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"Effective Science Communication for an Informed Society"

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Edited by: Professor Mayuri Wijesinghe, Professor R D Wijesekera

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Foreword

Informed communities more often take rational decisions for their betterment. Higher attainment in education and improved literacy make countries progress, not only through economic dimensions, but also social, environmental, and through overall human development. Science has a major part to play in national development. It drives and opens the way for progressive thinking and action. Nonetheless, science is still not given its due place in many countries including in Sri Lankan policy discourse. This is evident from the resource allocations in the country for science-based knowledge generation over the last five decades. Awareness of the public is a mandatory requirement to influence the selection of policy formulating positions. Public pressure, at least to some extent, helps in making correctly directed decisions. Thus, measures taken to increase awareness of the public is of utmost importance, more so in times of crisis.

Science Communication is the key to inculcate scientific knowledge and skills for pursuing better choices. One of the main objectives of the Sri Lanka Association for the Advancement of Science (SLAAS) is dissemination of scientific knowledge and promotion of discussion. Aligned to this objective, the annual theme for SLAAS sessions this year is 'Effective Science Communication for an Informed Society'. In order to fulfill this objective, many activities were undertaken during the course of the year. Improving the competencies of the scientists to interact with media, clarity of expression of their scientific findings through lay communications, training of media personnel on science communication, sensitizing school children on basic science communication principles and practices, and advocacy to improve space for science in mass media, are a few worthy of mention.

The is the cornerstone of the annual sessions of SLAAS, that tries to bridge the gaps of known to unknown on a contemporary topic of interest. In line with the annual theme, the theme seminar this year is dedicated to exploring the frontiers of science communication for a better future. The theme seminar brings together a rich pool of expertise to deliberate on many dimensions of science communication, from historical perspectives through contemporary engagements in policy issues, to emerging communication trends in the country, and the responsibility of the public intellectuals to engage in science communication. The insights gained will no doubt help us to improve the public accountability of scientists through active engagement in the development processes of the country.

I sincerely hope this would be the beginning of a new era for scientific discourse in Sri Lanka, where a transformation is envisaged, "science for people" and not "science for scientists".

Prof Manuj C Weerasinghe
General President, SLAAS

Effective Science Communication to the Public: Sri Lanka's performance and challenges

Sarath Wimalabandara Kotagama

Communication has to do with information. The little available information for the 'prehistoric' man who spent his life as 'Hunter-Gatherer' was adequate for them to survive. With the advent of 'agriculture' some 12-15,000 years ago the growth of information and the need to communicate the same became an important survival tool. **'Learnt information'** if it was to benefit **'man-kind'** as a whole, had to be communicated. Thus, the significance of communication for survival becomes inevitable.

How did we communicate? From available 'evidence' and 'information' we know that in the beginning this was 'verbal', 'symbolic' and 'illustrative'. Was this information reliable and accurate? It must have been, and where it failed, probably 'inaccurate' and unreliable!!! We will never know.

As the 'pastoral man' 'developed', the need to ensure 'reliability', 'accuracy' and 'repeatability' of the information became critical to ensure his survival. This 'inquisitive – inquiring mind' demanding 'accurate-reliable-repeatable' information paved the way to what we consider today as 'scientific information'. The next obvious question will be, 'how is this scientific information communicated? By the time we were generating scientific information modes of information transfer, other than verbal and symbolic, were in place. 'Written' forms of information transfer – on 'barks and plates', and finally on paper – made the process easier and faster. It enabled a wide coverage and led to the development of 'language'. The language for general communication was not adequate or precise. This required, to some degree, the growth of a 'scientific communication' system.

Scientific communication has its own features and styles. Thus, it somewhat distances 'itself' from the common communication 'language' and system. The effectiveness of this 'improved' overtime, with the development of science and technology through digitalization. Science Communication, is now inclusive, it is not only the language but the 'model', which needs to be 'effective' if it is to bring about 'change' or 'adjustments.

Inquiring into some pertinent questions in the development and use of science communication methods at this juncture may arouse the inquiring mind about effective scientific communication.
Reflections of some milestone events of the past is recalled here to illustrate the problem of scientific communication in the country.

In 1972, the late Prof Carlo Fonseka boldly stepped forward to provide a 'scientific' explanation for fire walking. As a university student I was privileged to have been part of the

story. We were there to validate 'scientific thinking' against 'belief'. The communication was not effective to squash the belief, despite the scientific basis of the exercise.
The common environmental notion that the 'tree cover in the mountains brings rain' is still with us, despite the scientific evidence that rains are generated due to the monsoonal winds that form in the oceans. The importance of the tree cover to 'trap the water in the clouds, help in the percolation to ensure the maintenance of the dry weather flow, and prevent the erosion of topsoil' has yet to sink into the minds of the masses.

In 2008, the National Science and Technology Policy had this to say – "Sri Lanka is in an enviable position of being one of the countries in the world with an exceptionally high literacy rate, a status that had been attained largely on account of the system of compulsory education up to the GCE Ordinary level Examination. However, the absence of a broad-based scientific literacy policy supported by an integrated approach to science and technology, has restrained the growth of an innovation culture in Sri Lanka" (NASTEC, 2008). Fourteen years later this situation has not changed, despite numerous attempts to inculcate an education that is 'holistic' and 'futuristic'. Has the scientific communication failed?

Seeking 'proven scientific evidence of the relationship between applications of chemicals in agriculture and CKDu among the people' is another interesting issue that relates very much to the misunderstanding of the so called 'experimental scientific proof'. In reality 'science does not prove anything but provides logical evidence to accept one notion while setting aside another'.

"Science Communication is about communicating science and building bridges between the people involved in scientific research and varied groups of the public. But Science Communication is much more than just communicating science. Science Communication is involved in developing government science policies, understanding relationships between 'the public' and 'scientists', and creating science stories in the mass media, as well as exploring how people learn about, and engage with science." (Emily Dawson).

The growth of Scientific Communication has much to do with the development of tools and applications that have over the years made our life better than before. It is also because we have come to recognize some of our mistakes in the processes that effect daily life for example, climate change. Development of GMOs, emergence of infectious diseases (EID) e.g. Covid), use of animals in research, Artifical Intelligence and robotics are all controversial in the society. They are all seen to be the future directions for the betterment of humankind. The final rejection or acceptance will depend on successful scientific communication.

In the field of natural resource consumption, the inability to understand protection

and conservation remains, as the science is not understood. Conflict resolution between man, animal, land resources, forest cover, water etc. are classical examples of poor Science Communication.

For most people, science is something they learn in school; after that, most of the science people see or hear about is in the mass media. In other words, science is something you do at school when you are young and is something you see on the television, or read about in newspapers or online, when you are older. If your job involves science, you will become a specialist in that area, but will probably not know more about other areas of science than anyone else. But science plays an important and complicated role in our lives, so being able to understand, learn, question and critique science is an important part of modern life.

Today, Science Communication is a broad field of activity and research, so people working in Science Communication do a wide range of activities. Some work for the government and research councils, and train scientists to communicate different aspects of their research. Others work for science centres and spend their days doing experiments in front of large gatherings. Others still do social research to understand how the public think about scientific issues. Science Communication is an important subject, but from what is evident of the situation in the country, it appears to have failed.

The writer, SW Kotagama gained admission to the Colombo Campus and graduated with a special degree in Zoology in 1974. In 1977, he proceeded to the University of Aberdeen, Scotland to read for a PhD degree. After his return in 1982 he served as a Lecturer in the Department of Zoology, University of Colombo, in the Faculty of Natural Sciences. He left this position in 1985 and joined the academic staff of the Open University of Sri Lanka where he also served as the Head of the Department of Zoology. In 1989 / 1990 he served as Director of the Department of Wildlife Conservation on secondment. In 1997, he was appointed professor of Environmental Science in the Department of Zoology, University of Colombo, and was appointed as Professor Emeritus on retirement. He served a tenure as Head of the Department of Zoology, University of Colombo.

Over the years, Kotagama has made a tremendous contribution towards uplifting the status of environmental education in Sri Lanka. His focus on field exposure and the hands-on training provided to many undergraduates, instilled in them a keen interest

in the natural environment. He has authored and edited a large array of books on birds which are widely used by school children, undergraduates, researchers, academics, and the general public. It is seldom that you come across a bird watcher in Sri Lanka not being in possession of one of the many illustrated bird guides he has produced. For the convenience of Sri Lankans, these books have been translated into Sinhala and Tamil languages. One of his most significant achievements was the establishment of the Field Ornithology Group of Sri Lanka (FOGSL).

During his career he had served as a Consultant to many government and non-government organizations, as well as being a member of several Advisory Committees – Central Environmental Authority, Department of National Museums and the Sri Lanka Foundation Institute. He has also served as an advisor to the Ministry of Wildlife Resources andConservation, and held the position of the Vice President of the Ecotourism Society of Sri Lanka.

He has received many awards, among them is the '2003 Distinguished Service Award for Environment Education and Journalism' awarded by the International Society for Conservation Biology. He was bestowed the title of Vidya Jyothi by the Government of Sri Lanka.

Role of Science Communication in Nurturing Innovation: The Sri Lankan Experience

Ajith de Alwis

The current crisis in Sri Lanka has its roots in communication failures, especially in scientific communication. Apart from issues resulting from the failure of values, significant corruption at all levels in the system, with aconsiderable number of situations being mishandled due to pseudo sciences, has been identified. Some recent examples are; the link between glyphosate usage and CKDu, chemical fertilizer becoming synonymous with agrochemicals, surges in infertility where the discussion did not focus on science, scientific evidence and the subsequent discourse. Sri Lanka's position on the global stage was undoubtedly affected by these situations. The origins of these situations can also be traced to as far back as post-independence. One fact to be understood is that Sri Lanka in principle did not embrace sciences significantly in its decision-making. The implications of this approach had been telling. The current situation which was subject to analysis reveals multiple failures.

Sri Lanka has demonstrated significant naivety when it comes to handling scenarios where sciences should have formed the core enabler in decision-making. Considering Sri Lanka's literacy level as well as its human development index, it is almost embarrassing to acknowledge some of these failures. Decision makers have boldly embraced horoscopes in place of telescopes in deciding on the way forward, and such decisions have had the potential to impact the trajectory of the nation.

The Scientific American was the first magazine in the United States. The Royal Society in the United Kingdom was quite influential in England. The Renaissance in Europe when coming out of the dark ages gave significant impetus to scientific development. There is no question that progress in science and technology, reflected as innovations, created trajectories of value and growth in these nations. Communication with the wider community was considered essential. Scientific work is not complete unless and until what one has realized or achieved has been effectively communicated. Humphrey Davy had open presentations where admission tickets were issued, and Michael Faraday was a result of such an event. 'The Scientific Method' is one of the most important elements in science. There is real value in internalizing this process in one's daily life. Emotional decision-making has resulted in so much distress and backwardness in our society. Politics significantly divorced from Science, has caused irreparable damage to the nation's psyche and fabric. Each major newspaper readily allocates space, time and energy to publish an astrology tabloid. With so many scientific and technological advances taking place finding space to enthuse and educate the reader is an uphill task. Stated simply, there is no reward for scientific communication in the annual awards presented to the media. SLAAS has in fact, been the only organization that has supported the upliftment

of the all-important segment of scientific communication. These efforts have continued unabated, but it is known that any progress achieved had been against much headwind.

The current economic crisis is not an easy problem to resolve. Years of inaction and erroneous practices have pushed us back significantly. Believing in a linear incremental growth will not help the citizenry. Innovation is the key factor in overcoming the crisis. Innovation however will not materialize as an item on a wish list. Sustained action is necessary from school education upwards with 'creative destruction' as an element in arriving at an answer within a satisfactory time frame. Innovation can support geometric or exponential growth. Innovation is not a 'single-person' activity. Teamwork requires positive communication. Well-targeted scientific communication is vital in mobilizing, energizing, and ensuring the masses stay on course with a purpose. It is easy to ensure purpose once a firm foundation has been laid.

There is ample evidence to demonstrate that communication supports innovation. President Kennedy and the 'Moonshot', and more recently, Prime Minister M Modhi 's 'Make in India' are examples of communication driving innovation. Remember Apollo 1 burnt on the ground and Apollo 11 landed on the moon. The wrong headlines with the wrong messages from the leadership would have stopped moonshot on the launching pads of the burnt-out capsule of Apollo 1. This also demonstrates that communication strategies are needed and that one must understand the audience. Science communication is not about giving what the people want but taking the people to a new level that they themselves would not be aware of.

Professor Ajith de Alwis holds a BSc. (Eng) degree from the University of Moratuwa (Sri Lanka), a PhD from the University of Cambridge (UK), and an MBA from the Postgraduate Institute of Management (PIM) of University of Sri Jayewardenepura (Sri Lanka). He is the recipient of numerous awards in recognition of his work, the most notable being the Senior Moulton Medal of the Institution of Chemical Engineers (UK), Danckwerts-Maxwell Award from the University of Cambridge for the best PhD Thesis, and the University of Moratuwa Research Awards from 1997 to 2007.

He is a Senior Professor at the Department of Chemical and Process Engineering at the University of Moratuwa and is also the Director of the University of Moratuwa-Cargills Food Process Development Incubator. He served as the Chairman of the Engineering Re-

search Unit (ERU) of University of Moratuwa from 2005-7. Ajith was also a post-doctoral research fellow at University of Reading (UK) and Visiting Scientist at the Indian Institute of Science (IISc) in Bangalore. He has published many research articles and book chapters in various international and local journals. He was also the Science team leader for Sri Lanka Institute of Nanotechnology (SLINTEC) from its inception in 2008 to 2011, and Chairman of the National nanotechnology committee at NSF from 2011-2012.

He is a member of various local and international professional bodies; the Cambridge Philosophical and Commonwealth Societies, the American Institute of Chemical Engineers (MAIChE), the Editorial Board of the European Journal of Food & Bioproducts, Fellow of the National Academy of Sciences Sri Lanka, Life Member of Sri Lanka Society for the Advancement of Sciences, the National Expert Committee on STEM Education of the Ministry of Education of Sri Lanka to name a few, and also the founding President of the Sri Lanka Biogas Association of Sri Lanka. He served as a member in the Board of Scientific Counselors of the National Institute for Occupational Safety and Health (NIOSH). He has served in the Intellectual Property Advisory Committee of the National Intellectual Property Office (NIPO), Sri Lanka, since 2015. He is currently the Project Director of the Coordinating Secretariat for Science, Technology and Innovation (COSTI) Sri Lanka. He is also a regular columnist to the Daily FT (www.ft.lk/columns) on Science, Technology and National Development.

Political Economy of Science Communication in the Global South: Lessons from India

Sunita Narain

Sunita Narain is the Director General of the Centre for Science and Environment (CSE) and Chief Editor of CSE's fortnightly science and environment magazine Down To Earth published regularly since 1992. She is an Indian environmentalist and activist as well as a major proponent of sustainable development. Narain began her work in the early 1980s, as a co-researcher with Anil Agarwal, an eminent and committed environmentalist who gave the country its environmental concern and message. In 1985, she co-edited the State of India's Environment report, which built an understanding in the country on why India is so important for the poor. She has continued to research and write about how environment must become the basis of livelihood security of people in the country. She has also linked issues of local democracy with global democracy, arguing that every human being has an entitlement to the global atmospheric common. In 2012, she has authored the 7th State of India's Environment Reports, Excreta Matters, which presents a comprehensive analysis of urban India's water and pollution challenges. In 2016 she was included in TIME Magazine's list of 100 Most Influential People in the world. In 2020, she served on "A future for the world's children?", a WHO-UNICEF-Lancet Commission. Narain appeared alongside Leonardo DiCaprio in the 2016 documentary 'Before The Flood' and talked about the impact of climate change on the Monsoon in India and how it affects farmers.

How Pakistan can develop a culture of Science

Pervez Hoodbhoy

School syllabi demand it, but even so very few young Pakistanis want to study science subjects and still fewer want to become scientists. Many generations have found science so odiously dull that they are now indifferent – even hostile – to a subject that stands at the very pinnacle of human understanding and progress. While some of our better students will be reasonably successful in science-related professions such as engineering, medicine, and information technology, their poor science backgrounds will leave them ill-equipped for pushing the frontiers of these rapidly evolving fields.

Contrast this with India. Surveys show that school students see science as the most prestigious and glamorous career to pursue. For them, Einstein, Stephen Hawking, black holes, genes, etc. is the way to go. Although most eventually opt for more 'normal' professions, sufficient numbers persist and some eventually rank among the world's better scientists. This has been key to India's emergence as a world power.

Why study science?

Across the world, science is taught in schools for an excellent reason – we owe pretty much the entire modern world to it. The prosperity of nations and individuals is contingent upon our ability to understand, apply, monitor and, when necessary, control science. Take the products of science away and we would return to the dark days of our ancestors when a child at birth was more likely to die than live.

There is another excellent reason to study science. Far from being a cold and soulless collection of facts, it is a delicate and beautiful human pursuit imbued with principles that are amazingly simple and precise. At the same time, scientific principles are incredibly powerful and universal. Exactly the same laws explain why the universe is expanding, stars shine, the sky is the colour blue, human hearts beat and birds fly. Science engages the imagination and fascinates endlessly.

But science is more than gadgets and processes. It is even more than a beautiful and elegant terse description of nature. Fundamentally, science provides a way to comprehend reality in ways that enable truth to be approached incrementally through a rigorous step-by-step process. Science insists on relentless questioning and testing of assumptions, using both logic and empirical verification.

The nature of science, which I have tried to describe above, also makes it the weapon of choice for combating the madness of fundamentalism that is now sweeping the globe. Science is a lethal antidote for every kind of dogma and fundamentalism. Consequently, it is deeply feared by the orthodox.

To appreciate this, let us revisit the epic trial of Galileo. It was not a question of cosmology or physics that worked the papacy into a hangman's frenzy. The church could not really have cared whether the sun goes around the Earth or vice-versa. Crucially important, however, was that the word of God stood in danger of being shown up. If, heaven forbid, the Earth actually encircled the sun, the Bible would be proven wrong, suggesting that its authors would have flunked freshman physics. This would have placed into jeopardy the entire text of the Bible, including all miracles. All the glorious stories of Joshua and Gideon – which good Christians must accept without question – would have been placed in doubt. Science, which nags constantly for empirical proof and obsessively asks for reasons, was simply too annoying – and threatening – to be tolerated or even ignored by the 17th century Catholic church.

Pakistan has had more than its share of miracles. As just one example, the sudden appearance of Prophet Mohammed's alleged footprint in the sleepy village of Dharabi near Chakwal sent a wave of religious excitement across Pakistan. Tens of thousands of visitors from Swat to Karachi sought blessings, spiritual enlightenment, miracle-cures, and relief from life's other stresses. A road that is sparsely traveled in normal times was clogged with traffic, vendors of food and drink, had a field day, new businesses sold pictures and holy paraphernalia, and a permanent shrine was constructed. But this also ignited a fierce war of words between various religious fractions in the larger Chakwal area. Some believers insist that the Prophet had left the earthly world once and forever, while others contend that he revisits it periodically to remind followers of his presence. The police were called to prevent further physical violence.

In India, archaeological science repudiates the fanatics of the Vishwa Hindu Parishad who in 1992 instigated bloody riots in India after pulling down a 400-year-old Babri mosque, claiming that the god Ram had been born in a temple that had once existed in the same place. Another example is that related by the Indian writer, Praveen Swami: Early in March 2012, little drops of water began to drip from the feet of the statue of Jesus nailed to the cross on the church of Our Lady of Velankanni, down on to Mumbai's unlovely Irla Road. Hundreds began to flock to the church to collect the holy water in little plastic bottles, hoping the tears of the "Son of God" would sanctify their homes and heal their beloved. Sanal Edamaruku, the eminent rationalist thinker, arrived at the church a fortnight after the miracle began drawing crowds. It took him less than half an hour to discover the source of the divine tears: A filthy puddle formed by a blocked drain, from where water was being pushed up through a phenomenon all high-school physics students are familiar with, called capillary action.

Molecular biology and genetic science have made nonsense of creationism and intelligent design that is cherished by Christian fundamentalists in the United States. Such

people continue to mount a relentless campaign to include in school curriculums their faith-based views of how the Earth and its living organisms came to be.

Some extremist Jewish groups also derive additional political strength from anti-science movements. For example, certain American cattle tycoons have for years been working with Israeli counterparts to try to breed a pure red heifer in Israel, which, by their interpretation of chapter 19 of the Book of Numbers, will signal the coming of the building of the Third Temple, an event that would ignite the Middle East.

Why our science teaching is so bad

I have argued above that some anti-science currents exist in many countries including America, India, and Israel. Fortunately for them, these are side-currents and those people who believe in combining religion with science are considered 'crackpots' in those countries. This has allowed a genuine science to flourish, both with regard to research and teaching.

Pakistan, unfortunately, is not doing well at all in science. Here we have many crackpots in the mainstream. In terms of new discoveries and inventions, Pakistan scarcely appears on the scientific map of the world. To understand the difference from scientifically successful countries is very important. Where should one begin?

As in many other developing countries, the dead hand of tradition blocks progress. The Pakistani educational system, shaped by traditional social and cultural values, discourages questioning and stresses obedience. This means that scientific thinking is difficult to develop and nurture.

Tyranny of the teacher lies at the core. In Urdu we say that the teacher is not just a teacher, he is your father. Since a father is all-wise, he dares not be questioned. Instead of experiencing science as a personally fulfilling quest for understanding, under the watchful eyes of despotic teachers, students memorize an arbitrary set of rules and an endless number of facts. X is true and Y is false because that is what the textbook says. I grind my teeth whenever a master's student in my university class gives me this argument! But this is the inevitable consequence of authoritarianism. The mindset needed for authentic science is alien to the educational environment of schools, colleges, and universities in countries such as Pakistan.

How can countries that remain mired in such a thought-deadening process of education develop a true scientific mindset?

The first thing that must be stated is that to begin the effort in colleges and universities is to begin too late. Change must be instituted at the primary school level. Good science pedagogy requires deliberate inculcation of the spirit of healthy questioning in

the classroom among five- and 10-year-old children not just 20 year-old young adults. Correct attitudes start developing naturally when students encounter questions that engage their mind rather than test their memory. For this, it is important to begin with tangible things. One does not need a doctorate in cognitive studies to know that young people learn best when they deal with visual, auditory, tactile, and kinesthetic objects. As their experience grows, they learn to understand abstract concepts, manipulate symbols, reason logically, solve theorems, and generalize. These abilities are destroyed, or left woefully undeveloped, by rote memorization.

It should therefore be normal practice for teachers to raise such questions as: How do we know and learn? What is important to measure? How can we confirm our measurements and conclusions? What evidence has been brought to bear on the question? How can we make sense out of the results? Is there a counter explanation, or perhaps a simpler one? The aim should be to get students into the habit of posing such questions and then framing answers.

Bad textbooks

In my opinion science textbooks authored in Pakistan should be banned because they are a serious impediment in the development of a scientific culture. Although a dysfunctional examination system and bad science teachers are also blameworthy, poor textbooks are especially debilitating in a culture where the written word is considered virtually unchallengeable.

Over the years, I have collected many titles, both in Urdu and English. The Urdu ones are even more unattractive than their English counterparts. All were produced by the Punjab and Sind textbook boards. The number of printed books must now run into many hundreds of millions.

The books reflect an attitude that science is to be taught no differently from geography or history. A stern looking Quaid-e-Azam on the inside of every front cover admonishes students to study else "we may be wiped out altogether". But threats – or exhortations that learning is a holy duty for improving our chances in the Hereafter – are useless. They cannot create interest in a subject that springs from human curiosity.

Local books seem designed to kill curiosity rather than nurture it. Mathematics is reduced to a set of drills shorn of relevance and meaning, while physics, chemistry and biology are just about remembering formulae and diagrams. Whether written from scratch, or with bits cut and pasted from here or there, these books give no hint that knowledge is being continuously created by human endeavor and intelligence.

Bad pedagogy is all over. For example, a terrible way of teaching about surface tension

is to begin with "surface tension comes because a skin is created on the surface of a liquid by attraction of molecules". Now, no one has ever seen a molecule with a naked eye, much less seen one attracting the other. A student who learns it this way has not learnt anything at all.

On the other hand, a good approach would be to ask the student to gently place a razor blade on the still surface of water. Why does it float? The student is then allowed to deduce that there is some kind of invisible skin; a drop of liquid soap thins it further and the blade sinks. In this manner the student could be led towards meaningful comprehension of phenomena through a logical process.

The weakest parts of the books I have browsed through are the chapter-end questions and exercises. This is useless memory-recall drill. The authors do not know that the essence of science is problem solving, and that good scientific training builds a student's capacity to internalize newly learnt principles by applying them to problems whose answers are yet unknown. In contrast, foreign-authored O-Level books – used only by a tiny sliver of up-scale Pakistani schools – usually do have good questions.

There is only a little good news. Compared to earlier textbooks, newer ones have fewer conceptual and spelling mistakes. Also, with time, better printing and use of color illustrations are more common. But, as before, a jumble of facts bundled together cannot spark the imagination of young minds.

Some say that money lies at the root of the problem. Indeed, authoring textbooks is a lucrative business because of the sheer volume of books sold. The pressure to include incompetent authors – and to share profits – is enormous. This is probably why the current class-10 mathematics book of the Punjab Textbook Board has six authors, and the slim 187-page class-10 chemistry book has eight authors! So, while every individual gets a cut from the sales, the blame can be easily passed on to others.

I doubt that stricter regulations can help. Local textbooks are such poor pedagogical instruments for a very good reason: Science is not part of Pakistan's national culture. There is endless political entertainment on TV but no locally produced science programmes. I know of no science museums except for one in Lahore. So great is the public's ignorance of science that the path-breaking work of Nobel Prize winner Abdus Salam is considered inferior to the copy-cat reverse engineering that led Pakistan to the bomb.

There is a solution: Good science books exist. So, use them! Elite O-level schools use books chosen from the most successful ones published internationally. Surely matric-level schools can be made to do the same after the books are properly adapted/

translated. Should a Pakistani be the author (or among the authors), so much the better! But quality alone should matter, not where the author comes from.

Unfortunately, nationalist bravado kicks in whenever this is proposed. The rhetoric is that Pakistanis can author science textbooks just as well as anyone else. The conclusion is that we should not rely upon foreign educational materials. But an inflated national ego, together with small scientific accomplishment, is hardly helpful.

Firm resolve is needed to turn the situation around. Pakistanis must admit locally written textbooks are nowhere as good as foreign ones and decide to use the very best ones available anywhere. The argument against importation is senseless because we use medicines and computers invented by outsiders, fly in their planes, and use their mobile phones. False pride and misplaced beliefs must be set aside. Eating humble pie is never easy, but surely this is a small price to pay for having scientifically smart Pakistanis in the future.

The way forward

Bad science teaching in Pakistani schools and widespread scientific illiteracy has made the siren song of unreason ever more sonorous and attractive. In older times, only the ignorant and illiterate accepted the idiocy of the aamils, pirs, mullahs and assorted soothsayers and charlatans. Today, however, even college graduates and the rich and powerful, calmly accept and embrace nonsense. To them it is high wisdom.

Good science education can help change this. In fact, the demons of superstition and narrow-mindedness can only be chased away by those who know and understand the spirit of science.

Though difficult, the situation in Pakistan is by no means hopeless. Let me give one personal example that shows that, bucking the mind-deadening 'education' in schools, Pakistani kids are still curious. Long before the age of the internet, inspired by the world-renowned scientists Carl Sagan (of Cosmos fame), I created and presented a series of popular science programmes for Pakistani television. The response was phenomenal. I received thousands of letters, many from young students living in remote villages. Dozens of young people personally came to my department: I even had an unannounced visit by the entire student body from a remote village school in southern Punjab!

Science cuts across every boundary – cultural, political, social, and even psychological. The only way to get a handle on many of today's conflicts is to enable people to learn to think more scientifically and to encourage them to move away from the various fundamentalisms derived from religion, nationalism and other exclusivist ideologies that create impenetrable, yet false, boundaries between me and you, and us and them.
The message of science is that we are one human family. The process of science proves

that the only way to effectively deliver this message is through clear and rational thinking that has been nurtured through good education and challenging and rewarding experience. Money counts in achieving this humanistic goal. But mindsets count much more.

The writer, Dr. Pervez Amirali Hoodbhoy is a nuclear physicist and prominent activist who serves as a professor at the Forman Christian College. He is particularly concerned with promotion of freedom of speech, secularism, scientific temper and education in Pakistan. Hoodbhoy studied at the Massachusetts Institute of Technology for nine years, where he received degrees in electrical engineering, mathematics and solid-state physics, eventually leading to a PhD in nuclear physics. In 1981, Hoodbhoy went on to conduct post-doctoral research at the University of Washington, before leaving to serve as a visiting professor at the Carnegie Mellon University in 1985. While still a professor at the Quaid-e-Azam University, Hoodbhoy worked as a guest scientist at the International Centre for Theoretical Physics from 1986 to 1994. He remained with the Quaid-e-Azam University until 2010, throughout which he held visiting professorships at MIT, University of Maryland and Stanford Linear Collider

In 2011, Hoodbhoy joined LUMS while also working as a researcher with Princeton University and as copa columnist with the Express Tribune. He is a sponsor of the Bulletin of the Atomic Scientists, and a member of the monitoring panel on terrorism of the World Federation of Scientists. He has won several awards including the Abdus Salam Prize for Mathematics (1984); the Kalinga Prize for the Popularization of Science (2003); the Joseph A. Burton Forum Award (2010) from the American Physical Society and was enlisted as one of the 100 most influential global thinkers by Foreign Policy. In 2013, he was made a member of the UN Secretary General's Advisory Board on Disarmament.

Hoodbhoy remains one of Pakistan's most prominent academics. He is the author of Islam and Science: Religious Orthodoxy and the Battle for Rationality and heads Mashal Books in Lahore which claims to make "a major translation effort to produce books in Urdu that promote modern thought, human rights, and emancipation of women". Hoodbhoy has written for Project Syndicate, DAWN, The New York Times and The Express Tribune. He is considered one of the most vocal, progressive and liberal members of the Pakistani intelligentsia.

A Science Communication Case Study: Sri Lanka's Agricultural Scientists Engagement with the Government on its 'Instant Organic Drive' and Agrochemical Ban in mid 2021

Buddhi Marambe

The crisis

The Sri Lankan economy has contracted by 1.6% and 8.4% in the first and second quarters, respectively, of 2022. Alarmingly, the agriculture sector also contracted – by 6.8% during the first quarter and 8.4% in the second quarter. In 2021 however, the agriculture sector grew at +6.4% and +11.2% during the first and second quarters, respectively. The most recent press release by the Department of Census and Statistics has stated that the shortages in supply of fertilizers and chemicals have negatively impacted agriculture resulting in a direct and major setback in this sector, especially reducing the paddy yield by approx. 37% in the Maha season of 2021/2022 as compared to that of the same season in 2020/2021.

The irrational policy decision by the Cabinet of Ministers in April 2021 to immediately ban the import of synthetic fertilizers and pesticides, virtually converting the whole country into an 'experimental field for organic agriculture', has paid the price. At last, the facts presented by the mandated government agency that provides national accounts have over-ridden the myths propagated and decisions made without a valid scientific base. The results distressingly illustrate the severity of the damage to the agricultural economy of Sri Lanka in less than one year of imposing an unfortunate and a hasty decision. The Sri Lankan agriculture sector has headed towards a man-made disaster at a massive cost to the society, with irreversible negative impacts.

The food crisis has become imminent and has already sent shockwaves among all strata of the Sri Lankan society. The joint food security assessment of the Food and Agriculture Organization and World Food programme reported that over 6.2 million people (28% of the population) are estimated to be suffering from moderately acute food insecurity and 66,000 people from severe food insecurity. As expected, the urban population has felt the first impact of a food crisis. This is mainly because of the breakdown of the urban-rural connectivity in the food system, especially the City Region Food Systems.

The academia and scientists, and more importantly the experienced farming community, have expressed their views and pleaded with the government to reverse this ill-fated decision taken by the Cabinet of Ministers on 27 April 2021, which was later empowered through a Gazette Extraordinary No. 2226/48 issued on 6 May 2021. A published scientific report and scientifically valid data were presented in many forums on the re-

percussions and the imminent disasters due to this decision. However, all these efforts went unheard by the ignorant policymakers leading the country into such a crisis. After a lapse of seven months, and sensing the danger and realizing the validity of the facts presented by the scientific community and the farming community, the government finally issued a Gazette Extraordinary No. 2256/23 on 30 November 2021, reversing the previous decision. However, it was too late, as by this time, the country was facing an overall economic crisis with no adequate foreign currency available to procure the much needed agricultural inputs. We have lost opportunities. The impact of such unwarranted decision making is explained in the following sections.

The reality

The uncertainty in the future agricultural production process, the possibility of crop failure in the 2022 Yala season, etc., have aggravated not only the food crisis but also the fear of food insecurity in people's minds. In such a situation panic buying and food hoarding by some supply chain actors and the consumers have also created artificial food shortages in the market. This practice in return has raised food prices, making them unaffordable to many, connecting dots in the vicious cycle. Furthermore, it is high time to take a closer look at the amount of food we throw away, especially from our food plate. We should reduce food waste as much as possible, especially during a food crisis. The amount of food waste from the household food plate is about 10% on average. The wastage is 15-30% in restaurants and hotels and can increase to around 50% in buffet-style catering (Dr. Anuruddha Karunaratne, Faculty of Agriculture, University of Peradeniya – Personal Communication). Food waste in major hotels is often used as animal feed in farms, but such use is minimal in households. Therefore, reducing or preventing food waste is an immediate action that would benefit the country enormously. This will reduce the pressure on the food supply and on finding foreign exchange for food imports at such a difficult time.

According to the Ministry of Agriculture (MOA), apart from paddy production, the production of maize in the last Maha (2021/2022) and present Yala (2022) seasons, has drastically dropped due to the ban on the use of chemical fertilizers, further increasing the risk of food and nutrition insecurity in Sri Lanka. The production of liquid milk, eggs and poultry meat has decreased due to lack of maize that is required to produce animal feed and 'Thriposha' (an additional food rich with nutritious quality), and since the supply of marine fish had also reduced mainly due to the fuel crisis. Sri Lanka has already stopped using locally produced or imported rice for animal feed. At face value, this seems a good decision. However, in a crisis where animal feed also becomes a scarce commodity, such decisions can also escalate 'hidden hunger'- the protein malnutrition. We have already started experiencing the exorbitant price escalation of chicken eggs (and meat), one of the cheapest sources of nutritious food available to children, pregnant women, lactating mothers, and the elderly. With unaffordable nutritious food, the irreversible impact of

malnutrition will only be seen in years to come.

From March to June, the production of broiler meat decreased by 30% from 18,000 Mt to 12,000 Mt a month, with a sharp increase in prices (e.g. from LKR 460 in March 2022 to over LKR 1,500 per kg in early September). Daily egg production, which used to be between 700,000 and 800,000, has now dropped to about 400,000, and prices have risen well above LKR 50 per egg from LKR 17 reported in March 2022 (Mr. Ajith Gunasekara, Chairman of the All-Island Poultry Association of Sri Lanka – Personal Communication).

Tea, being the main agricultural export crop has recorded a loss of 34.7 million kg of made tea, during the period January-July 2022, an 18.8% loss compared to that of the same period in 2021. The tea export volumes have reduced by 9.77% in January to July 2022, recording a loss of 14.77 million kg compared to a year ago. The foreign exchange earnings from tea was reduced by USD 70.4 million in January to June 2022, a 10.8% reduction compared to a year before. We have lost a significant amount of foreign exchange at a time when it was required most.

The need

When the input supply is limited, prioritization of crops becomes a must in terms of their use. A few months ago, the academia and scientists strongly recommended making paddy (main food crop), maize (main feed crop) and tea (main export crop) as prioritized crops in such scenarios. This is not to neglect all other crop sectors in terms of input supply.

Furthermore, academia and scientists have highlighted the urgent need to provide adequate fuel to support the distribution of rice and other food products throughout the entire food system. It is important to note that the MOA has prioritized the crops to provide fertilizer, and fuel service stations have been designated to provide the requirement of the farming community. However, the fuel supply requires more effective mechanisms to be implemented without delay. Sensing the crisis, and considering the predictions by the academia and scientists, Sri Lanka had already imported about 596,000 Mt of rice (including about 45,000 Mt as humanitarian aid) by the end of August 2022. This is to fill the void of the rice requirement of the country that could have occurred during October to December. All these activities have helped Sri Lanka to push the barrier of the food crisis further away (at least in the case of the major staple). This is our hope and the overall objective of such exercises. However, Sri Lanka should gradually curtail rice imports and have a fresh look at the import requirements based on the need for the first quarter of 2023, as the Maha season harvests will only begin at the end of January or early February of 2023.

Making the Maha season (2022/2023) a massive success in food production is a major

task to be achieved. This would help us to leap forward in regaining the food security status that the country badly suffered from in the past few months. It is important to note that the agriculture that was 'destroyed in seconds' due to the irrational policy decision to turn the whole country into organic farming, cannot be revived in one season. Securing the seed paddy requirement (approx. 80,000 Mt) for the Maha season from the output of the Yala season, and acquiring finances from the World Bank (WB; USD 110 million) to procure 150,000 Mt of urea and from the Asian Development Bank (ADB; USD 40 million) to procure 40,000 Mt of Muriate of Potash (MoP), are some commendable initiatives taken by the MOA, Department of Agriculture and other line agencies, along the road, to revive agriculture in Sri Lanka. This is in addition to the 65,000 Mt of urea imported during the latter part of the Yala season of 2022 from Oman through an Indian Credit Line. Recently, the United States Agency for International Development (USAID) also pledged nearly USD 46 million to procure about 36,000 Mt of Triple Super Phosphate (TSP). There is still more to be done. The quality of the secured seed paddy requirement is questionable. The finances for TSP procurement arrived late and hence, the fertilizer may not reach Sri Lanka on time for the next Maha season to be applied as a basal dressing in paddy cultivations. One way out is to provide the limited quantities of TSP currently available in Sri Lanka, to paddy farming in the Ampara and Batticaloa districts, on a priority basis in areas where soils are deficient in phosphorous. The academia and scientists have discussed such needs with the relevant authorities, and fortunately after learning a bitter lesson, the policy makers are at least giving ear. The decision makers should also consider the global trade and international politics, especially the Russia-Ukraine war that would affect the supply of agricultural inputs to Sri Lanka impacting our food security.

Considering the issues in the international trade and shortages of agricultural inputs, the academics and scientists have advised the MOA to limit the supply of synthetic fertilizer, especially urea for paddy, to 70% of the total requirement through the government machinery, and for the remaining 30% of the requirement to be fulfilled either through fertilizers available in the open market or quality-controlled organic fertilizer that will be made available at the Agrarian Service Centers. This is mainly to cushion the adverse impacts to some degree. The MOA has also decided to provide urea at a price of Rs 10,000 per 50 kg bag (a subsidized price, as at the time of landing, this would cost over Rs 15,000 as of October 2022).

The financial pledges from the Development Partners of Sri Lanka to procure fertilizer only target paddy production (main staple) in the Maha season of 2022/2023. However, we should not ignore maize (animal feed) and tea (major export earning crop) cultivations that requires due attention to get the agriculture sector back on track. Sri Lanka currently faces an issue of not having adequate quantities of hybrid maize seeds to be planted in the Maha season of 2022/2023. As such, we only expect about 50-55% of the

land extent of an estimated 125,000 ha to be cultivated for maize in the forthcoming season. About 600,000 Mt of maize are needed annually to fulfill the requirement of Sri Lanka. The United Nations Development Programme (UNDP) and the Japan International Cooperation Agency (JICA) have come forward to support the MOA to procure 200 Mt of hybrid maize seeds worth approx. USD 1.4 million to be cultivated in the dry zone during the Maha season of 2022/2023. However, it is important to note that hybrid seeds for planting cannot be purchased from an open market. They should be ordered well in advance, providing at least 6-8 months of lead time for the suppliers/producers of hybrid seeds (as planting material) to be ready with the requirements.

Finally, we now see that the policymakers are ready to face reality, understanding the science behind agri-food production, having left aside their whims and fancies, and over-reliance on illusions. However, there are no positive signs of adequate volumes of essential agro-pesticides (herbicides, insecticides, fungicides) being made available to the farming community for crop protection, due to the shortage of foreign currency. The smuggled pesticides that have been banned several years/decades ago in Sri Lanka due to their mammalian and environmental toxicity, seem to have invaded the markets to fill gaps created due to the absence of registered pesticides. The well-regulated pesticide market in Sri Lanka has fallen apart creating more problems, especially for humans and environmental health than ever before, owing to one unjustified decision that was made.

Agriculture in Sri Lanka does not end with the completion of the next season (Maha season of 2022/2023). It will continue with the Yala season in 2023 and so on. Many institutions, including the faculties of agriculture of state universities, have lined up to strengthen the operational mechanism of the government institutions, the private sector and farming community, to develop the agriculture sector. The academia and many professional associations have submitted proposals containing pragmatic approaches to overcome the food crisis in Sri Lanka. The policymakers should ensure that there are no unnecessary political interventions, but facilitate the operations of mandated institutions through responsible and accountable, and science-based decision-making. The planning process should start now with the active engagement of key stakeholders, if we are to expect a revival in the agriculture sector, at least by the end of the Maha season of 2023/2024.

The interim budget approved by the Parliament of Sri Lanka in August 2022, has recognized the need to tackle food insecurity of the country. It suggests developing a National Food Security Programme, adopting a National Food Security Bill, ensuring input supply supporting value chain development, food packaging and food transport (e.g. using railway), promoting export-oriented agriculture, to name a few, to stabilize the economy and facilitate growth of Sri Lanka. The agriculture policies developed in the recent past should be implemented as soon as possible with the approval of the Cabinet of Minis-

ters, if well-coordinated actions are to be implemented at national, provincial and local levels. The Overarching Agriculture Policy (OAP) developed in 2020, addressing eight sectors related to agriculture, and the National Agriculture Policy (NAP) developed in 2021 focusing on food and feed crops sectors, will help in setting up a strong basefor this. None of us want to experience a food shortage in the future. The 'National Food Security' should not be compromised at any cost.

The writer, Professor Buddhi Marambe obtained a BSc degree in Agriculture from the University of Peradeniya, Sri Lanka, and an MAgr & DAgr from the Hiroshima University, Japan. He has more than 36 years of experience as an academic at the Department of Crop Science of the Faculty of Agriculture, University of Peradeniya, Sri Lanka. His research interests include weed science, climate change adaptation, and food security. With more than 150 research publications, Professor Marambe has also won a Presidential Award and a National Research Council (NRC) Merit Award in Sri Lanka, for scientific research.

Buddhi is the Chairman of the National Invasive Species Specialist Group (NISSG) and the former Chairman and a member of the National Experts Committee on Climate Change Adaptation (NECCCA) of the Ministry of Environment. He has been a member of the Government Delegation on climate negotiations at the United Nations Framework Convention on Climate Change (UNFCCC) for the past eight years. He was also the Assistant Secretary of Lanka Organic Agriculture Movement for the period 2001-2003.

While an academic, he also served as a non-executive member of the Boards of several private sector organizations providing technical guidance to agriculture-related operations, and has been a Council Member/Executive Committee member of many professional associations. He has provided his services as a consultant to the World Bank, ADB, EU, UNDP, FAO, UNEP, ICRAF, and CIAT in nationally and internationally important issues related to climate change adaptation, food security, and agriculture.

Panel Discussion

"Scientists Using Digital Media to Communicate Science and Reason Directly to the Public"

Panelists

Asha de Vos

Asha de Vos is an internationally acclaimed Sri Lankan marine biologist, ocean educator, pioneer of long-term blue whale research within the Northern Indian Ocean and strong advocate for diversity and equity in marine conservation. She is also an Adjunct Research Fellow at the Oceans Institute of the University of Western Australia. She has degrees from the University of St. Andrews (Scotland), University of Oxford (UK) and the University of Western Australia (Australia) but escaped academia to establish her own Sri Lankan grown non-profit, Oceanswell - Sri Lanka's first marine conservation research and education organization. Her work has been showcased internationally by the BBC, the New York Times, TED and National Geographic to name a few. Amongst her many accolades Asha was listed on the BBC 100 Women 2018 list of most inspiring and influential women from around the world and named Lanka Monthly Digest's Sri Lankan of the Year. In 2019, Asha was named one of 12 Women Changemakers by the Parliament of Sri Lanka and in 2020 was awarded an inaugural Maxwell-Hanrahan award in field biology whilst also being named Scubadiving magazine's Sea Hero of the Year. In 2021 Asha was awarded a Vanithaabimani lifetime achievement award and the Tällberg-SNF-Eliasson Global Leadership Prize.

Ruchira Wijesena

Ruchira Wijesena completed a BSc Eng (Hons) degree in Textile Process Engineering at the University of Moratuwa and a PhD in Chemistry of Biopolymers at the University of Colombo. He is an academic and materials researcher with varied experience in the private and public sectors. His role as an academic includes his current position at the Institute of Technology, University of Moratuwa as a senior lecturer, and a visiting lecturer in several other state and private universities. Ruchira is also a material researcher, with established expertise in nanotechnology and advanced materials with many related commercialized innovations, patents, and publications in the field. He served as a Senior Research Scientist at the Sri Lanka Institute of Nanotechnology, Sri Lanka. He believes that real progressive changes in a nation can only be achieved through the effective dissemination of science, mathematics, and philosophy among the general public.

From Public Understanding to Public Engagement: Science Communication in a Complex World

Nalaka Gunawardene

"In a democratic system, public opinion has a major influence on the decision-making process. It is therefore important that individual citizens, as well as the decision-makers, recognize and understand the scientific aspects of public issues. To decide between competing claims of vocal interest groups concerned about controversial issues such as 'acid rain', nuclear power, in-vitro fertilization or animal experimentation, the individual needs to know the factual background and be able to assess the quality of the evidence being presented. A wider understanding of the scientific aspects of a given issue will not automatically lead to a consensus about the best answer, but it will at least lead to more informed, and therefore better, decision-making."

The words expressed in a report by the Royal Society of the United Kingdom more than three and a half decades ago, are valid even today. The report, titled 'The Public Understanding of Science', published in 1985 was named 'Bodmer Report' after Dr (later Sir) Walter Bodmer, the British geneticist who chaired the consultative process. Among the other members of the group was a zoologist turned broadcaster Sir David Attenborough and Dame Margaret Weston, the then Director of the Science Museum in London. The report posed a vital question as part of its premise: "Would the world be a better, or even a different place if the public understood more of the scope and the limitations, the findings and the methods of science?"

Its compilers gave a resounding 'yes' to the question and argued that better public understanding of science can be a major element in promoting national prosperity, raising the quality of public and private decision-making, and enriching the life of individuals. The report, analyzed the British public's knowledge of science, identified major gaps, and recommended a broad range of science communication activities for enhancing public understanding of science. The report ended with a direct and urgent message to scientists themselves: "Learn to communicate with the public, be willing to do so, and consider it your duty to do so."

The Bodmer Report's influence extended beyond Britain and inspired greater interest in nurturing science education, science communication and science journalism in many other countries. It might have inspired the decision by the Sri Lanka Association for the Advancement of Science (SLAAS) in 1986, to introduce a new annual award recognizing excellence in science communication.

In the years since the publication of the Bodmer Report, academic theories and public discourse on communicating science to non-scientists have been evolving. With greater

insights and critiques from researchers and practitioners, the earlier models created to increase public understanding of science (PUS) have been improved upon to make them more nuanced and participatory.

Models of science communication

For much of the twentieth century, PUS was driven primarily by what is known as the 'deficit model'. It is based on the notion that the public has a 'knowledge deficit' that affects their perceptions of science and scientists. The deficit model assumes that science communicators can change attitudes towards science by increasing the supply of accurate and accessible scientific information in the society. Many science popularization activities are designed using this model, where experts typically provide all the information and explanations.

By the 1990s, the deficit model's inadequacies were highlighted by studies that showed how supplying scientific information and explanations alone, to people, do not necessarily change their entrenched views. Evidence pointed to pockets of resistance to scientific knowledge and reasoning that stemmed from religious or cultural beliefs, and sometimes from deeply held political opinions.

In response, researchers in PUS came up with what they called the 'dialogue method' of science communication. In this, the non-specialist public are no longer considered passive receivers of scientific information. Instead, science specialists are encouraged to listen to non-specialists, recognizing that the latter could make meaningful inputs to scientific policy making.

During the 1990s and the 2000s, the dialogue method was tested and sharpened in contentious public debates surrounding, for example, genetically modified organisms (GMOs), human-induced climate change, and the ethics of human cloning and stem cell research.

It was necessary, but not sufficient, to have subject experts presenting and explaining the scientific evidence. Additionally, people's fears, suspicions and objections had to be acknowledged using social science frameworks and open dialogue methods.

This evolution in thinking was also reflected in the emergence and subsequent closure of the UK's Committee on the Public Understanding of Science (COPUS). It originated in 1987 in response to the Bodmer Report and was a partnership between the Royal Institution, the Royal Society and the British Association for the Advancement of Science (BA).

By December 2002, however, its co-founders decided to phase out COPUS, saying: "We

have reached the conclusion that the top-down approach which COPUS currently exemplifies is no longer appropriate to the wider agenda that the science communication community is now addressing."

Public Engagement with Science

Since the early 2000s, the processes of science communication and public understanding of science have been broadened in scientifically advanced societies to what is known as public engagement with science (PES).

According to the American Association for the Advancement of Science (AAAS), PES describes intentional, meaningful interactions that provide opportunities for mutual learning between scientists and non-scientists. Mutual learning means scientists are not simply disseminating scientific knowledge to others but are also listening to non-scientists to better understand what forms the latter's perspectives and worldviews.

PES differs from the traditional approaches to the science-society relationship based on enhancing the public knowledge and understanding of scientific discoveries and theories, which was pursued through science popularization and science communication activities.

The PES approach does begin with the public understanding of science, but it goes beyond and seeks more interactive opportunities for dialogue. Through PES, scientists and the public participate in discussions about the societal benefits as well as potential risks of the science and technology.

The rise of PES responds to the widening gap between science and society seen in many countries, in turn, could lead to public apprehensions about both science and scientists.

Dialogues based on Facts

While the science communication models have evolved to accommodate increasingly complex and contentious issues involving science and society, the earlier and simpler models are not completely discarded. In fact, clear and unbiased science information remains essential for dialogue to be based on facts, not fallacies.

"Both journalists and other types of science communicators face the task of providing individuals with the facts that empower them to engage properly in such dialogue," argued David Dickson commenting on the nexus between the deficit and dialogue models.

Dickson, a British science journalist who worked on the editorial staff of Nature, Science and New Scientist, and who later founded the SciDev.Net online science communication initiative, wrote in 2005: "The process of democratic dialogue over science and

technology-based issues is critical to the effective functioning of modern societies. But providing reliable information in an accessible way – in other words, filling the relevant 'knowledge deficit' – is an essential prerequisite of both healthy dialogue and effective decision-making."

Challenges in Sri Lanka

Sri Lanka's public science communication has a history going back to several decades. Many public-spirited scientists, science teachers, science writers as well as various professional scientific bodies have contributed to the popularization and public understanding of science. One of the four goals of SLAAS, founded in 1944, is the "dissemination of scientific knowledge and promotion of discussion".

Notwithstanding these worthy efforts, anecdotal evidence suggests that Sri Lanka still has a low level of scientific literacy, defined as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity".

Sri Lankans are proud of their high adult literacy levels, which was 92 per cent in 2020. But do we have a high level of scientific literacy? If we did, it would not be easy for various conspiracy theories to spread rapidly in society and gain acceptance even among some with higher education or professional training.

Recent examples include claims of attempts – through food and garments – to make majority ethnic group infertile, and scare mongering about vaccination against COVID-19. The inability of many citizens to critically analyse these and other claims endanger ethnic harmony and public health.

Therefore, in the Sri Lankan context, public engagement with science needs to go well beyond the learning of science and technology subjects in formal education. Various public science activities – ranging from science content in the media to science centres and exhibitions – can be helpful but at its most basic, what we need to promote is scientific literacy as a way of life.

Progress of science and technology since the 1960s has given us many gadgets and media tools, but the more information we have, the less we seem to be able to think for ourselves. Thus, we have broadband internet alongside narrow minds, a poor juxtaposition!

Indeed, the spread of internet use has been both a boon and bane for public understanding of science. By 2022, more than half of Sri Lanka's 22 million population was using the internet, making it an integral part of the island nation's social infrastructure.

Benefits of internet use are manifold from enabling free expression and exchange of information to promoting education and fostering enterprise. Yet the absence of gate-keeping has enabled disinformation to spread at an unprecedented scale and speed, raising serious concerns about trustworthy sources and highlighting the need for critical consumption of all online content.

What is to be done? For a start, a healthy dose of scepticism is useful to safeguard ourselves from assorted superstitions, fantastic political claims and misleading product advertising.

Unless we make scientific literacy an integral part of everyone's lives, ambitious state policies and programmes to modernize the nation could well be jeopardized. Developmental progress could be undermined – or even reversed – by extremist forces of tribalism, feudalism and ultra-nationalism that thrive in a society that lacks the ability to think critically.

Trained as a science writer, Nalaka Gunawardene is a journalist and development communication specialist with over 25 years of professional experience in Sri Lanka and across Asia. He has made a career out of asking questions, connecting dots and helping audiences make sense of complex technical and policy issues. He is a well-experienced journalist across print, broadcast and web outlets in Sri Lanka and internationally.

Nalaka holds journalism and mass media qualifications from the University of Colombo and the Open University of Sri Lanka. He initially worked as a journalist with English language newspapers and magazines, and also freelanced on local radio and TV. At various times, he has been a news reporter, feature writer, columnist, science editor, foreign correspondent, and radio/TV programme host.

From the early 1990s, Nalaka has chronicled and critiqued the evolution of information society in Sri Lanka. He is a leading commentator and analyst on social, cultural and political impacts of information and communications technologies (ICTs) in South Asia.

He won the SLAAS Science Communication Award (English medium) in 1988 and 1989 for his science reporting in The Island newspaper, and further national awards for outstanding science journalism. Nalaka moved to the development sector where he worked as a communication specialist with agencies like UNEP, UNDP, UN-ESCAP and