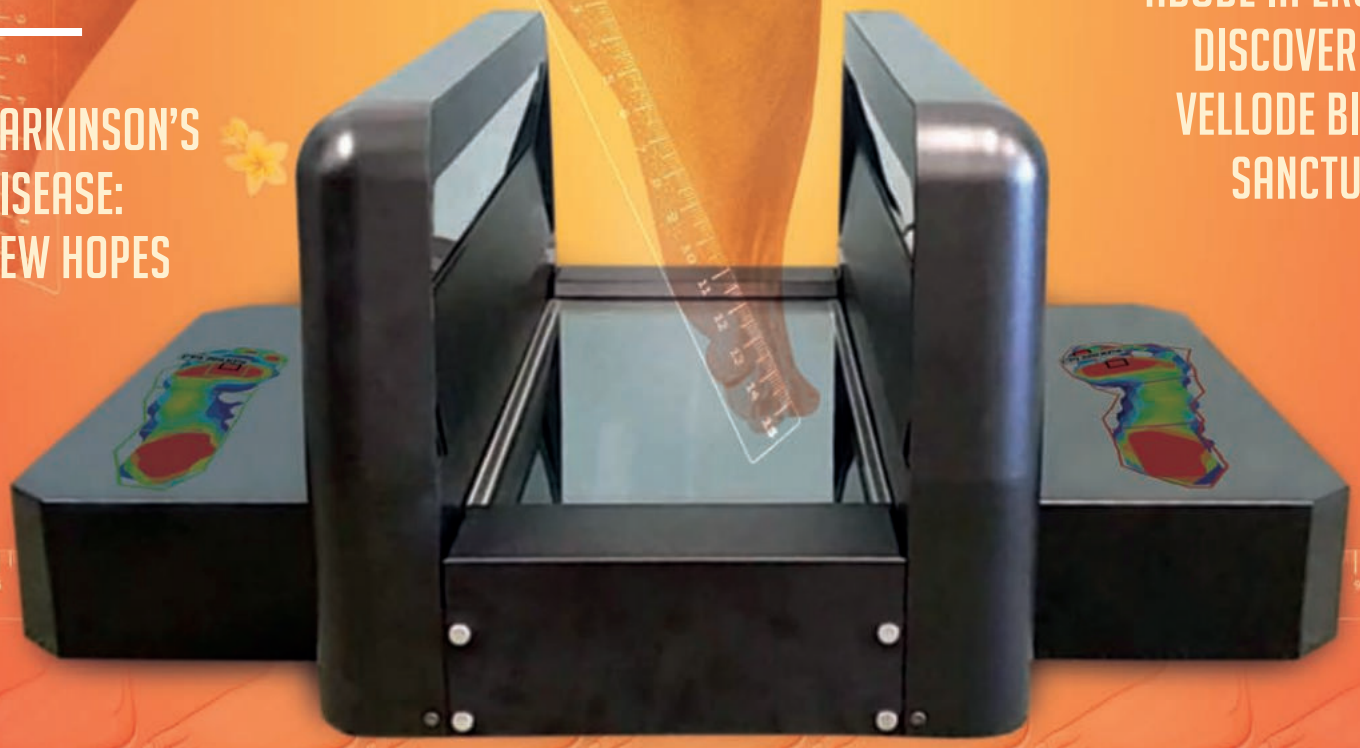
MARCH 2022 / Vol. 25 / No. 3 / ₹ 20

NITROGENOUS FERTILIZERS: AN INTRICATE RELATION WITH POPULATION, PRODUCTIVITY AND POLLUTION

PARKINSON'S DISEASE: NEW HOPES

SRINIVASA RAMANUJAN: A GIFTED GENIUS

WINGED VISITORS' ABODE IN ERODE: DISCOVER THE VELLODE BIRDS SANCTUARY



FOOT SIZE 'HINDUSTANI'

Azadi Ka Amrit Mahotsav

VIGYAN PRASAR

स्वतंत्रता का अमृत महोत्सव

Editor-in-Chief
Nakul Parashar

Editor
Nimish Kapoor

Production
Pradeep Kumar
Ganesh D. Kalghuge
Bipro Kumar Sen

Language Editor
Sumita Mukherjee

Address for correspondence
Vigyan Prasar, A-50,
Institutional Area, Sector-62,
Noida-201 309, U.P., India

Tel: +91-120-2404430, 35

e-mail
dream@vigyanprasar.gov.in

website
http://www.vigyanprasar.gov.in

Published by Dr Nakul Parashar on behalf of Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida-201 309, U.P. India.

Cover Design & Illustrations By: BIPRO KUMAR SEN

NAKUL PARASHAR

Hybrid in AI too

IN MY SEARCH

to locate masterpieces from the history of artificial intelligence (AI), I came across a book titled 'Artificial Intelligence: The Very Idea' written by late Prof. John Haugeland in 1985. This is where I came across the term GOFAI (good-old-fashioned artificial intelligence that he coined) or the so-called symbolic AI. Initial approaches related to AI were based on facts and rules that were then used to train the machine. This approach carried on until RPA (robotic process automation) attained a certain level of maturity. The quest of "what after that" forced AI scientists to look beyond Symbolic AI and move towards the human brain's flexibility. That is where machine learning and neural networks came together. This was a turning point for AI. Deep learning emerged, and advancements like facial recognition, language applications, and many more in health research came up, benefiting human beings immensely. Yet, as things advanced, this too had its limitations. Deep learning requires the availability of large volumes of data.

On the other hand, neural networks were vulnerable to adversarial data. Adversarial data can affect machine learning techniques where it is found to compromise the results of an AI model. So, what's the way out?

A combination of symbolic AI, deep learning, and neural networks seems to be a new route—Hybrid AI. Researchers have moved ahead in this domain and have found satisfactory results with several complex problems, including those related to visual question-answering problems of the VQA. Intriguing and exciting world of AI! Isn't it?

Indeed it is, and that's why Vigyan Prasar had started this year's 52-episode radio serial called 'Welcome Tomorrow' in English and Aane Wala Kal in Hindi dedicated to AI. This is being relayed through more than 120 MW and 14 FM radio stations in 19 different languages across the country every week. This serial is currently in the middle of its course. Thus, I request the readers of Dream 2047 to tune in and listen to this wonderful radio serial conceived and produced by seasoned science communicator Dr B.K. Tyagi. I happened to attend a few interactive sessions of this wonderful radio serial. The producers of the programme have been receiving enormous number of postcards, letters, and emails from its listeners. The numbers of these letters, I've noticed, have been increasing every time I attend these sessions, a clear indication of how much we all are eager to understand AI and the race to reach the maximum possible automation in our lives.

For the past two years, the onset of summers, especially this time frame, hasn't been very pleasant. The wrath of COVID-19 has been too cruel, and yet, as we brave these times, we would urge everyone to stay safe, cautious and follow the COVID-19 protocols strictly. Mask and sanitizers have become an integral part of what we carry while stepping out of our homes.

To keep you abreast with the Indian S&T efforts against the COVID-19, Vigyan Prasar has been bringing out short films, documentaries, news bulletins, and a lot more. Please stay tuned to IndiaScience.in, the one-stop repository of exciting and informative Indian S&T content on the Internet/video. Otherwise, I urge you to visit the Vigyan Prasar website for the latest in science communication popularisation and its extension (SCoPE).

Wishing all of you a very happy Holi.

Email: nakul.parashar@vigyanprasar.gov.in

COVER STORY

NEHA TRIPATHI

FOOT SIZE ‘HINDUSTANI’

Do you have any idea about how your shoe size is determined? Moreover, do you know your shoe size varies with the country? It is different in America, Europe, London, Japan, etc. And what about India? When you shop for footwear online, options are provided, for example, US/UK/Europe. It becomes difficult to choose the size.

Don't get surprised if you find a team visiting your doorstep with a 3D machine to scan your feet. The foot survey has already begun from 2 December 2021. This is part of a very interesting nationwide survey which will help to develop an indigenous footwear sizing system.

HOW IMPORTANT IS THE FOOTWEAR INDUSTRY?

India is the second largest global producer of footwear after China. It produces 2065 million pairs of different categories of footwear annually and exports about 115 million pairs. Thus, nearly 95% of its production goes to meet its own domestic demand.

WHY IS AN INDIAN SIZING SYSTEM NEEDED?

The size that you think is right for you is actually derived from English footwear sizing system. However, our foot characteristics are very different from the English feet and the size varies with brands. It is 7 with some brands and 6 with some other manufacturers. This is because our foot size has never been measured and footwear were never customised as per Indian feet.

Indian Standard Specification for Sizes and Fitting of Footwear (IS 1638-1969) was given in 1969 by the Bureau of Indian Standards (BIS).

The new footwear sizing system will fall under Rules and Criteria that define the best fit–IS 1638:2021
Shoes are much more popular, and important to people now. "From owning 0.5 to 0.6 pairs/person many decades ago, Indians now own 1.5 pairs/person on average.

Dr K.J. Sreeram, Director, CSIR-CLRI is quite enthusiastic about the project. He says, "This project is one-of-its-kind endeavour of Government of India, coinciding with the Azadi Ka Amrit Mahotsav to ensure the better health of Indians through better fit footwear."

THE MEASURING TECHNOLOGY

The measuring method may range from a fully manual to a well-mechanised approach. The manual (or traditional) methods are based on drawing the plantar projection of foot on a sheet of paper and taking its dimensions using simple tools such as liners or measuring tapes. Semi-mechanised methods use mechanical devices for determining dimensions of feet. The modern measuring technology takes advantage of high-tech optical, electronic, and computer-aided techniques.

FEATURES OF THE 3D FOOT SCANNER:

1. Fast scanning of the foot;
2. Foot parameters with high accuracy;
3. Efficient data of 3D foot with measuring points;
4. Retrievable historical foot data storage based on Foot ID;
5. The scanner is compact and easy to carry around.
6. The scanner takes 3 to 5 minutes per person and can scan 12 to 20 persons per hour.

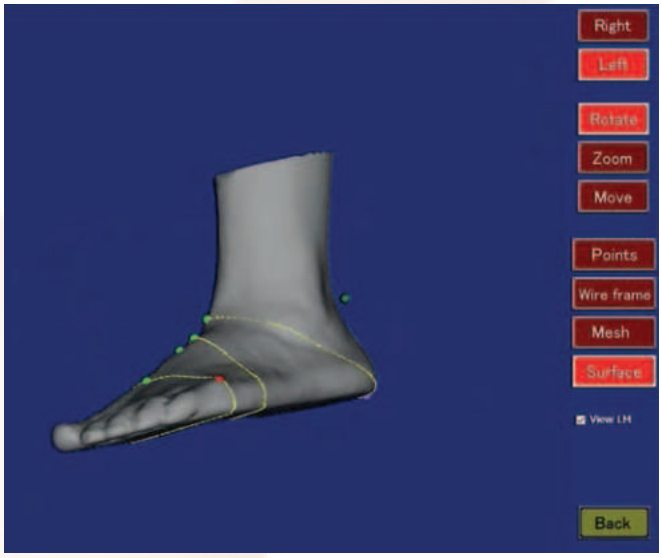
WHAT ARE THE DIMENSIONS OF THE INDIAN FEET?

Designing footwear is complex and requires scientific and engineering expertise. The 3D scanner in this case is going to take 30 different measurements of a human foot to support developing Indian Footwear Sizing System.

Md Sadiq, footwear sizing project team member clearly

FOOT MEASURING ITEMS

0	Foot Length
1	Ball Girth circumference
2	Foot Breadth
3	Instep circumference
4	Heel Breadth
5	Instep Length
6	Fibulare Instep Length
7	Height of Top of Ball Girth
8	Height of Instep (Default: 50% of foot length)
9	Toe #1 angle
10	Toe #5 angle
11	Toe #1 Height
12	Toe #5 Height
13	Height of Navicular
14	Height of Sphyrion fibulare
15	Height of Sphyrion
16	Height of the most lateral point of lateral malleolus
17	Height of most medial point of medial malleolus
18	Arch Length
19	Angle of heel bone
20	Heel Girth circumference
21	Horizontal Ankle circumference
22	Calf circumference (height 230mm)
23	Foot Breadth 2 Breadth perpendicular to foot axis
24	Heel-Sphyrion length
25	Heel-Sphyrion fibulare length
26	Heel-Navicular length
27	Horizontal distance: Lateral malleolus-Achilles tendon
28	Horizontal distance: Medial malleolus-Achilles tendon
29	Horizontal distance: CP of L&M malleolus-Achilles tendon



states, "For me the most important aspect of the project is been the harnessing of the expertise gained by CLRI in implementing a foot measurement survey with a lesser sample size of 10,000. It was also challenging to successfully carrying out children's foot survey with both exercises resulting in the development of "Last" for footwear manufacture with perfect comfort and fit. In this project we have been guided by NSSO who have shared their expertise and have narrowed down the number of locations as well as the number of measurements pan India to design a statistically robust foot measurement survey. Synergy Partners drawn from leading institutions across the country are a source of great help in the smooth data collection process and in the successful completion of the project."

SURVEY PLAN FOR THE PROJECT

The places of measurement are selected based on geographical, ethnic, and social variables. The Survey teams will travel to identify schools, offices, groups of households, CSIR labs, and defence institutions.

Dirctor, CLRI appeals to the people at large that "In spite of the pandemic, people attending schools and colleges, and those who are working in industries, parents etc. need to voluntarily come forward to help the project team when they approach them for the survey of foot size. This will be a highly safe procedure spanning less than 5 minutes and following all COVID protocols."

As per the plan till now, for the Pan India survey, the country is divided into 4 Zones: North, South, East (further split into North East and rest of East), and West. Based on the foot growth parameters the population is divided into various age and gender groups which can be classified as:

C-GROUP	Children (boys and girls aged 4-11)
G-GROUP	Girls (only girls aged 12-18)
B-GROUP	Boys (only boys aged 12-18)
W-GROUP	Women (only women aged 19-55)
M-GROUP	Men (only men aged 19-55)

Dr D Suresh Kumar, Scientist and Co-Project In-charge at CLRI opines, "This project is very useful because footwear developed based on adapted sizing systems can never fit the Indian population, and therefore it becomes imperative to conduct an anthropological foot survey to arrive at Indian footwear sizing system based on which we can develop comfortable footwear with proper fit."

The Pan India survey will help us find out something that has never been factually discussed; if there are differences among various ethnic groups and geographic areas or if it proves that no differentiation is needed when a footwear is produced and supplied to any part of the country. Once the survey is completed and the report is submitted by CLRI, it is expected that the standards for footwear sizes would be updated by the Bureau of Indian Standards.

Data is to be protected at CSIR-CLRI and to be revised every 20-25 years to accommodate lifestyle changes.

R Selvam, Executive Director, Council for Leather Exports says, "The Survey currently being undertaken by CSIR-CLRI for development of India-specific foot sizing system is utmost essential and would play a pivotal role in having our very own Indian Standards. The leather and footwear industry wholeheartedly welcomes this survey and would render all necessary support as well as participation in the survey."

INHERENT CONNECTION OF RIGHT FOOTWEAR SIZE AND HEALTH

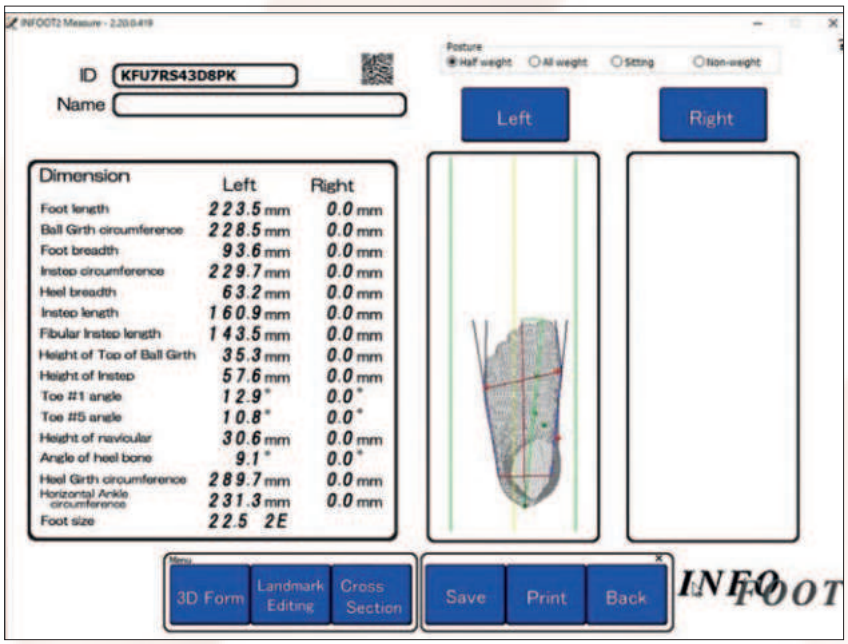
Foot pain, ankle pain, back pain, headaches etc. are very

common these days. We curse our lifestyle for these pains. However, in many cases, footwear might be reason for the suffering. Experts deduce that one of the obvious reasons is usage of ill-fitting footwear that is a major concern and cause of aggravation of foot problems. Bad footwear fits can cause injuries, more so in those above age 40, women and diabetics.

Dr Rajesh Malhotra, Professor and Head at Department of Orthopaedics, AIIMS alarms that shoes have tremendous impact on foot health and well-being in health and disease. Every part of the shoe (toe box, sole, counter, heel, and upper) can bite into comfort and result in disorders. He answered a couple of questions as well.

1. HOW DO YOU SEE EFFECTS OF FOOTWEAR SIZE AND FIT ON HEALTH?

Size and fit issues can lead to corns and callosities, foot strain and ache, toe deformities such as Hallux valgus or bunion, pain on plantar aspect of space between foot bones due to nerve friction and irritation (Morton's metatarsalgia). Over three-fourth of the adult patients, without any foot deformity by birth, face problems that are caused by ill-fitting shoes.



2. WHAT IF WE DON'T WEAR THE RIGHT FIT (TIGHT OR LOOSE) SHOES/SANDALS/SLIPPERS ETC.?

Apart from not being able to walk properly or the risk of losing balance, falling, and hurting oneself, all or some of the problems enumerated earlier can result. A shoe bite/wound caused by ill-fitting shoe in a diabetic or person with impaired sensation can even lead to amputation.

3. DOES DESIGN OF FOOTWEAR PLAY ANY ROLE?

Footwear design features are extremely important. A narrow toe box will cramp the toes and cause corns, callosities, deformity, pain, and inability to walk without discomfort. A high heel will cause callosities at the base of toes on sole and constrict the nerves on the plantar or sole side of the foot. Hard sole, especially in overweight persons or those who have to stand for long or walk far, can cause heel pain or plantar fasciitis. Tight fitting counter at the back can cause friction and cause pain on the back of the heel by causing retrocalcaneal bursitis, the most common heel inflammation.

Thus, optimal comfort and foot health can be expected only with appropriately sized footwear. All the footwear brands should market shoes that are made as per Indian standard fittings, which will help their customers to have perfect fitting shoes in order to safeguard the feet.

STAGE II OF INDIAN FOOTWEAR SIZING SYSTEM PROJECT

While the Stage I is all about anthropometric survey, statistical analysis, and development of an Indian footwear sizing system, Stage II involves foot biomechanics and gait study, materials identification, 'last' fabrication, development of design patterns and comfort parameters, wear trials, generation of specification, etc.

V Muthukumaran, Global Business Head of Leather Products at Tata International and President of Indian Shoe Federation says, "This is going to be very important for our organisation as we are looking at India as a great opportunity to supply shoes for domestic market and we are following now only either French/UK/US sizing system that are more based on their feet. What CLRI is planning to do, Indian Sizing system will help the country and we can make good products with perfect fittings based on Indian's feet."

Similarly, Ketan Sanghavi, Managing Director at Indian Footwear Components Manufacturers Association highlights, "Once CLRI comes up with the standard sizing systems, we shall incorporate these by developing reference lasts and last bottom profiles and keep into our model library. As and when any domestic shoemaker places orders, we can try to advise them about the new standards. Whether the shoemakers are willing to adopt them, that is not in our control. It is the domestic shoemakers who can make the new sizing systems reach the common man if they take it seriously."

So, as they say, the best is yet to come. The foot survey, jointly carried by Central Footwear Training Institute (CFTI) and CLRI, has begun. Measurements are being taken and hopes are booming. It is said that people notice your shoes before they look at your face, it is better to be little obsessed with your footwear.

The author is a science journalist, writer and filmmaker.
Email: neha_tripathi@icloud.com

SCAN TO GET THE INDIA SCIENCE APP NOW

INDIA'S OWN 24X7

SCIENCE & TECHNOLOGY CHANNEL

India Science is an OTT Science channel. This 24X7 video platform is dedicated to science and technology knowledge dissemination, with a strong commitment to spreading scientific awareness with focus on Indian perspectives, ethos and cultural milieu.

www.indiascience.in

PRAGYA GAUTAM

Growth of disease

PARKINSON'S DISEASE:

New Hope

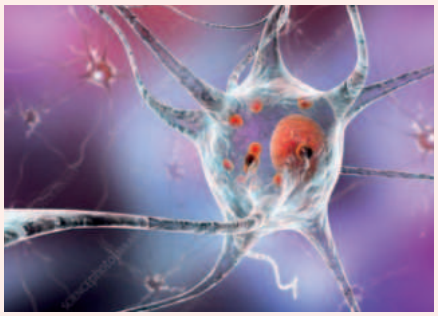
The New Year has brought in news on some new achievements in the field of medicine. Some specific substances have been identified that would prove to be effective in the treatment of Parkinson's disease. This disease still does not have any specific treatment And medicines are used only to control the symptoms of the disease to some extent.

Like the Alzheimer's disease, Parkinson's disease is a common neurological disorder that affects nearly ten million people in the whole world. Due to gene diversity this disease has lower percentage in India, but as the population of our country is high, quite a significant number of patients are found here. Generally, it affects people over the age of sixty. However, depending on heredity and environment, it can also be seen on younger people. It is one and a half times more prevalent in men than women.

Parkinson's disease and its management

There is a small area in the midbrain which looks darker and is known as the substantia nigra (SN). The cells of this area generate the hormone dopamine that works as a messenger among brain cells. It also controls the 'basal ganglia' section of the brain. Basal ganglia instruct our body on performing different activities. Dopamine has some other important functions as well. In Parkinson's disease the nerve cells of the SN begin to die. This results in reduced production of dopamine. Moreover, it is identified so late that by that time sixty to seventy per cent of the cells generating dopamine have already been dead.

One more hormone, norepinephrine begins to reduce in Parkinson's disease,

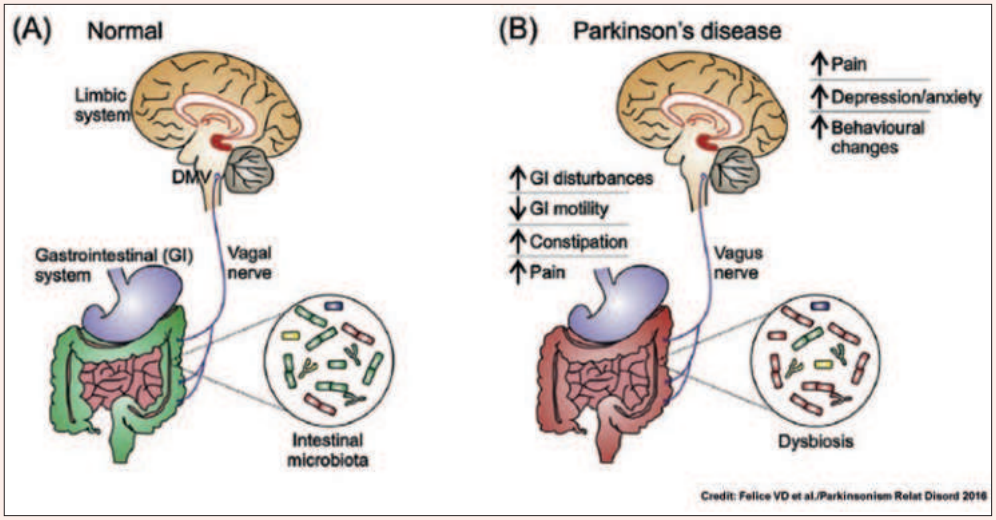


Lewy bodies accumulated in nerve cells

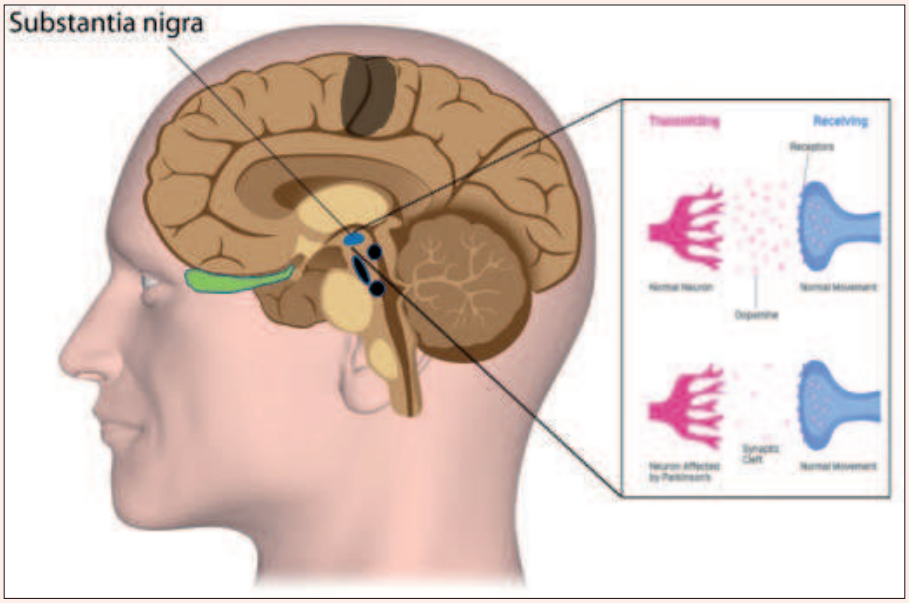
which regulates autonomic nervous system. It affects functions like digestion, heart beats, respiration, and blood pressure.

Gene mutation is one of the chief reasons behind Parkinson's disease. Heredity is often the prime cause when it is seen in young patients. A close family member suffering from Parkinson's disease or depression makes them more prone to the disease. Besides, impure water and close contact with pesticides can be other reasons. A sedentary lifestyle intensifies this disease.

At the initial stage, the patient feels shivering in one hand, leg, or one side of the jaw. Old people often ignore it as symptoms of old age. As the disease progresses the shivering increases. The patient does not shiver while sleeping and walking. Stressful daily routine adds rapid growth in the disease. Gradually, movements of hands and legs slow down as body parts do not receive signals from the brain. It affects daily activities like



Effects of Parkinson's disease



Substantia Nigra

bathing and wearing clothes. Muscles start turning stiff and the patient feels unable to balance their body.

At the next stage, the face turns blank or expressionless. It is difficult for the patients to swallow, speak, write, or urinate. The patient suffers from constipation and does not sense smell. It affects their thinking process also. Apart from this, it causes depression and hallucinations.

There has hitherto not been any kind of treatment which can cure this disease. There are some subsidiary treatments for disease management, which decrease the effects of the disease. For example, a medicine (Levodopa) is given that helps the cells generate dopamine or chemicals similar to dopamine. Medicine like COMT enzyme that destroys dopamine is also given. Gradually, these medicines turn ineffective. Also, they have a number of side effects.

Some surgical treatments are also available for this disease like Deep Brain Stimulation (DBS). In this procedure electrodes are implanted in the brain. The electrical stimulations produced by these electrodes control abnormal activities of the brain and treat movement disorders but it cannot treat other symptoms. Levodopa feeding tube is also implanted in the brain through surgery. Besides, a little part of the brain which is most affected is often removed. But all these treatments are not completely effective.

Stem cell therapy has not been much successful yet for the treatment of Parkinson's disease. It has a lot of negative aspects like certain risk at the time of surgery and rejection of cells by the body. It may also cause a tumour. It can help only improve movement disorders. Moreover, it has a moral aspect also as the stem cells are taken from human embryo.

Gene therapy presents some hope in the treatment of Parkinson's disease. This therapy affects the enzyme which transforms levodopa into dopamine. Currently, researches are being carried out on this.

New achievements in the field of Parkinson's disease in 2021

Levodopa Nasal Spray

Scientists at the University of York in the UK have developed a Levodopa nasal spray. This spray reaches the brain through nerves of the nose. This is more effective than the medicine taken orally and provides dopamine directly to the brain cells.

Problem in eating

Discovery of new Peptide

Scientists at the University of Bath (USA) have discovered a molecule that helps develop a drug that can improve patients' health. This research has been led by Professor Jody Mason and Dr Richard Meade.

A protein is found in the brain cells named alpha-synuclein (as). After misfolding, it accumulates in large masses which are called Lewy bodies. These kill the cells producing dopamine. Scientists were trying to discover something that can prevent this protein misfolding. For this work 209,952 types of peptides were screened. Short chains of amino acids make peptides that build protein. Finally, they found a peptide (4554W) which was capable of stopping the production of alpha-synuclein. Recently, the scientists have modified this peptide to make them effective. Even little amount of this new form (4654W) is quite effective. Now they are going to use this peptide as a precursor of the new drug.

Identification of the responsible protein

A protein, PINK 1, present in the cells helps build new mitochondria removing the damaged one. Mitochondria produce energy through oxidation of food in the cell. Damaged mitochondria cannot be removed from the cell when this protein does not work properly And the cells die in absence of energy.

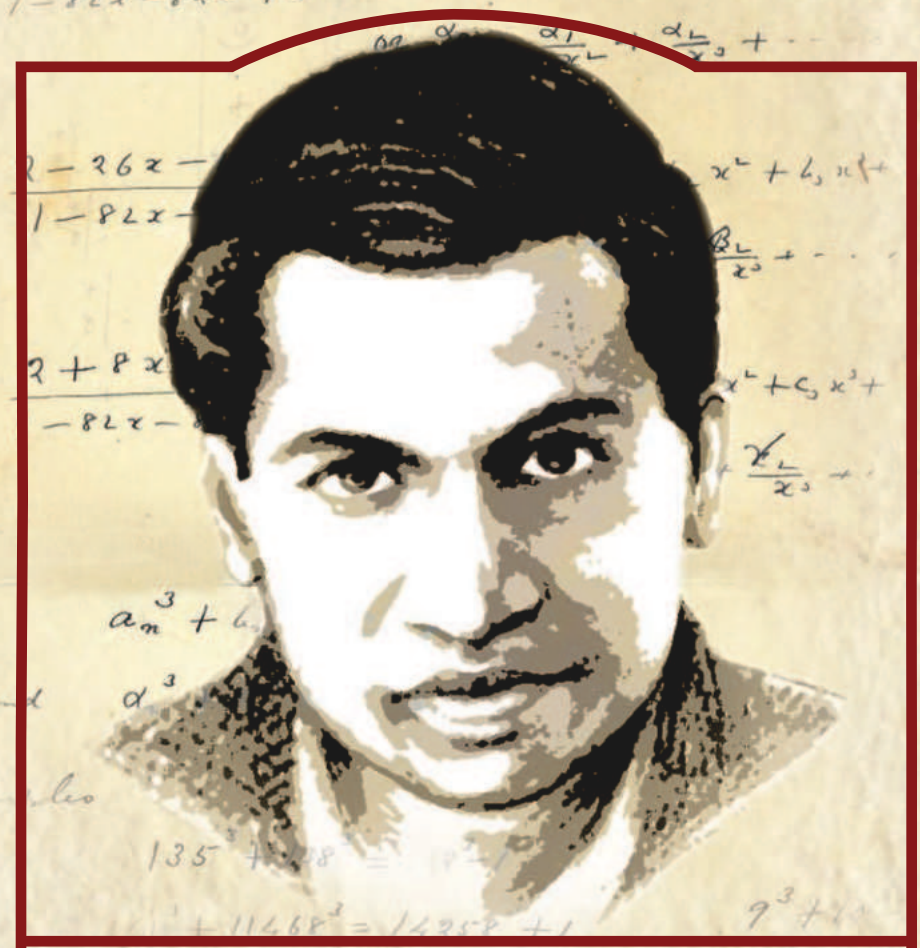
After this discovery, soon a path could be paved for the development of such a medicine which would end this disease by activating this protein again.

These achievements of the year 2021 are going to be a huge relief for the patients of Parkinson's disease. It would not only improve the quality of their life but the development of the new medicine would give them a new hope of recovery.

Translation: Kshama Gautam

The author is a Lecturer (Biology) at GSSS Talera.
Email: pragyamaitrey@gmail.com

SHIVAPRASAD KHENED



SRINIVASA RAMANUJAN: A Gifted Genius

← Continued from February issue

Failure in BA exams made Ramanujan concentrate completely on his maths research, and it was during this period, 1903-1914, Ramanujan meticulously kept a record of the final results of his original research work in the form of entries in two large notebooks. He worked extensively on his slate and recorded his final results in the notebooks. With time his profound works in maths were beginning to be noticed and he was lucky that he could show some of his recorded notebooks to eminent citizens in the city including Diwan Bahadur Ramachandra Rao, V. Ramaswamy Iyer (Founder of Indian Mathematical Society), R. Narayana Iyer (Madras Port Trust), and others to convince them of his abilities as a Mathematician. Fortunately, it helped him get an employment at the Madras Port Trust as a clerk, at a salary equivalent to about 25 Pounds a year. By this time, Ramanujan had already established himself as a fairly well-recognised scholar in maths, and reports of his unusual abilities had begun to spread far and wide. Fortunately, his talent in maths came to the notice of Dr G.T. Walker at the Madras University and with his influence, Ramanujan obtained a small scholarship, which relieved him and set him free for research.

During this period Ramanujan published several papers in influential Indian Mathematical journals. He also sent his long list of complex theorems to three academics of Cambridge. One of them was G.H. Hardy. Ramanujan had come across a book by Hardy titled 'Orders of Infinity' which motivated him to write his now famous letter to Hardy. Ramanujan's life took a decisive turn in 1913, when his 10-page letter containing 100 statements of theorems on infinite series, improper integrals, continued fractions, and number theory reached Professor Hardy. The letter was a collection of Ramanujan's self-derived equations and unproven theorems. Hardy was perplexed to receive this letter from an ordinary clerk in India who had professed to have discovered some infinite series and had listed some 100 odd findings in his letter. Hardy knew that the letter warranted some merit but was also sceptical. He met his compatriot mathematician Littlewood and mentioned some of the claims he had received in the mail from an unknown Indian clerk. Hardy opined to Littlewood that some of the assertions made in the letter of Ramanujan were well known, others could be proven, while some others they could disprove. Hardy and Littlewood decided to have a relook of the letter, which they did and agreed that many of the statements were not only fascinating and unusual but also impossible to resolve.

Hardy and Littlewood continued their discussion on this letter over the next couple of days and soon they were convinced that the sender of this innocent letter must be a genius. Hardy therefore replied to Ramanujan, encouraging him on his works. This was the beginning of a series of letter exchanges between the two of them. Although Hardy by now was sure that Ramanujan was an exceptional mathematician; however, in spite of his amazing feats in mathematics, Hardy realised that Ramanujan lacked the basic tools of the

trade of a professional mathematician. Hardy knew that if Ramanujan was to reach his full potential, he had to have a solid foundation in mathematics, which are normally possessed by the best of Cambridge graduates. For this Hardy extended an invitation to Ramanujan to come to Cambridge. Hardy was completely taken aback when Ramanujan could not make up his mind to accept this invitation. He later realised that as a Brahmin, Ramanujan was not expected to cross the 'seven seas'. His mother was totally opposed to the idea of Ramanujan's sea voyage. But fortunately Ramanujan could manage to convince his mother by invoking Goddess Namagiri to get his mother's consent. Hardy soon swung into action. He asked E.H. Neville, another fellow of Trinity College, who was on a trip to Madras, to secure Ramanujan a scholarship from the University of Madras. Neville wrote in a letter to the university, "the discovery of the genius of S. Ramanujan of Madras promises to be the most interesting event of our time in the mathematical world ...'.

What followed next is now a legend that has entered into the annals of history. Courtesy Hardy and Neville, Madras University offered Ramanujan the first research scholarship of the University. Hardy also ensured that Ramanujan was offered a scholarship of 250 pounds a year for five years with 100 pounds for passage by ship and for purchasing initial outfit to travel to England. Ramanujan, at the age of 26, set sail to England and reached Cambridge, just before the outbreak of World War I. In the very first year of his stay in Cambridge (1914), Ramanujan made some path-breaking contributions. However, he faced some major hurdles during his initial days in Cambridge. Ramanujan was majorly influenced by Carr's style of summing up his final findings and stating the formula for an infinite series or such other mathematical problem, without assigning any deductive solution. However, it neither pleased his mentor Hardy nor any other mathematicians. This incident has been beautifully depicted in a scene in the film "The Man Who Knew Infinity". The scene shows the excitement of Ramanujan to publish his new findings, and in his discussion with Hardy, Ramanujan presents him two of his notebooks adding to the 100 formulas, which he had already sent him and other problems which he had been corresponding with him. One of this was an interesting series which was mind boggling for Hardy to comprehend how Ramanujan could even visualise it. The very equation looks quite deceptive and it goes as follows: 1+2+3+4+5..... = -1/12. Interestingly, Hardy immediately recognised this to be the theory of analytic continuation (Riemann Zeta

"To preserve my brains I want food and this is now my first consideration. Any sympathetic letter from you will be helpful to me here to get a scholarship...."

Srinivasa Ramanujan

"No, it is a very intersting number, it is the smallest number expressible as a sum of two cubes in two different ways."

Srinivasa Ramanujan

Function) from complex analysis. Hardy was convinced that Ramanujan must learn to produce mathematical solutions for the answers that come naturally to Ramanujan, so that other mathematicians take him seriously. The scene shows a brief argument that ensues between the two in which Ramanujan (played on screen by Dev Patel) is seen arguing with Hardy (played by Jeremy Irons). Ramanujan expresses his desire to publish while Hardy insists that he must first learn to communicate his mind in the exacting standards that befit the standards of Cambridge. Hardy advises Ramanujan to take some basic lectures to learn a more formal language in maths which he could use to communicate his findings to his fellow compatriots in Cambridge.

With great difficulty and with support from Littlewood, Hardy manages to convince Ramanujan of his need for a formal learning to be recognised in Cambridge. The scene in the film beautifully depicts Hardy taking Ramanujan on a walk through the famous library of Cambridge. He says to Ramanujan that if areas of maths are to be challenged he must provide proofs to the formulas and that too in a manner which is understandable to the other mathematicians and for that, structured learning in maths is needed for Ramanujan. The scene shows Hardy leading Ramanujan to the hall where Newton's 'Principia' is preserved. Hardy says Newton produced this monumental findings, which took long time for the people to understand. Hardy further says to Ramanujan that if he provides proofs to his formulas, which he has noted in his notebooks, the time will not be far when those notebooks could find a place in this very precinct of Cambridge where Newton's book finds its place. Hardy's prophetic vision has been proved right. Ramanujan's lost notebooks have finally made their way to Cambridge and are in their possession even today. The scene beautifully depicts the dichotomy of relationship that existed between Hardy and Ramanujan.

Ramanujan Manuscript

Ramanujan The Lost Notebook

Ramanujan and Hardy had one of the most productive collaborations ever, and during his five years of stay in Cambridge, Ramanujan wrote around 30 papers, some alone and some jointly with Hardy. Most of his works transformed the field of mathematics. On his way to achieving success, Ramanujan had to overcome severe hardships, racism, difficulties of the World War I, procuring food appropriate for his vegetarian eating habits, and many more. Hardy was no doubt a great mentor for Ramanujan, but there is an argument that he may not have shown enough humanitarian considerations for Ramanujan, which

may have ensured a better living condition for him in England. But then these are mere afterthoughts, which have little or no meaning.

Ramanujan's contributions were soon recognised by his compatriots in Cambridge and he was befittingly elected 'Fellow of Trinity College', Cambridge, even though he didn't have a formal college degree. But, unfortunately, his stay at Cambridge was the harshest for Ramanujan. He was a strict vegetarian and he remained uncompromising about his dietetic observance. The World War I made availability of vegetarian food items for Ramanujan very scarce. Ramanujan always cooked his own food and most often neglected his health. It was during this stay in England that Ramanujan was awarded a BSc (later renamed PhD). In 1918, Ramanujan was elected as a Fellow of the Royal Society (FRS), as a Research Student in Mathematics, Distinguished as a pure mathematician, particularly for his investigations in elliptic functions and the theory of numbers. It was a rare honour for someone not formally educated, that too at a very young age. Ramanujan was also elected to the Trinity College Fellowship, in October 1918 (a prize fellowship worth 250 pounds a year for six years with no duties or condition). Unfortunately, he was not destined to make full use of this fellowship.

Godfery Hardy

John Edensor Littlewood

His health kept deteriorating in England and Ramanujan was frequently admitted to hospital. When his health improved slightly he preferred returning back to India. Ramanujan returned to India in 1919, after World War I, as a highly acclaimed mathematician. But years of stay in an unfamiliar climate in England and his uncompromising lifestyle had taken a heavy toll on his health. On his return to India, Ramanujan was diagnosed with tuberculosis and he was very weak and fragile. All through this period, Ramanujan continued to work and exchanged letters with Hardy. In January 1920, he wrote the last letter to Hardy about his discovery of "Mock Theta functions," another stupendous contribution from a man who was almost in his death bed. In this last letter to Hardy, Ramanujan speaks of a class of very interesting functions, which he describes as "mock theta functions". In his quintessential style, Ramanujan gives 17 examples of the mock theta functions but provides no precise definition. However, we now know that by "theta function" Ramanujan actually meant what we call today a "modular form"and by "mock" something "whimsical". In these 17 functions, he described properties, which are analogous to those of usual modular functions, which do not belong to any known class. The mystery of Ramanujan's Mock Theta function was solved in 2002 by Sander Zwegers in his Ph.D. paper.

Ramanujan succumbed to his long standing ailments and died on 26 April 1920. In his small lifetime Ramanujan compiled more than 3,000 results on equations and identities, many of them have been posthumously proven right. His 'Lost Notebook' was found in 1976 by Prof. George Andrews of Pennsylvania State University, and its facsimile edition was brought out by Narosa Publishing House in 1987, on the occasion of Ramanujan's birth centenary. Besides his published work, Ramanujan has left behind several notebooks, which have been the subject of academic discussion and study even today.

In his short life of little over 32 years, Ramanujan scaled unimaginable heights. What is so very unique is that his mathematics, done over a hundred years ago, finds applications today in areas other than pure mathematics, which were not even established during his time. Two among these are signal processing and Black Hole physics. What could have been the contributions of Ramanujan if conditions were more conducive for him and if he had lived longer will continue to remain in the realms of speculation. May he continue to inspire millions of Indians and global students.

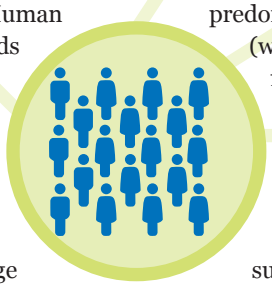
The author is Former Director,
Nehru Science Centre, Mumbai.
Email: dirnscm@gmail.com

SUBODH KUMAR SINHA

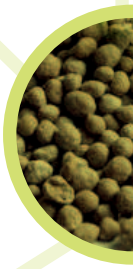
NITROGENOUS FERTILIZERS:

An intricate relation with population, productivity and pollution

It is impossible to imagine life without nitrogen because almost all major biomolecules, e.g., amino acids, proteins, nucleic acids (the genetic material, i.e., DNA, RNA, etc.), enzymes, co-factors, which constitute basic unit of life, i.e., cell, are comprised of nitrogen. Therefore, it is considered as an essential element for different life processes. Similarly, all plant species including agriculturally important crops like wheat, rice, maize, etc., require nitrogen for their growth and development, and therefore applied externally to maximize their productivity. Human population directly depends on these crop species to meet their requirements and survive. Fortunately, there is adequate nitrogen available in atmosphere, i.e., ~78%, which can suffice the need of producing large amount of agricultural produce; however, the elemental nitrogen (N_2), that is available in the atmosphere is in inactive form and cannot be utilized directly by any plant species. Most of the agriculturally grown crops prefer either ammonical (NH^{4+}) or nitrate (NO^{3-}) forms of nitrogen (active nitrogen) present in the soil depending on its biophysicochemical conditions. For instance, in aerobic soil, nitrate is the predominant form of N that is available and is preferred by wheat; whereas on the contrary, for rice that predominantly grown in anaerobic (water-filled) soil, ammonical form of nitrogen is abundant. So, abundantly available elemental atmospheric nitrogen has to be essentially converted into active forms in order to sustain all forms of life.



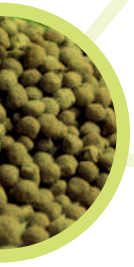
Ironically, nature bestowed only a few living entities, e.g., nitrogen fixing microorganisms, with the ability to convert the elemental nitrogen to ammonia, by a process called biological nitrogen fixation (BNF). Subsequently, the fixed N (NH_3) is further converted to other acceptable forms of nitrogen (i.e., nitrate) by other soil microbes, to be used by plants. Interestingly, leguminous crops (e.g., pulses) have the ability to develop a symbiotic relationship with such microbes by allowing them to reside in the roots (nodules), in which the resident microbes convert elemental nitrogen and supply fixed nitrogen (NH_3) to such crops. Therefore, such nitrogen fixers available either in the soil (i.e., free living) or in root nodules (i.e., symbiotic) supply ammonia which can be utilized by plants as such or it could be converted to nitrate in the soil by different groups of microbes (e.g., nitrifiers). The process of conversion of ammonia to nitrate in soil by microbes is known as nitrification. Although BNF and nitrification processes do supply useful forms of nitrogen to the agricultural soil, it is not adequate for achieving highest yield potential of any cereals (non-leguminous crops) and to some extent leguminous crops.



Therefore, it was one of the greatest challenges before humankind to devise alternative technique/process to synthesize the first active form of nitrogen (i.e., NH_3) non-biologically/chemically from elemental N_2. Thanks to Fritz Haber, a German chemist, who invented the process of converting N_2 and H_2 into NH_3 which consequently saved every fifth individual who is surviving at this moment on the planet earth. Later, the process was scaled up to an industrial level by a German chemical company (BASF) under the supervision of Carl Bosch, popularly known as Haber-Bosch process. This invention led to the foundation of manufacture of different chemical fertilizers, viz., urea, diammonium phosphate (DAP) etc., the major nitrogenous fertilizers which supply active forms of nitrogen, i.e., NH_3 and NO^{3-}, in the soil.

In order to feed ever increasing human population globally, the current and future food and feed demand led

plant breeders to develop nitrogen fertilizer responsive crop varieties. This consequently resulted in continuous increase in consumption of nitrogenous fertilizers which in turn resulted in significant jump in agricultural production globally, including India. It is estimated that by 2050 the world population will cross the 9-billion mark. Therefore, in order to feed such a large population it is quite likely that N-fertilizer consumption will also increase by manifold. Current statistics confirms that India is one of the three largest consumers (the other two are China and Pakistan) of N-fertilizer in the world. This consumption is continuously increasing each year at the rate of 6% since 1970. However, ironically, the ability of crops to utilize the applied nitrogen is decreasing which has reached to level of nearly 35% from 55% between 1960 and 2010. This implies that currently nearly 65% of applied nitrogen in agricultural land is not used by the plants; rather they are lost to the environment in its active form by several processes, viz., leaching, surface run-off, denitrification, volatilization, etc. All of these processes contribute large amount of active forms of nitrogen in the environment. One of the forms of nitrogen that is lost in the environment is nitrous oxide (N_2O), a greenhouse gas, which is almost 300 times more potent than that of CO_2 with respect to its ability to cause global warming. Similarly, the excess nitrate lost due to surface run-off and leaching cause eutrophication in water bodies harming aquatic life and finally destroying them. Nitrate contamination in water table has been reported to have serious consequences on human population. Therefore, loss of unused nitrogen causes not only an economical loss but also an environmental loss.



Technologies available

Attempts are being made globally to make a balance between agricultural use of nitrogen to meet global food demand and minimize loss of nitrogen into the environment. As opposed to other major fertilizers, i.e., phosphorus and potassium, application of N-fertilizer to crops in the agricultural field is given in split doses, supplied at critical growth stages, in order to minimize economical as well as environmental loss without any yield penalty. Farmers are being trained and encouraged to use Leaf Color Chart (LCC) to compare its colour with the greenness of leaves of standing crop in the field to estimate N demand of these crops, and then decide the suitable time of its application to adopt a demand-based supply of N-fertilizer rather than random application. Apart from it, currently neem cake-coated and neem oil-coated urea, polyurea microcapsule and nitrification and urease inhibitors are being used to minimize nitrogen loss from urea in soil by delaying the process of conversion of urea/ammonia to nitrate during nitrification.

Effect of low and optimum doses of nitrogen on wheat seedlings can be seen. The first pot has 100 times less nitrate than the second pot.

Apart from using different management practices to minimize N-losses during cultivation of crops, there is tremendous scope of improving the crops' ability to use applied nitrogen efficiently. Although different plant species utilize applied nitrogen through different inter-connected complex biological processes, the individual process of taking external nitrogen into the plant and then its further utilization to synthesize various bio-molecules for growth and development can be improved biologically. There is likelihood of getting diversity in crop genotypes for their ability of taking N from soil (N-uptake) and then utilizing (N-utilization) it efficiently even under lesser application of N-fertilizers without losing yield. One may get a completely efficient genotype or efficient in just one of the steps, e.g., either uptake or utilization (component traits) of using applied nitrogen. In any case technology is available in agricultural sciences to bring useful characters in one plant/crop in order to develop a plant/crop that is efficient in nitrogen use. However, if one does not get such superiority in any of the component traits, gene(s) responsible for such efficiency can be transferred in the desired plant/crop transgenically. Globally, including India, research attempts have been undertaken in various laboratories to improve nitrogen use efficiency of major crop species of the respective country.

Therefore, holistic approaches including sensitization of farmers about the balanced application of nitrogenous fertilizer in agriculture together with suitable scientific and policy intervention are essentially the need of the hour.

Dr Subodh Kumar Sinha is Principal Scientist at ICAR-National Institute for Plant Biotechnology, New Delhi.
Email: subsinha@gmail.com; subodh.sinha@icar.gov.in

VAITHIANATHAN KANNAN

WINGED VISITORS' ABODE IN ERODE:

Discover the Vellode Birds Sanctuary

Birds have always fascinated us, both the high-flyers stretching into clouds to land birds. Vellode Birds Sanctuary, situated in Vadamugam Vellode Village of Perundurai taluk in Erode District of Tamil Nadu, is easily accessible by road. The Government notified this site as 'Birds Sanctuary' in February 2000, under section 26(1) of Indian Wildlife Protection Act 1972.

The predominant vegetation found in the sanctuary is *Acacia nilotica* (Babul) and *Prosopis juliflora* (Velikaathan). Other tree species present in the sanctuary are *Azadiracta indica* (neem), *Borassus flabellifer* (Palmyrah) and *Muntingia calabura* (Singapore cherry). The wetland is rain-fed and canal fed by seepage water from the Lower Bhavani Project main canal. The major soil type found in this area is clay, red sandy and black cotton soil. The terrain of the sanctuary is flat with a gentle slope from the north-west towards the south-east.

In the Vellode landscape, the following villages are close to the bird sanctuary viz., Karukkangattu valasu, Vellode Mettupalayam, Thalaikattur, Sellappalayam, Semmandapalayam and ThatchangaraiVazhi. Though the Vellode Bird sanctuary is one of the ten critical breeding habitats of wetland birds in Tamil Nadu, the wetland does not have any known traditional or customary systems of water conservation, nor does the landscape have any sacred groves or species.

Earlier, not many birds were visiting this sanctuary, but soon after the establishment of *Acacia nilotica* plantation by the Tamil Nadu Forest Department under Social Forestry scheme, birds started arriving in large numbers. These trees help the birds for perching, nesting, and breeding. The farmers are also happy about the sanctuary because they feel that their crop yields have improved after the arrival of large number of birds in the sanctuary because of the irrigation water is getting enriched due to the droppings of birds. This is an added advantage to the farmers, as they get better productivity with organic fertilizers. The sanctuary receives rainfall mainly from the north-east monsoon, that is from September to December. The area remains dry from February to June. The average annual rainfall is estimated between 575 to 835 mm.

Acacia nilotica (Babul)

Muntingia calabura (Singapore cherry)

Until the Forest Department took over the wetland as a protected area, it was under the control of the Public Works Department of Erode division. The wetland was used for fishing operations till 1984. However, in July 2002 due to the failure of monsoons and scarcity of water, a large number of fish started dying due to eutrophication. Since the drying up of the wetland became almost a yearly occurrence due to failure of monsoon and accumulation of silt deposition, de-siltation is required at regular intervals.

For the conservation of birds, the Tamil Nadu government has established 13 bird sanctuaries and Vellode bird sanctuary is one among them. Due to the legal protection status the sanctuary harbour hundreds of birds species which use them as roosting, foraging, and nesting ground. A total of about 150 bird species were recorded in the Sanctuary. Of which 80% were residents and 20% were migrants. Other abundantly occurring species are the Little Grebe *Tachybaptus ruficollis*, Black-crowned Night Heron *Nycticorax nycticorax*, Indian Pond Heron Ardeola grayii, Grey Heron *Ardea cinerea*, Little Cormorant *Phalacrocorax niger*, Great Cormorant *Phalacrocorax carbo*, and Little Egret *Egretta*

Spot-billed Pelican (Pelecanus philippensis)

Oriental Darter (Anhinga melanogaster)

garzetta. Rosy Starling *Sturnus* roseus, a passage migrant in Pakistan and winter visitor to India and Sri Lanka is a migratory terrestrial bird species which is also seen here in large numbers. After the north-east monsoon, the migratory birds start to arrive in the Sanctuary. Till now, not much attention has been paid for research on the birds of the Sanctuary. Near-threatened species were also found in this sanctuary, such as, Spot-billed Pelican (Pelecanus philippensis), Oriental Darter *Anhinga melanogaster*, Painted Stork *Mycteria leucocephala* and Black-headed Ibis *Threskiornis melanocephalus*.

Birds are unique; each and every bird has a different natural habitat. Sanctuaries are built to protect these birds and their species and conservation of various species and their natural habitat. It also promotes the survival and rehabilitation of these birds. In India, we have a total of 49 bird sanctuaries, of which Tamil Nadu has eight active sanctuaries. Vellode was notified as a protected area in 2000 to maintain the diversity in this region.

The Vellode Bird Sanctuary supports four near-threatened species; overall the estimated population is about 530 birds of which there are about 300 Spot-billed Pelican i.e., 7.5% of the threshold level

Little Grebe (Tachybaptus ruficollis)

of global population. However, the Spot-billed Pelican does not breed at Vellode Bird Sanctuary as it breeds only during or just after the monsoons and uses this protected area as their foraging ground. Similarly, there are about 20 Painted Storks Mycteria *leucocephala* that visit Vellode Bird Sanctuary just after the monsoon which is 0.5% of the threshold level of global population estimation. Other than these two, large waterbirds that breed at Vellode are the Oriental Darter *Anhinga melanogaster* (60 birds) and Black-headed Ibis *Threskiornis melanocephalus* (150 birds) which is about 1.5% and 3.8% of the threshold level of global population.

After Vellode became one of the protected areas, hunting incidences have reduced and people living around the Sanctuary attempt to cut and remove dead trees from it. Similarly, sporadic instances of illicit fishing were also reported. However, the wetland was occupied by the invasive African giant catfish *Clarias gariepinnus* which is identified as the most critical detrimental factor affecting the wetland habitat. Vellode Birds Sanctuary has a great tourism potential due to the closeness to Erode. Various types of facilities have been established to attract tourists and promoting bird conservation by the Forest Department.

Other than cattle rearing, crops such as paddy, sugarcane, turmeric and maize are cultivated during monsoon. Water from Lower Bhavani channel is released; minor crops such as ragi, tapioca, vegetables, greens, and banana are cultivated including coconut plantations. The flagship species of the sanctuary are the great cormorant and darter, the numbers of which are reported to be declining within the Sanctuary. Necessary actions must be taken for protection and conservation of the birds following research-based recommendations. The Sanctuary can also be developed as a place for observing and studying birds and its diversity.

The author is former Wildlife Biologist,
Sathyamangalam Tiger Conservation Foundation
Tamil Nadu Trust, Mullaigam, Erode, Tamil Nadu.
Email: kannan.vaithianathan@gmail.com

VIGYAN SARVATRA PUJYATE:

THE WEEK-LONG PAN INDIA SCIENCE FESTIVAL TAKES OFF

Union Minister of State (Independent Charge) Science & Technology; Minister of State (Independent Charge) Earth Sciences; Minister of State PMO, Personnel, Public Grievances, Pensions, Atomic Energy and Space, Dr Jitendra Singh on 22 February emphasised the need to incorporate the scientific achievements made in India into the country's cultural ethos to help in laying the road map for the future progress.

Inaugurating a week-long pan India science festival titled "Vigyan Sarvatra Pujyate" (Universal Reverence for Science), along with Mr. G Kishan Reddy, Union Minister of Tourism, Culture and Development of North-eastern region of India, Dr Singh said that one should not ignore the past while marching forward. "As Churchill said, 'The longer you look back, the farther you can look forward".

Tracing the legacy of scientific achievements in the last 75 years, Dr Singh said that under Hon'ble Prime Minister Narendra Modi, technology has now entered every household and it is for the scientific community to decide how to get the optimum results from the new scientific breakthroughs. He noted that Prime Minister Modi, on numerous occasions, has highlighted the role of science and technology in achieving the country's national and international goals and the need to nurture scientific temper and take science to people in their mother tongue.

The Minister pointed out that India's scientific laboratories as well as scientific manpower now compete with the best in the world. He recalled that the world's best corporations and companies, such as Alphabet, the parent company of Google, Microsoft, Twitter, Adobe, and IBM are being headed by Indians or people of Indian Origin, who have got their basic scientific training in scientific institutions within the country.

Dr Singh urged that to get the maximum fruits and benefits out of science and technology, there was a need to inculcate a scientific mindset and to achieve that, access to scientific information and knowledge is a must. He noted that "Vigyan Sarvatra Pujyate" is being organised in 75 different cities across the country, from Kashmir to Kanyakumari and from Kutch to Kamprup, marking the National Science Week (22-28 February 2022) and popularise science among the public.

The event is part of the "Azadi Ka Amrit Mahotsav" to pay homage and showcase the achievements of the 75 glorious years of India's independence. It is being coordinated by Vigyan Prasar, under the aegis of the Ministry of Culture, Office of the Principal Scientific Adviser (PSA) and Ministries of the Government of India.

Dr Jitendra Singh said the Government was bound to achieve not just a 100% literacy rate but 100% scientific literacy rate and noted that Vigyan Prasar had commenced an ambitious programme in this direction, Project Vigyan Bhasha, to communicate science in various Indian languages. Including Sanskrit, work has begun in Urdu, Kashmiri, Punjabi, Marathi, Kannada, Tamil, Telugu, Bangla, Nepali, and Assamese.

The science festival will end with a grand valedictory function. It will coincide with the National Science Day, celebrated on 28 February every year since 1987 in remembrance of Nobel Laureate Sir C.V. Raman's path-breaking discovery of the Raman Effect in 1930. National Science Communication Awards to this year's awardees and prizes to the winners of various contests held as part of the Mahotsav would also be presented. Information on Vigyan Sarvatra Pujyate is available on www.vigyanpujyate.in

Dr K VijayRaghavan, Principal Scientific Adviser (PSA), Government of India, Dr S. Chandrasekhar, Secretary, Department of Science and Technology, Dr Parvinder Maini, Scientific Secretary, Office of the PSA and Dr Nakul Parashar, Director Vigyan Prasar and other senior officials joined the inaugural event.

VP Team

Form IV (see rule 8)

Details of the ownership and other facts relating to monthly newsletter 'DREAM 2047'.

Place of Publication	Noida
Periodicity of Publication	Monthly
Name of the Publisher & the Printer	Nakul Parashar (on behalf of Vigyan Prasar)
Nationality	Indian
Address	Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida-201 309, U.P., India
Name of the Editor	Nimish Kapoor
Nationality	Indian
Address	Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida-201 309, U.P., India
Name & Address of the owner	Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida-201 309, U.P., India

I, Nakul Parashar do hereby declare that to the best of my knowledge and belief, facts mentioned above are true.

Sd/-
Nakul Parashar