Proceedings of Jaffna Science Association

Presidential Address
Chief Guest's Address
Sectional Chairpersons' Addresses
Popular Lectures
Theme Seminar Presentations

Volume: 28 **No: 02**

Twenty-Ninth Annual Sessions
23 - 25 February 2022
Jaffna, Sri Lanka

ISSN 1800-1300

Proceedings of Jaffna Science Association, Vol.28, No. 2

ISSN: 1800-1300
Jaffna Science Association (JSA)
Reg. No.: G/L/2427

From Editor's Desk….

The Jaffna Science Association (JSA) has been carrying out various activities for the benefit of the community for more than 30 years. The Jaffna Science Association (JSA) was established in 1991 by late Professor Alagiah Thurairajah with the objectives of promoting science, scientific research and advancement of science education and technology. In this regard, JSA has been carrying out various knowledge-sharing activities to inform the latest advancements in science to the people in this region. The activities carried out by the different sections of JSA are targeted at school students, university undergraduate students and the general public.

Generally, a specific topic, which addresses the most crucial issue to the region or to the people in the region, is selected as the theme of the year and more focused activities are carried out by the JSA to identify the causes of the issues and to propose appropriate scientific solutions to these issues. Seminars, review lectures and popular talks are organized according to the identified themes, during the annual sessions. Then the presentations made at the annual sessions are recorded and published as proceedings.

This Proceeding (Volume 28, No. 2) contains the Presidential address, Chief guest's address, Chairpersons' addresses, Popular lectures and Theme seminar presentations, delivered at the 28th JSA Annual Sessions. The sessions were held on 23-25th February 2022 on the theme "Uncovering an array of essential skills for scientific success during the crisis "at the Library Auditorium, University of Jaffna.

I wish to thank the distinguished speakers for their contributions to this volume.

Mrs. Piratheepa Sivakumar
Chief Editor,
Jaffna Science Association (JSA),
March, 2023

Table of Contents

Popular Lectures

Section A:

Section B:

Section C:

Section D:

Theme Seminar Presentations

Presidential Address

Idiolect in Academia: Hindrance or Help for Communication

Dr. Kandiah Shriganeshan (President, JSA)
Department of English Language Teaching (DELT), University of Jaffna

Preamble

Being a second language learner in the so-called Colonized country, Sri Lanka (formerly Ceylon) by the British, I was able to pick up the pronunciation and spellings of English words at the very prime age. From Gr. 3 onwards I started learning reading loudly and comprehending the meaning of the sentences. But from teacher to teacher I observed the differences in pronunciation and accents and also the way they used the vocabulary and the phrases. There are differences among the teachers in using the English Language with regard to grammar, appropriate vocabulary and pronunciation leaving alone the differences in the British and American Englishes. No more question of following the Standard English and the Received Pronunciation (RP) of the Southern London dialect which has been used by the British Broadcasting Corporation (BBC) World Service. However, the second language speakers continue to survive despite the differences and mistakes and errors made during communication.

Introduction

There is a problem of appropriateness when the speakers consider the choice of words. But language teachers are very strict in teaching what to choose. They prefer the question
"What have you had for breakfast?" instead of "What have you eaten?".
In the name of politeness, they prefer to use the word 'have' instead of' eat'. But there are speakers who would stick to their own way of speaking and writing. This would be termed in the phrase called "idiosyncrasies of a speaker". In linguistic terms we would term it as the "idiolect" of the speaker.

Dialect, Sociolect and Idiolect

In this context, a special mention about dialect and sociolect is required. Languages as well as dialects can convey geographical information about their speakers. Regional variations of a language are considered dialects of the same language. All languages are analyzed into a range of dialects which reflect the regional and social background of the speakers. Everyone speaks a dialect whether urban or rural, standard, non-standard, upper class or lower class. No dialect is superior to the other one in linguistic terms. No two people is identical in the way each one uses the language. Everyone has a personal style of using the particular language. It is known as idiolect.
In fact, languages are formed on the basis of dialects and dialect is developed from sociolect and sociolect is developed from idiolect. Idiolect is the linguistic system of an individual. Individual speakers do create new language patterns. Especially writers and poets do influence their languages in their formation. English writers like Geoffrey Chaucer, William Shakespeare, William Wordsworth, T.S. Eliot, Charles Dickens, D.H. Lawrence and many others did make an impact on language development with their literary pieces. Their special usage of language has come into stay with poetic license and become traditional and conventional use of language. In the ancient days, the intellectuals in the villages did speak creatively (that they turned out to be the sayings and proverbs of the language) though they may not have studied scriptures and other literary texts critically.

Thus, new forms of language have come into exit. For example, the proverbs and sayings are very good examples as they were the outbursts and spontaneous overflow of feelings of the superior intellectuals of the particular language community. One could observe that there are parallels in proverbs and sayings in many a language. However, the language experts do not support the idiosyncrasies of an individual speaker to make mistakes in using the language which is rich in literary texts and spoken varieties. For example, William Shakespeare's phrase in 'Julius Ceasar', "*The most unkindest cut of all"* by Mark Anthony on the attack by Brutus on Caesar is well accepted by the language experts and literary critics with the concept of poetic license.

Language for communication

Language has no globally recognized definition. A lot of definitions are given by many scholars over the world but all are connected with their meanings. That is, 'Language' is a tool that aids in the expression and conveyance of thoughts and feelings of two individuals. Aristotle (3rd century AD) states that "Language is a speech sound produced by human beings in order to express their ideas, emotions, thoughts, desires and feelings". According to Sapir (1921) "Language is a purely human and non-instinctive method of communicating ideas, emotions and desires by means of a system of voluntarily produced sounds". Language a set of (finite or infinite) sentences, each finite in length and constructed out of a finite set of elements (Chomsky, 1957). Some important characteristics of Language are discussed below:

Language is a system of system: it is as a system which contains phonological, morphological, syntactic, semantic, and discourse levels for analysis.

Language is symbolic: human beings make use of sounds for conveying messages. Only a few are selected and assigned meaningful functions. This use of sound is symbolic

Language is Arbitrary: the connection between the word or a sound is unexplainable.

Language is creative and unique: each Language is unique. Its phonology is specific to itself; its morphology and syntactical patterns are unexplainable in terms of the uniqueness of the particular language.

LANGUAGE AND COMMUNICATION

A language is a tool of communication, while communication is the process of transferring messages to one another. Language focuses on the signs, symbols and words. Communication is a process of involving an exchange and understanding of information, ideas, opinions, suggestions, feelings between two or more people. Most common skills used in communication are speaking, and writing, and strategies like visual images, signs and gestures.

Communication lays emphasis on the message. Communication occurs in all the sensory channels. The basics of communication do not change at all. Conversely, daily new words are added to the dictionary of the language, as it changes every day. However, language and communication are connected with each other because language is a means of communication. But there are so many languages in the world. The world needs a common language for communication.

World Languages and the Place of English in Sri Lanka

At present, there are 7000 languages distributed amongst the world population. But 12 languages are used by 50%. English is used by the greatest number of people due to its predominant position in economy, technology, communication and on the internet. English is one of the International

languages. Other International Languages accepted by UNO are Arabic, Chinese, French, Russian, Spanish. English is the legacy of Colonial rule as Sri Lankans were under British rule. It is a window to the world and the people are able to get different perspectives through English. English is leading the other languages in inventions, publications, literature and media. Higher education is globalized alongside the economy because of the domination of the universities in the English-speaking world.

English Language Education

In the field of education, the titles like English–medium Education, Bilingual Education, CLIL: Content and Language Integrated Learning, ELF: English as a Lingua-Franca, EYL: English for Young Learners are very popular because of the influence of English entertained internationally. Global English is termed in the following phrases:

- English as a European Lingua Franca
- English as an Asian language
- English as an African Language
- English as an International Language
- In the field of English Language Teaching (ELT) the following phrases are very popular:
- ENL- English as a National Language
- EFL- English as a Foreign Language
- ESL: English as a Second Language
- EGP: English for General Purposes
- ESP: English for Specific Purposes
- English for Science, Medicine, Engineering and Technology.
- English for Business Communication

Since the use of English language has become very essential in various parts of the world at various planes and the way the language is used with remarkable differences, various types of Englishes came into exist (Kachru, 1985). World Englishes are found with various titles**:** British English, American English, Australian English, Canadian English, Black English/ African English, Asian English, Indian English & Singaporean English, and Sri Lankan English.

The Status of English in Sri Lanka **and ELT during the British Colonial Rule**

English was introduced as a subject with the advent of the British Colonial rule in the latter part of the 18th century. It was subsequently introduced as the medium of education in the early part of the nineteenth century. At the beginning of the 20th century, Three-tiered System of Education in Ceylon (Sri Lanka) was found.

- English education in English medium schools System
- The vernacular schools used the national language/s as the medium of instruction.
- Anglo-vernacular schools used national language/s as the medium of instruction during the early years of the schooling (Jayasuriya, 1978, p.426).

At the time of Independence, English was taught in the primary classes and it was made compulsory in the classes 6, 7 and 8. Mother tongue education was gradually allowed at the time of Independence along with the English medium. However, at the university level English was the medium of education. In 1948, English was the medium of instruction in most of the leading schools and at the university level in Sri Lanka. After Independence, (From 1944 to 1953) there were moves to change the medium of instruction from English to the mother tongue of the learners at school level. (J.E.

Jayasuriya, 1968: p.73). The Government continued to introduce the national language/s as the medium of instruction in the pre.H.S.C. class and H.S.C.class except for science, maths and Western languages. However, the Minister of Education declared in 1952 to impart education at the top level in the national languages only *(Jayasuriya, 1968, p.77*).

The Report of the Committee of Inquiry into the Teaching of English in Ceylon schools recommended that English should be compulsorily taught as a subject to all, up to and including Eighth Standard and that thereafter it should be optional *(Sessional paper No.5, 1960, p.24)*. By 1960, the University of Ceylon commenced teaching arts subjects in the national languages when the first batch of mother tongue medium students entered the university (*Sessional paper 1, 1962, p.11*). However, the teachings of medicine, engineering, law and similar professional studies were continued in the English medium in the university. Since early sixties to latter part of seventies, there is a decline in the standards of English in speech, reading and listening comprehension and writing skills. Educated people migrated during the civil war is another cause for this state of affairs in the Tamil areas.

The country has to adopt itself to the international demands with regard to trade, business, education and science. In 1977, the country opened its doors to open economy. This resulted in the development of the private sector and it needed the services of an international language: English.

Methods Adopted to Teach English in Schools

At the beginning of the British period, the American Missionaries used the grammar-Translation method *(Vigna Raja, 1994). (Perera, 1994).* The Direct Method was introduced in Sri Lanka in the early 1960s. *(Sessional Paper No. 5, 1960, p. 24).* The book designers of the sixties shifted the emphasis on teaching from literature to language skills. The Lanerolle's report recommended the Graded Structural-Oral-Situational Approach which was widely used at that time in the world to be adopted in the Sri Lankan schools (*Lanerolle, 1973, p. 58*). The Curriculum Development Centre tried to introduce the Communicative Approach in 1984 and introduced new set of books. Earlier, in the seventies, the textbooks had been based on the oral situational approach with pattern practice and drills.

Having seen that all these methods were not very successful in producing communicatively efficient students, the Ministry of Education introduced the Communicative Approach in 1984 (Perera, 1994, p.74). The set of books produced on the basis of communicative approach were expected to meet the demands of speech. They introduced more dialogues, role plays, reading comprehension pieces and poems, extracts from novels and stories selected from literature. No proficiency was achieved. The curriculum designers integrated science, social studies and others and taught Grammar in action with more real-life situations. Teachers gave up the mechanical type of drilling of the Structural-Oral-Situational Approach and introduced role plays for developing communication skills. But they did not produce the required proficiency and competency in English.

The communicative approach with revisions of syllabuses was not successful. Therefore, *The World through English* was produced (late nineties) to cater to the demands of the modern Sri Lankan society incorporating texts related to local and global situations to promote oral and written skills. In 2002, the Government introduced English to all who go to schools from Grade one onwards, year (class) one students started with Oral English – Conversational English. Students use a new set of books entitled 'ENGLISH' (from 2006). It accommodates many cultural and literary aspects with more activities and tasks in colourful pages (Gr. 3 to A/L). Most of the students learn in Tamil/Sinhala with English as one

of their subjects from class 3 onwards. New books with Task-based methodology (2015) were published. Task-based teaching methods have been advocated to promote learning skills since then. Even at the universities the academics are advised to coach the students using activity-oriented teaching. However, the proficiency expected to achieve is somewhat problematic.

English for Academic Purposes

The students at the universities are guided to be proficient in English for Academic Purposes. In fact, they first follow the courses in English for General Purposes (EGP) and then English for Specific Purposes (ESP) and finally when they continue their research, they make their studies in English for Academic purposes (EAP). Many academics face a lot of problems in learning the English language.

Barriers for Communication: Mistakes and Errors

Language mistakes can be corrected and language errors can be explained and rectified. Common problems (that are not mistakes or errors but wrong usages of language imprinted in the minds of the learners due to false concepts and fallacies) were observed in the classrooms and seminars. More were identified when the scripts of the young academics and researchers were screened as the editor of Journals like (VCARS Proceedings), Journal of Science and Management, Vavuniya Campus and Sri Lanka Journal of South Asian Studies (Faculty of Arts, University of Jaffna). They can be categorized as follows:

Use of auxiliary

Can and Could with 'be able to' in
'We can / could be able to'

Adding infinitive 'to' in

make them (to) understand.
You help them (to)understand

Use of article

(an) University, (a) academic

More Problems

Science Faculty for Faculty of Science, *Jaffna University* for University of Jaffna
The preparedness tools instead of 'The tools of preparedness'
An efficiency response plan for 'A plan for an efficiency response'

Passive constructions are difficult to make properly. **No auxiliaries used**

- students …affected by,
- calender ..extended, exam ..postponed,
- Students who…involve…..

No appropriate participle is used

- was select,
- You are invite
- an experiment was make

No correct use of prepositions-

- In/ through..on Zoom
- Discuss about

Present tense is recorded as follows:

- I am write or he is write or, write

Present or present perfect for past tense

- We are/ have developed in 1960
- They are decide..
- You will (get) success(full) results

Plural form is missing

- one of the member(s), insects'/ insect's

Present ContinuousTense for Perfect Continuous

- We are publishing for four years

Redundant use of prepositions/ adverbs

- He returned back

Wrong use of infinitive

- He was able to pointed out

Past participle as Adjectives:

- disease plant- diseased plant

Inappropriate Choice of words

- Impacted communities' for 'Affected communities

Double use of cohesive devices

- Because to check we continue to look for….

Wrong use of If Clauses

- as if / as though he is chief he behaved
- If you don't able to find out…
- If you are home garden you can see it
- Deaths would have been prevented if preparedness (were) had been in effect

Redundant use of cohesive devices:

so, therefore…

Use of Present Continuous Tense for Simple present

- *Where are you working?*
- *I am working the bank*

In Reported speech question patterns:

I asked what is the situation? ***Instead of*** *I asked what the situation is.*

Sentence pattern should be a statement

I asked where you are going.

Some more Problems Identified among the students

The following problems were identified from the study administered to the two groups of students at the University of Jaffna.

Inability to distinguish between possessive pronouns and subject pronouns.

eg. *he book* instead of 'his book'

Inability to write in the correct word order.

eg. *My society will help I* instead of 'I will help my society'

Mistakes in Subject- Verb agreement

e.g. *My favourite subjects is Tamil and English (Is* is used instead of 'are'*)*
I plays netball. (plays is used instead of play*)*
Senior students was in the University. (was is used instead of 'were'*)*

Misuse of prepositions and non-use of prepositions

e.g. Now I stay on the room (*On* is used instead of 'in')
*I joined the University October 2*5th. (No preposition is used)

Improper use of numbers

e.g. *I wore saree for two week*. (*Week* is used instead of' weeks')

Inability to distinguish between plural and possessive forms

e.g.: *That is teachers job*
(No apostrophe is used at the end of the word *teachers)*

Dropping of the article and misuse of the article

e.g.: *I study at University of Jaffna* (The definite article is not used)
Sanscrit is a interesting subject (*a* is used instead of 'an')

Telegraphic writing

e.g.: *I go to market morn*ing (No use of articles and prepositions)

Inappropriate use of words

e.g.: *I want to come a teacher*. (*come* used instead of 'become')
My interest subject is sociology.
(interest is used instead of 'favourite')

Tendency to use active voice instead of passive voice

e.g.: *I awarded the prize for Tamil.*
(*awarded* is used instead of 'was awarded'.)

Dropping infinitive

e.g.: I want serve the country. ('to' is not used.)

Problems at various levels

Thus, there are problems in learning the language at grammatical, syntactic and vocabulary levels. When we talk about English, we are expected to teach the British Variety - the Standard English with Received Pronunciation. Nevertheless, we are tempted to use American English because of the influence of Globalization, in other words 'Americanization". But nowadays, the influence of Black

English is found more. Eg: “I wanna go. Practically, Sri Lankan English is used. In language teaching error analysis plays an important role. Researchers acknowledge many different problems faced by students in second language learning. First of all, it is better to note that there is a distinction between errors and mistakes.

Error Analysis

Corder (1974) says: “Mistakes in spelling, grammar and pronunciation are deviations due to performance factors such as memory limitations, fatigue, emotional strain etc” (e.g, mistakes in the sequence of tenses and agreement in long sentences). They are typically random and are readily corrected by learner when his attention is drawn to them. “Errors, on the other hand, are systematic, consistent deviancies characteristic of the learners, linguistic system at a given stage of learning.” (Srithar, 1980). Identifying the errors of second language learners would be helpful in preparing lessons and designing materials in order to remedy possible errors. To have a thorough study of students’ errors linguists suggest various methods: Contrastive analysis, Error analysis etc. It is necessary to have a principled and systematic approach to deal with students’ errors to enable them to achieve language command and proficiency.

Contrastive analysis

Contrastive analysis played an important role in language teaching in the forties and fifties. Contrastive analysis deals with learners’ difficulties in learning a second language with the basic idea that the difficulties are caused by the differences between their own first language and the target language. It points out that language learning is mainly a process of habit formation. Therefore, it had better avoid errors at the beginning when the habit is about to form.

The learners’ idiosyncratic nature

S. Pit Corder (1974) says in his article entitled ‘Idiosyncratic Dialects and Error Analysis’ that many errors committed by the learners are caused not because of the habit formation theory of learning but because of the learners’ idiosyncratic nature. He argues that the learner is carrying over the habits of his/her mother tongue into the second language, and this is called interference of the mother tongue. Mother tongue interference could be analysed with the help of ‘Contrastive Analysis’ which deals with learners’ difficulties in learning a second language. In terms of Tamil students Suseendirarajah, (1972) states that some of the dominant problems are those created by the interference of the first language. He further says that the English teacher does not recognize the importance of the first language of the student in teaching English as a second language. As often stressed by the modern linguists a contrastive study of the structures of the native and the foreign language will help organizing a very efficient and effective language teaching programme.

A Process of Habit Formation

Language learning is mainly a process of habit formation and errors could be avoided at the beginning of the language learning process once the differences between the mother tongue and the target languages are identified. But Corder brings another explanation that language learning is some sort of data-processing and hypothesis-forming activity of a cognitive sort. The learner makes idiosyncratic sentences because of the false hypotheses and this could be eliminated if the student is supplied with the right sort of information from the target language. He further argues that the correction of errors provides precisely the sort of negative evidence which is necessary to discovery of the correct concept or rule.

Error analysis (Corder, 1960) was an alternative one to contrastive analysis, influenced by behaviorism through which applied linguists sought to use the formal distinctions between the learners' first and second languages to predict errors. Consequently, a better description of idiosyncratic sentences contributes directly to an account of what the learner knows and does not know at the moment of his career. At this juncture, the teacher should be able to supply him, not just with the information that his hypothesis is wrong, but also, importantly with the right sort information or data for him to form a more adequate concept of a rule in the target language (Richards, 1974).

In order to avoid errors, one could say that literary materials would provide ample data from the target language to the learner so that he could avoid errors caused by his idiosyncrasy. Corder's argument in another essay titled 'The significance of Learners' Errors' is that both first language acquisition and second language learning have the same mechanism behind. If proper motivation is given to a student, he would learn a second language as a child acquires his first language. On another level Jack C. Richards (1974) focuses on several types of errors observed in learning English as a second language. He speaks of intra-lingual errors and developmental errors other than inter-language errors caused by the interference of the learner's mother tongue.

The interference errors are those caused by the influence of the learner's mother tongue on his production of the target language in presumably those areas where the languages clearly differ. The intra-lingual errors are those originating within the structure of English itself. Complex rule-learning behavior is typically characterized by over-generalization, incomplete application of rules, and failure to learn conditions for application. When the complexity of English structure encourages such learning problems, all learners, regardless of the background language, tend to commit similar errors. The developmental errors reflect the strategies by which the learner acquires the language. These errors show that the learner, often completely independent of his native language is making false hypotheses about the target language based on limited exposure to it.

A Non-Contrastive Approach to error Analysis

Jack C. Richards argues with examples of a different class of errors represented by sentences such as

- did he comed,
- what you are doing.
- he coming from Istrel,
- make him to do it,
- I can to speak French.

He categorizes the intra-lingual and developmental errors under four titles. They are

- over-generalization,
- ignorance of rule-restrictions,
- incomplete application of rules and
- false concepts hypothesized.

Over-generalization

The above categories of errors were committed by students. Over-generalization generally involves the creation of one deviant structure in place of two regular structures. The omission of the third person 's', applying '-ed' marker to every verb to show pastness are some examples of over-generalization.

eg.: *Ravi study, I taked exam*

Ignorance of rule-restrictions,

The second category is the ignorance of rule restrictions. Students' failure to observe restrictions of existing structures is found in the following examples:

eg.: *That is the man who I saw <u>him</u>*

Misuse of Prepositions

The learner encountering a particular preposition by analogy with one type of verb attempts to use the same preposition with similar verbs.

eg.: He said to me …leads to….. *He asked to me…., He thanked to me*

He talked about it …….. leads to ……*He discussed about it.*

Wrong Use of the Article

e.g.: The sparrow is a small bird

Sparrows are small birds

Students tend to use the definite article in front of the plural sentence as follows;

The sparrows are small birds

Incomplete Application of Rules

Under the third category, incomplete application of rules is analyzed. According to Jack C. Richards:

A statement form may be used as a question; one of the transformations in a series may be of twenty-two points, plus triple-word-score, plus fifty points for using all my letters. Game's over. I'm outta here omitted, or a question word may simply be added to the statement form. (Richards, 1974).

False Concepts Hypothesized

In addition to the above-mentioned errors, Jack C. Richards brings in another class of developmental errors which derive from faulty comprehension of distinctions in the target language. This is called 'False Concepts Hypothesized'. Students tend to use 'is' and 'was' as markers of present tense and past tense respectively.

e.g.: *It was happened.*

He is speaks English

The use of present continuous tense for simple present tense in expressing sequence of events is often noted.

e.g.: Ravi is taking the ball and throwing it to the keeper.

The above sentence should be as follows:

Ravi takes the ball and throws it to the keeper.

Such building of false systems or concepts could be avoided with the help of teaching authentic materials like literature. The use of appropriate words and correct use of prepositions, articles and tenses could be practiced through literature related to the field and errors could be avoided.

Conclusion

Thus, the theories of explaining the reasons for errors made in second language learning revolve around not only differences and difficulties in both target language and mother tongue of the students but also the learner's habits and idiosyncrasies. Therefore, the structural and developmental conflicts which could emerge due to over-generalization, false-concepts hypothesized, ignorance of rule restriction and incomplete application of rules could be sorted out by adopting appropriate teaching

techniques and procedures. A major study has to be made in order to find out more errors committed by individual learners due to their idiosyncrasy nature of language earning.

References

Chelliah, J.V. (1921). *A Century of English education – The story of Batticota Seminary and Jaffna College*. Jaffna College: Vaddukoddai.

Chomsky, Noam. (1957).*Syntactic Structures*. The Hague: Mouton.

Corder, S.P. (1973). *Introducing Applied Linguistics*. Australia: Penguin Education.

Druary, James and RajeevaWijesinghe, (Eds.). (1991). Aspects of teaching and learning English as a Second Language. Maharagama: National Institute of Education.

Education in Ceylon. Centenary Volume 1 and 2. (1969). Ministry of Education. Cultural affairs, Ceylon. Colombo: The Government Press.

Gunasekara, M., et.al. (Eds.). (1994). *Compendium of University ELT papers*. Colombo: ELT Units of Sri Lanka.

Jeyasuriya, J.E. (1978). *Educational policies and progress during the British Rule.* Colombo: Associated Educational Publishers.

Kachru, B.B. (ed.) (1992) *The Other Tongue: English across Cultures*, 2nd edn, Urbana: Illinois University Press.

Lanerolle, K.M. De., et al. (Sept 1973), *The Place in the Sun - Report of the Committee of Inquiry into the Teaching of English in the Schools of Sri Lanka*: Colombo: Government Publication Bureau.

Report of the Committee Appointed by the Hon. Minister Education to Report on the Organization of the Higher Education, (June 1971). Colombo: Government Publication Bureau.

Report of the Education Reform Committee of 1979. (1982).Colombo: The Department of Government Printing.

Richards, Jack and Theodore S. Rodgers (1986). *Approaches and Methods in Language Teaching.* Cambridge: Cambridge University Press.

Richards, Jack. (Ed.). (1974). *Error Analysis Perspectives on Second Language Acquisition.* England: Longman

Ruberu, T.Ranjith. (1962). *Education in Colonial Ceylon*. Kandy: The Kandy Printers Ltd.

Sapir, E. (1921/ 1949). *Language.* Berkeley: University of California Press

Sessional Paper No 5, (1960). *Report of the Committee of Inquiry into the Teaching of English in Ceylon School.* Colombo: The Department of Government Printing.

Sessional Paper No. 1. (1990). *The Report of the National Education Commission on Youth.* Colombo: The Department of Government Printing.

Sessional Paper No. 10. (1963). *The InterimReport of the National Education Commission.* Colombo: The Department of Government Printing.

Sessional Paper No. 16. (1963). *Report of University Commission 1962.*.Colombo: The Department of Government Printing.

Sessional Paper No.1. (1962). *The InterimReport of the National Education Commission.* Colombo: The Department of Government Printing.

Sessional Paper No.23 (Nov. 1959). *Report of Ceylon University Commission.* Colombo: The Department of Government Printing.

Souza, Doric de. (1960). *A Commission of Inquiry into the Teaching of English in Ceylon Schools*. A motion of the Senate: Colombo.

Sridhar, (1980). In Kenneth, Croft and Little Brown. (Eds.). *Readings on English as a Second Language*. USA (Canada): Little Brown and Company Ltd.

Sumathipala, K.H.M. (1968). *History of Education in Ceylon: 1996- 1965*. Sri Lanka: TisaraPrakasakaya.

Walatara, D. (1974). *Reconstruction.* Colombo: Virani Printers and Publishers.

Wignaraja, S. (1994). Approaches of the American Mission in Teaching the English language during the British Period in Jaffna, PGD dissertation submitted to the University of Jaffna.

Chief Guest's Address

Changing Landscape of Mental Health disorders in Sri Lanka

Professor Shamini Prathapan
Chair professor, Department of Community Medicine, University of Sri Jayewardenepura

Mental illness is not new nor newly discovered. Throughout history, every man has faced a number of mental health issues. Since the beginning of recorded time, abnormal behaviors have been part of the human experience. As late as the 17th century, treatment for those "under the devil's control" was worse than any physical ailment. Many individuals suffering from mental illness were tortured in an attempt to drive out the demon. When this didn't work, and of course it usually didn't, the victim was thought to be eternally possessed and in need of execution. Death provided a permanent release from mental torment. By the 18th century, a slightly more enlightened attitude began to take hold. Sufferers were put into "lunatic asylums", as they were called. They could be grim places, and those inside were treated more as prisoners than patients.

Sri Lanka being under the British, gave us one another advantage with regards to mental health. Continuing in his hierarchical footsteps, in 1839 governor Mackenzie introduced an ordinance to establish lunatic asylums. History records that formal mental health services in Sri Lanka began as asylums under the Lunacy Ordinance of 1839. Such "lunatic asylums" were also built for the Sri Lankan mentally ill patients. The first of such was leprosy asylum in Hendala. Another building was built in Borella close to the city of Colombo in 1846 and patients from Hendala Leprosy asylum was transferred to Lunatic asylum Borella in 1847 (1). However, with the increased number of patients this hospital was overcrowded, and mentally ill people were imprisoned in jails throughout the island which only provided protection and occupational therapy as the main mode of treatment (2).

After overcrowding of three further asylums, Sri Lanka needed a bigger hospital to provide the care that these patients deserve and thus the Angoda asylum was completed in 1926 with 1728 beds providing mainly acute inward care to mentally ill patients. This was upgraded to National institute of mental health (NIMH) in October 2008. By the 21st century, Sri Lanka has expanded its mental health services throughout the island. A major shift occurred at the level of organization of services, from institutionalized mental health-care delivery to care in smaller facilities. In 2007, the major mental hospital at Angoda was restructured into the National Institute of Mental Health.

In 2022, there were 61 adult inpatient units and three child inpatient units in Sri Lanka to provide acute mental health curative services. While the medium stay units were available only in 15 districts, the outreach clinics and community support centers, which serve as hubs for promotion of mental wellbeing exist in almost all health divisions (3).

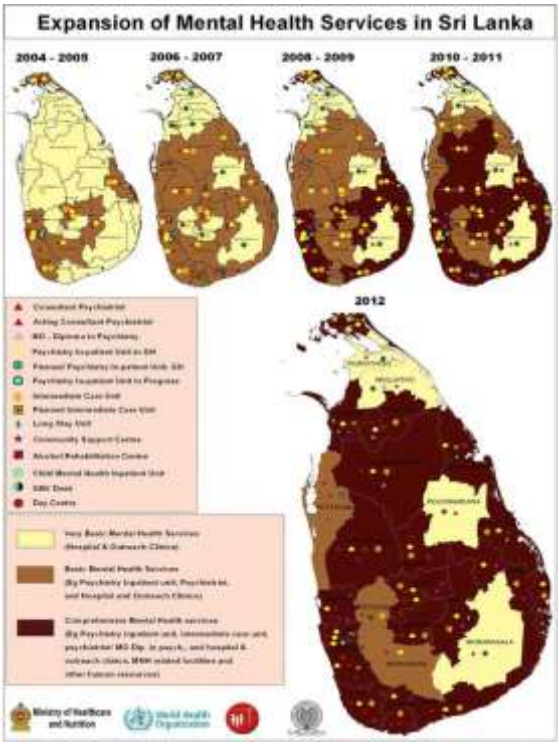


Figure 1: Mental health services in Sri Lanka

These services cater for a wide range of mental health disorders. Dementia, alcohol misuse, behavioral and emotional disorders have been accounted for most of the highest number of admissions to the hospitals (4). The aim of this oration was to look at four aspects of mental health disorders in Sri Lanka, Attention Deficit Hyperactivity disorder (ADHD), psychosocial problems among adolescents of Army war widows, COVID related mental health problems and stigma and discrimination which could change the landscape of the country and which have been analysed at great depth.

Attention Deficit Hyperactivity Disorder in Sri Lankan Children

ADHD is a neuro developmental behavioral disorder characterized by cardinal symptoms of impaired attention, hyperactivity and impulsiveness. This usually starts in childhood and lasts for at least 6 months (5). Children with ADHD find it hard to pay attention, get distracted easily, and find it hard to sit still.. This can get in the way of doing important things like in school or home work. Some forms of ADHD children may also have difficulties with reading, spelling or being clumsy and in communicating with others or having more emotions than others. Unfortunately the ICD 10 version 2010 do not have definition for ADHD. Although ADHD, is the second most common psychiatric disorder in children worldwide it was a major limitation to in not having a definition. Therefore the prevalence for the current study was determined according to diagnosis based on DSM-5 criteria made by the Consultant Child and Adolescent Psychiatrist where the SNAP-IV P/T—S served only as a screening tool. As there was no validated tool to screen for ADHD, the tool was first translated and culturally adapted and then validated and with a high reliability of SNAP-IV Parent and Teacher rating scale (6). The prevalence of ADHD in the Colombo district was determined with the help of a Child psychiatrist. A descriptive cross-sectional study was conducted to assess for Psychiatric Comorbidities among ADHD diagnosed Primary School Children attending Sinhala medium state schools in the District of Colombo. A case control study was further conducted to identify risk factors of ADHD

among primary school children. A trial was later conducted to assess the effectiveness of an intervention to improve the knowledge and misperception of ADHD.

The study population consisted of primary grade school children from grade 2 to 5 between 6 and 10 years of age in selected state schools. There were 305 Sinhala medium state schools with primary grades in the Colombo district among which 1,205 were selected. Prevalence on the current study was determined according to diagnosis based on DSM-5 criteria made by the Consultant Child and Adolescent Psychiatrist. The overall prevalence of ADHD was 6.5% (95% CI = 5.1, 8.1) for primary school children aged 6 to 10 years, with the prevalence three times higher in males (9.6%; 95% CI = 7.4, 12.3) compared to females (2.9%; 95% CI = 1.6, 4.7). Seven to eight year old was the most afflicted age group while combined was the commonest subtype. Among the 73 children diagnosed with ADHD, a greater majority (65.8%) of them had one or more psychiatric comorbidities. The commonest comorbidity among the children with ADHD is Specific Development Disorder of Scholastic Skills which was 46.5%, followed by Oppositional Defiant Disorder which was around 26.0%. A substantial proportion of children had one comorbidity (n=29, 39.7%) while 20.6% (n=15) had two and 5.5% (n=4) had three comorbidities (7).

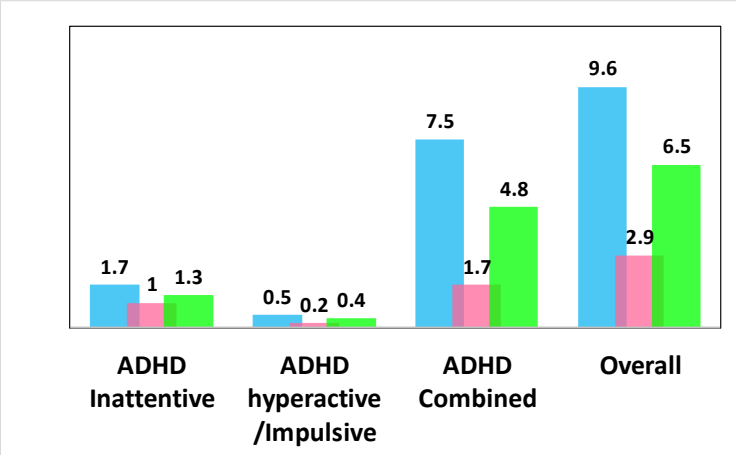


Figure 2: Prevalence of ADHD in Colombo District

Table 1: Distribution of various psychiatric comorbidities among diagnosed ADHD primary school children

Psychiatric comorbidity	Number(N=73)	%
Specific Developmental Disabilities of Scholastic Skills (SDDSS)	34	46.5
Oppositional Defiant Disorder (ODD)	19	26.0
Conduct Disorder (CD)	5	6.8
Anxiety Disorder	7	9.6
Depression	3	4.1
Intellectual Disability (ID)	3	4.1

SDDSS= Specific Development Disabilities of Scholastic Skills
ID= Intellectual Disability
CD= Conduct Disorder
ODD= Oppositional Defiant Disorder

The overall prevalence rate (6.5%) is comparable to a Chinese study carried out among 2 to 6 graders which reported an estimate of 5.91%, and a systematic review conducted with 67 Chinese studies which reported a pooled estimate prevalence of 6.26% (8). Systematic reviews and meta-analyses conducted from time to time on global prevalence of ADHD have varied at 5%. City of Belagavi, India reported among 6- to 11-year-olds, a lower value, than the current study of 5.29% (9). A study in state of Assam in India among a similar age group reported a higher value of 12.7% (10). A large study conducted in Korea among a group of 7- to 12-year-old elementary graders, revealed a similarly high estimate (11).

Psychosocial problems among adolescents of war widows in Sri Lanka.

This was a national study excluding Jaffna, Killinochchi, Mannar, vanvuniya and Mulllaithuvu Districts. A war widow was defined as an individual who's lost a spouse in the course of, consequent to, or in connection with the armed conflict in Sri Lanka. The loss of the spouse is due to death or disappearance; identified as "missing in action"; in situations where a death certificate or a "certificate of absence" was issued. The Pediatric Symptom checklist (PSC) and the PSC-Youth are freely available 35 item scales that measures psychosocial problems in children and adolescents. PSC-Y is the youth version of the parent reported version administered to adolescents' ages 11 years and above. Inclusion criteria for the study were adolescents of war widows aged 10-19 years from Western province. Among 348 adolescents screened, 50 were found to have psychosocial problems following clinical evaluation, giving an overall prevalence of 14.4% (95%CI=10.6-18.9). The most prevalent subtype of psychosocial problems was Anxiety / depression (internalising) problems, 5.7% (95%CI=3.5-8.9), followed by Attention problems 4.6% (95%CI=2.6-7.4) and Conduct (externalising) problems 3.2 % (95%CI=15.8-56.6). Least prevalent subtype was combined psychosocial problems (0.9%. 95%CI = 0.2-2.5). While the overall prevalence of psychosocial problems was 14.4% (95%CI=10.6-18.9), inter district variations were observed. Colombo district had the highest prevalence of 25% closely followed by Anuradhapura, Matale and Kurunagala. Trincomalee has zero percent prevalence among adolescents followed by Matara with 6.3%.

Table 2: Prevalence of psychosocial problems among adolescents of army war widoes based on their district of residence

District	%	95%CI
Ampara	12.5	(0.3-69.6)
Anuradhapura	20.0	(5.4-51.2)
Badulla	11.1	(2.3-32.5)
Colombo	25.0	(8.1-58.3)
Galle	10.0	(1.2-36.1)
Gampaha	17.9	(5.8-41.7)
Hambantota	9.1	(0.2-50.7)
Kalutara	18.2	(2.2-65.6)
Kandy	13.2	(5.3-27.2)
Kegalle	11.1	(1.3-40.1)
Kurunegala	20.5	(8.7-40.4)
Matale	20.0	(2.4-7.2)
Matara	6.3	(0.1-34.8)
Monaragala	14.3	(0.2-51.6)
Nuwara Eliya	14.3	(0.2-51.6)
Polonnaruwa	7.7	(0.1-42.9)
Puttalam	14.3	(0.3-79.6)
Rathnapura	6.7	(0.1-37.1)
Trincomalee	0.0	-
Total	**14.4**	(10.6-18.9)

COVID-19 Related Stigma and discrimination

Stigma and discrimination began with the spread of HIV/AIDS. With a lot of public health awareness, internationally and nationally, stigma and discrimination among people infected with HIV/AIDS became less. However, with the COVID-19 pandemic, stigma and discrimination became a concern worldwide. With the increase in stigma and discrimination, the community is less likely to be tested and be treated.

During the first few months of COVID-19 in Sri Lanka, Sri Lankans arrived at the airport, and were all quarantined or isolated in camps. Laboratory-confirmed COVID-19 patients from the above mentioned camps and those who had been discharged from four state hospitals of Sri Lanka; namely, the National Institute of Infectious Diseases (NIID), Colombo East Base Hospital (CEBH), Mulleriyawa; Base Hospital (BH), Welikanda; and Base Hospital, Homagama were interviewed. In this qualitative study, semi-structured interviews were performed with patients who were Sri Lankans. Those in the medical and nursing professions were excluded from the study, as they may have been treated differently from Sri Lankan COVID-19 patients. The majority of participants were men (n= 80; 57.6%), with a mean age of 43 years (SD= 11.2). In total, up to one-third of the study participants experienced stigma related to COVID-19 and were discriminated by the community, co-workers and healthcare workers in Sri Lanka. Social discrimination included barriers in accessing basic needs, insulting, blaming, defaming, spreading rumours and receiving no support during emergencies. A quote by a cancer survivor was "when I came home after recovery, my neighbours said hurtful things. Some even asked "why are you not dead yet". Another disturbed finding from our study was, like the ancient days of leprosy, the villagers lighting fire to the houses of COVID-19 positive patients. A 52 year old tourist guide said "our neighbours tried to avoid me and my family. They even set fire to my house claiming that we are spreading corona…We were labelled as corona infected". Patients were isolated and discriminated from the workplace and community due to COVID-19, even after full recovery. Stigma and discrimination at workplace was seen as another problem. Among those who lost their jobs, one 55-year-old male security officer said that he felt desperate without a job. Another 44-year-old female who works in a cleaning service said that her employer has informed that they will not take her back to work. A self-employed female who was a dress maker said that clients did not return to collect their clothes. Loss of earnings as a result of workplace stigma and discrimination has led to multiple social and financial problems for the affected families. Stigmatised individuals have experienced stress, anxiety and depression. Furthermore, they experienced a sense of social worthlessness due to discrimination. A 30 year old married female had felt like ending her life as the villagers have spread the rumor that she had contracted COVID-19 through an extra martial affair as her husband and children had not had COVID-19 (12).

We also targeted the health care workers and assessed the psychological distress of doctors and nurses during the first lockdown. Among a sample of 385, 11.4% had stress, 15.7% were anxious and 13.9% were depressed. Stigma was experienced by 29.7% of health care workers, 8.1% were not accepted into shops, 3% were asked to leave from their place of accommodation and 15.5% felt their family was discriminated in the villages (13, 14).

Future perspectives and recommendations

Addressing the increase prevalence of mental health disorders and mainly the long-term outcomes of these, warrants primary preventive measures and a structured rehabilitation. Evidence recommends strengthening and implementation of mental health services. Furthermore, other co-morbid conditions should be addressed by measures to prevent the above conditions should be strengthened in primary care setting. Sri Lanka offers free healthcare services and has initiated outreach clinics and community support centers, in almost all health divisions. The main service objective of these hubs are to promote mental wellbeing and to improve the access for care of those found have mental disorders. With the availability of screening tools, the scope of such hubs can be extended for the above mentioned mental health disorders in Sri Lanka. Such an initiation should be accompanied by informing the general public about the importance of assuaging stigma and discrimination so that they could undergo screening enabling successful treatment. A further step would be to advocate for a policy decision to evaluate the need for a screening program among adolescents and children in Sri Lanka.

References

1. Daniel Ball, We died and were reborn: an anthropological study of health-seeking strategies for mental and emotional distress in post al distress in post-war eastern Sri Lanka. University of Kentucky, https://doi.org/10.13023/etd.2020.369.
2. Harischandra Gambheera. The evolution of psychiatric services in Sri Lanka. The south Asian Journal of psychiatry.
3. Directorate of Mental Health, Ministry of Health. https://mentalhealth.health.gov.lk/index.php?option=com_content&view=article&id=6&Itemid=125&lang=en
4. Annual Health Bulletin, Ministry of Health, (2021). Sri Lanka
5. Harrison JR, Evans SW, Baran A, Khondker F, Press K, Noel D, Wasserman S, Belmonte C, Mohlmann M. Comparison of accommodations and interventions for youth with ADHD: A randomized controlled trial. J Sch Psychol. 2020 Jun;80:15-36. doi: 10.1016/j.jsp.2020.05.001. Epub 2020 May 25. PMID: 32540088.
6. Nazeer, N., Rohanachandra, Y., & Prathapan, S. Criterion Validity Of Sinhala Version Of Swanson, Nolan, And Pelham Iv Scale (Snap-Iv-S): Parent And Teacher Ratings Of Attention Deficit Hyperactivity Disorder Among A School Based Sample Of Primary Graders In Sri Lanka. APACPH 2020.
7. Nazeer, N., Rohanachandra, Y., & Prathapan, S. (2022). Prevalence of ADHD in Primary School Children, in Colombo District, Sri Lanka. Journal of Attention Disorders, 26(8), 1130–1138. https://doi.org/10.1177/10870547211058704
8. Wang T, Liu K, Li Z, Xu Y, Liu Y, Shi W, Chen L. Prevalence of attention deficit/hyperactivity disorder among children and adolescents in China: a systematic review and meta-analysis. BMC Psychiatry. 2017 Jan 19;17(1):32. doi: 10.1186/s12888-016-1187-9. PMID: 28103833; PMCID: PMC5244567
9. Joshi HM, Angolkar M. Prevalence of ADHD in Primary School Children in Belagavi City, India. J Atten Disord. 2021 Jan;25(2):154-160. doi: 10.1177/1087054718780326.
10. Ghosh P, Choudhury HA, Victor R. Prevalence of attention deficit hyperactivity disorder among primary school children in Cachar, Assam, North-East India. Open J Psychiatry Allied Sci. 2018;9:130-5. doi: 10.5958/2394-2061.2018.00025.3.

11. Kim MJ, Park I, Lim MH, Paik KC, Cho S, Kwon HJ, Lee SG, Yoo SJ, Ha M. Prevalence of Attention-Deficit/Hyperactivity Disorder and its Comorbidity among Korean Children in a Community Population. J Korean Med Sci. 2017 Mar;32(3):401-406. doi: 10.3346/jkms.2017.32.3.401. PMID: 28145641; PMCID: PMC5290097
12. Jayakody S, Hewage SA, Wickramasinghe ND, Piyumanthi RAP, Wijewickrama A, Gunewardena NS, Prathapan S, Arambepola C. 'Why are you not dead yet?' - dimensions and the main driving forces of stigma and discrimination among COVID-19 patients in Sri Lanka. Public Health. 2021 Oct;199:10-16. doi: 10.1016/j.puhe.2021.07.001. Epub 2021 Jul 10. PMID: 34517288; PMCID: PMC8429037.
13. Alles, P.S., Rohanachandra, Y.M., Amarakoon, L. and Prathapan, S., 2021. Psychological distress, challenges and perceived needs among doctors and nurses during the COVID-19 pandemic, in a tertiary care hospital in Sri Lanka. Sri Lanka Journal of Psychiatry, 12(1), pp.4–10. DOI: http://doi.org/10.4038/sljpsyc.v12i1.8279
14. Rohanachandra, Y.M., Alles, P.S., Semage, S., Palihawadana, P. and Prathapan, S., 2022. Psychological impact and coping strategies in persons who experienced institutional quarantine for COVID-19 in Sri Lanka. Sri Lanka Journal of Psychiatry, 13(1), pp.4–13. DOI: http://doi.org/10.4038/sljpsyc.v13i1.8326

Begomoviruses Diversity in Sri Lanka

E.C. Jeyaseelan
Chairperson, Section A, Department of Botany, University of Jaffna

Plant viruses

Viruses are very tiny particles, smaller than bacteria. Since their size is too small, electron microscopes are essential to observe and study their morphology and structure. Structurally, plant viruses are simple. A plant virus consists of a protein coat which surrounds nucleic acid. The nucleic acids can be deoxyribonucleic acid (DNA) or ribonucleic acid (RNA). Viruses do not show living properties outside a host cell; they are considered as particles. When viruses infect host cells, they hijack the cells' major metabolic pathways and use those pathways to multiply themselves. The virus infection and subsequent alterations in the physiology lead to disease development in plants.

The system currently used to name a virus dramatically differs from that used for animals, plants, bacteria or fungi. A virus name consists of three components. The first component is the name of the host plant in which the virus was detected, the second component is the symptom that develops in the host plant when the virus infects, and the name ends with "virus". The species name of the virus which causes mosaic disease in tobacco plants is *Tobacco mosaic virus*. The International Committee on Taxonomy of Viruses (ICTV) is the approved body responsible for developing criteria for virus classification and binomial species naming. According to the recent ICTV report, plant viruses are classified into 49 families. Family *Geminiviridae* is the most important family and comprises 520 virus species. Out of 14 genera reported in *Geminiviridae*, the *Begomovirus* genera consists of 424 virus species. Many of these *begomoviruses* are serious pathogens in crops and cause severe losses.

Begomoviruses

Begomovirus is the largest group of plant-infecting DNA viruses. Begomoviruses have received much attention in the last decades by researchers across the world, especially in the tropical and subtropical regions, as climates favour the multiplication and ability of vectors that transfer this virus. It is a serious threat to the cultivation of solanaceous and cucurbitaceous vegetables in South Asian countries such as Pakistan, India and Sri Lanka.

Begomovirus consists of monopartite or bipartite single-stranded DNA genomes. The genetic material is individually encapsidated in twinned quasi-isometric (geminate) 22-38 nm virions. The monopartite begomoviruses have a single circular DNA strand which code for six genes essential for the coat protein synthesis, replication and movement. But in bipartite begomoviruses, two circular DNA strands are present and named DNA-A and DNA-B. The DNA-A consists of genes which are functionally similar to the DNA present in monopartite begomoviruses. At the same time, DNA-B encodes two proteins involved in intra- and intercellular movement. The monopartite begomoviruses are widely spread in the Old World (countries in the eastern hemisphere), but only a few examples have been reported from the New World (Countries in the western hemisphere). Old World and New World viruses are well separated and of diverse lineage.

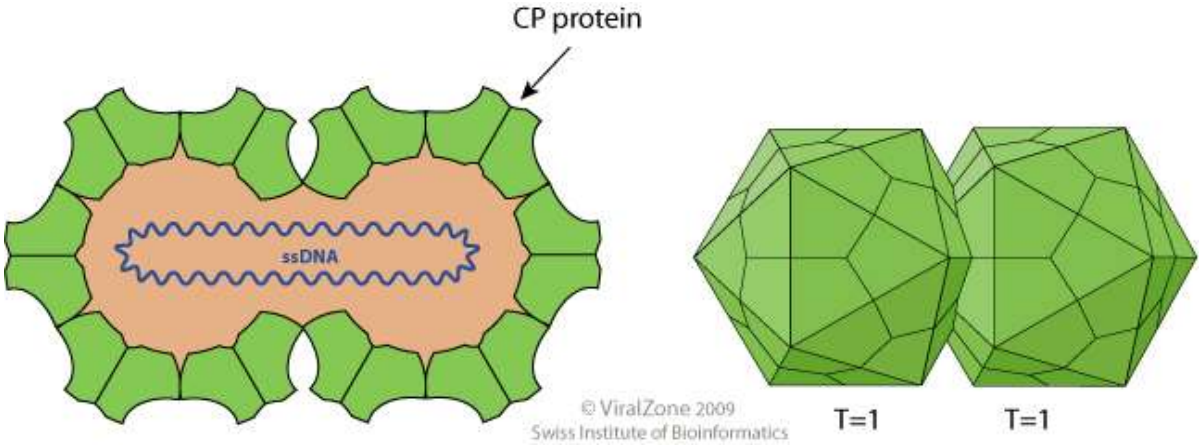


Figure 1: Structure of begomoviruses. Twinned quasi-isometric particles consist of ssDNA

Studies have shown that the viruses that come under the genera *Begomovirus* are transmitted from diseased plants to the healthy plant via whitefly (Bemisia tabaci) vectors. Begomoviruses are not known to replicate in their insect vectors and do not negatively affect their insect host.

The monopartite begomoviruses are usually associated with virus-dependent nucleic acids known as satellite molecules. So far, three different types of satellite molecules have been identified, namely, alphasatellites, betasatellites and deltasatellites. ICTV has recently classified the satellites and named them as separate species. Among the satellites, the betasatellite has been reported with many monopartite begomoviruses. Betasatellites encode the βC1 protein, which has essential roles in symptom induction and suppression of transcriptional and post-transcriptional gene silencing.

For the identification of begomoviruses and satellites, their complete genome should be sequenced, and the sequences should be analyzed using specific bioinformatics tools to determine the identity percentage with the reference species recommended by ICTV.

Why are begomoviruses important?

In addition to the presence of many species, the begomoviruses also have a wide host range. They infect vegetable crops (e.g. Cassava, Bean (Soybean, Mungbean, French bean), Okra, Bitter gourd, Cabbage, Tomato, Chilli, Cucurbit, Pepper, Potato, Sweet potato, Squash, Spinach, Radish), fruit crops (e.g. Papaya, Passion fruit, Watermelon) and highly commercially valuable plants such as Tobacco and Cotton. In addition to crops, several weeds in the agricultural fields are also host to begomoviruses. For example, weeds such as *Stachytarpheta*, *Senna*, *Abutilon*, *Ageratum*, *Alternanthera*, A*ndrographis*, *Catharanthus*, *Cleome*, *Coccinia*, *Clerodendrum*, *Datura*, *Eclipta*, *Euphorbia*, *Malvastrum*, *Mesta*, *Sida* and *Vernonia* are infected by this virus.

Even a single begomovirus species has several host plant species. *Tomato leaf curl New Delhi virus* (ToLCNDV) is originally identified as a pathogen in tomato. But in recent days, ToLCNDV infection has been reported in 43 other dicotyledonous plant species, in addition to tomato cultivars.

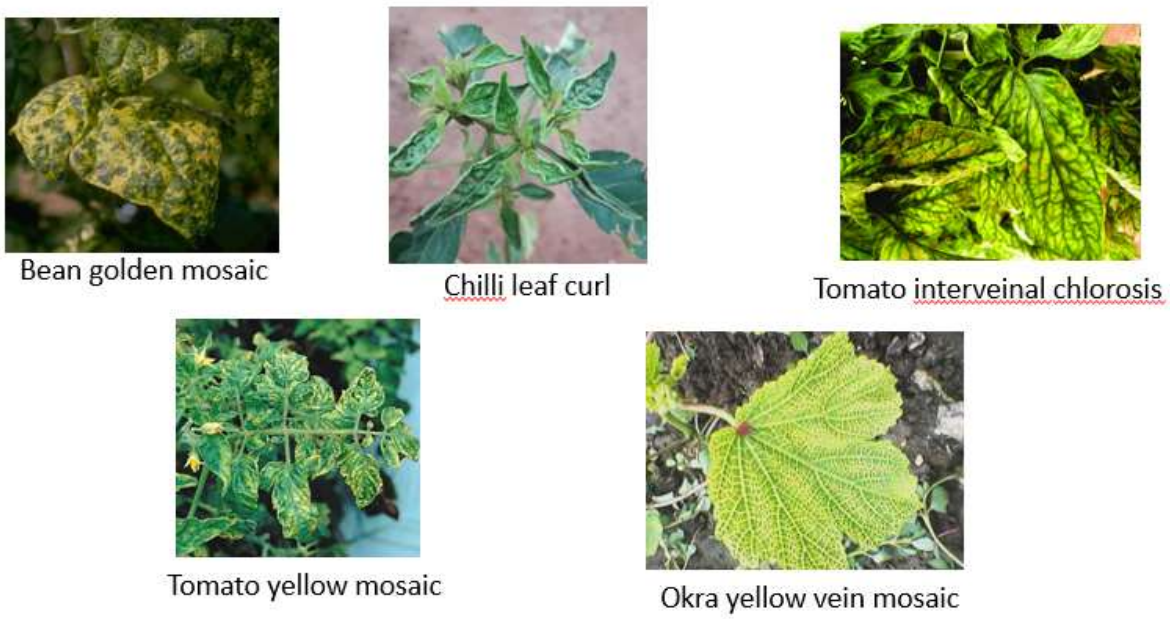


Figure 2: Different types of diseases caused by begomoviruses

Begomoviruses cause serious diseases and significantly reduce plant growth and yield. Early infections lead to 100 % loss when a favourable environment and susceptible host variety exist.

Following recent findings clearly show the increasing threat from begomoviruses.

1. In some bipartite begomoviruses, betasatellites could complement the lack of DNA-B in systemic infections.
2. Presence of a second betasatellite-encoded protein, βVl, also contributes to symptom development.
3. Co-occurrence of unrelated begomovirus species.
4. The diverse associations of satellite molecules with different begomoviruses and development of begomovirus–satellite complexes.
5. High mutation rates and recombination frequencies due to the mixed infection.
6. Seed-borne transmission.

Begomoviruses in Sri Lankan

Begomovirus related diseases are widespread in Sri Lankan agricultural fields, especially in dry zone regions. However, very few research groups are working on plant viruses in Sri Lanka. Most disease diagnostic and pathogen identifications are conducted based on the symptoms. Molecular-level studies are rarely undertaken in Sri Lanka. In Genbank, only 40 nucleotide sequences are submitted for begomoviruses; 11 sequences are partial sequences. Seven begomovirus species are identified based on the complete genome sequencing method. Those identified species are, namely, *Ageratum yellow vein sri lanka virus*, *Tomato leaf curl sri lanka virus*, *Sri lankan cassava mosaic virus*, *Horsegram yellow mosaic virus*, *Chilli leaf curl sri lanka virus*, *Bhendi yellow vein mosaic virus* and *Okra enation leaf curl virus*.

On the other hand, seven different betasatellites species have been reported from Sri Lanka, namely Bhendi yellow vein mosaic betasatellite, *Leucas zeylanica* yellow vein betasatellite, Chili leaf curl sri lanka betasatellite, Ageratum yellow vein sri lanka betasatellite, Chili leaf curl betasatellite, Tomato

leaf curl betasatellite and Chilli leaf curl virus. In okra enation leaf curl disease the first alphasatellites have been reported as associated with the begomovirus and betasatellite. Bhendi yellow vein alphasatellite and Okra leaf curl alphasatellite are the two alphasatellites detected in Sri Lanka.

Ageratum yellow vein sri lanka virus was first reported by Tsai et al., and the complete DNA sequence was submitted to GenBank in 2000. This species is different from the *Ageratum yellow vein virus* reported in many other countries. ICTV has been accepted as a separate species. However, no research articles describe further details of this virus. Several research activities are going on tomato leaf curl disease in Sri Lanka. However, very few research articles are available on the molecular level studies of the pathogen. The ICTV accepted genome sequence of the virus species Tomato leaf curl sri lanka virus was submitted to GenBank by Shih et al. in 2000. Interestingly, there was no Sri Lankan researcher in that submitted group, and the samples had been collected from Bandarawela. In the above two studies, there were no researchers affiliated from any Sri Lankan research community and the works were conducted entirely outside Sri Lanka.

In 2002, a research group from John Innes Centre, UK, first published molecular level findings of *Sri lankan cassava mosaic virus*. Prof. Nazeera Salim, a Sri Lankan scientist, worked in that group. After that, several research activities and publications were raised about this virus. The first report of *Horsegram yellow mosaic virus* was made in 2010 as a pathogen on beans (*Phaseolus vulgaris*). This research was also partly conducted outside the country. However, a researcher from Horticultural Crop Research and Development Institute, Sri Lanka, worked on that research project. The chilli cultivation has been severely affected by the leaf curl disease. The molecular identification of the pathogen was first reported by Dr. D. M. J. B. Senanayake and others in collaboration with the Indian Agricultural Research Institute, New Delhi. The pathogen has been identified as *Chilli leaf curl sri lanka virus,* and ICTV also has been accepted as a new begomovirus species causing leaf curl disease in chilli.
Another research group from the Department of Botany, University of Jaffna, has identified the causative agent of the begomovirus species, which causes yellow vein mosaic disease and leaf curl disease in okra (*Abelmoschus esculentus*). This was achieved by a collaborative research activity with researchers from the Department of Agricultural Biology, University of Peradeniya and School of Agriculture, Policy and Development, University of Reading, UK. This study revealed the association of the *Bhendi yellow vein mosaic virus* and *Okra enation leaf curl virus* with diseased okra plants.

Conclusion

Like other South Asian countries, Sri Lanka also has a severe threat from begomoviral infection on agricultural crops, which belong to Solanaceae, Malvaceae, Fabaceae and Cucurbitaceae families. Identification of the exact causative agent is essential to selecting specific control measures. However, studies conducted on the begomovirus identification are relatively low in Sri Lanka. Most diseases are identified based on symptomatology, but it is not always reliable. Currently, many laboratories have sophisticated facilities to conduct molecular-level studies in Sri Lanka. Therefore, I encourage young researchers to consider begomovirus in their research projects.

References

Díaz-Pendón, J. A., Sánchez-Campos, S., Fortes, I. M., & Moriones, E.. Tomato Yellow Leaf Curl Sardinia Virus, a Begomovirus Species Evolving by Mutation and Recombination: A Challenge for Virus Control. Viruses, 11(1), 45 (2019).

Elvira, F. O. & Jesús, N.C. Molecular and Biological Characterization of a New World Mono-/Bipartite Begomovirus/Deltasatellite Complex Infecting Corchorus siliquosus. Frontiers in Microbiology 11, (2020).

Emmanuel, C.J., Manohara, S. & Shaw, M.W. Molecular characterization of begomovirus–betasatellite–alphasatellite complex associated with okra enation leaf curl disease in Northern Sri Lanka. 3 Biotech 10, 506 (2020).

Hu, T., Song, Y., Wang, Y. et al. Functional analysis of a novel βV1 gene identified in a geminivirus betasatellite. Sci. China Life Sci. 63, 688–696 (2020).

Jeyaseelan, T.C., De Costa, D.M. & Shaw, M.W. Two different begomovirus species are associated with yellow vein mosaic disease of okra in Sri Lanka. Mol Biol Rep (2021).

Kil, E.J., Vo, T.T.B., Fadhila, C., Ho, P.T., Lal, A., Troiano, E., Parrella, G. & Lee, S. Seed Transmission of Tomato Leaf Curl New Delhi Virus from Zucchini Squash in Italy. Plants 9, 563 (2020).

The need of engineered hydrochar from biomass residues for removal of pollutants from water

Dr.N.Kannan
Chairperson, Section B, Department of Agricultural Engineering, University of Jaffna

1. Introduction

World's population growth and industrial revolution are two major factors that increase the demand for natural resources. Water is one of the most indispensable resources for the survival of living organisms and is getting polluted significantly over time (Vörösmarty et al., 2000). Application of various chemicals in the field of agriculture and release of waste materials from various industrial processes influence the quality of water that is being used (Carpenter et al., 1998). Many people in the world are affected by diseases that are caused by water pollution. However, removal of such pollutants from water is a challenging task due to the high cost associated with existing methods (Shannon et al., 2008).

Among water pollutants, heavy metals and dyes, which are produced by industries such as metal plating, mining, tanneries, agricultural chemicals, textiles, plastics and cosmetics can be highly toxic (Chuah et al., 2005). These pollutants cause serious health impacts on the human population. Many developed and developing countries are looking for cost-effective strategies for removing such toxic pollutants from water. Hence, the development of a simple win-win strategy for the removal of pollutants like heavy metals and dyes from water has a great importance in maintaining environmental sustainability (Shannon et al., 2008). Among low cost remediation strategies, biochar has the potential to be used as a sorbent for water purification. Biochar, a partially burnt carbon compound, produced from biomass residues by thermal treatment, has active surface functional groups to adsorb pollutants from water (Kambo and Dutta, 2015).

Type of biomass residues plays a crucial role in determining functional properties of biochar. Moisture content of the biomass significantly influences char yield at the end of various thermal pre-treatment (Kambo and Dutta, 2015). Harvested crop residues, animal waste and purposely grown biomass are commonly used for the production of biochar (Kambo and Dutta, 2015). However, the selection of biomass for biochar production has to be made properly for obtaining biochars of high quality for removing a wide range of pollutants (Kambo and Dutta, 2015).

Furthermore, hydrochar, is a group of biochar produced via hydrothermal carbonization (HTC) for environmental applications because of their low production cost and enhanced functional groups (Xue et al., 2012). A lot of research works has already been conducted to study the role of biochar in the removal of various pollutants present in polluted water. Although a number of potential applications in water treatment have been reported and discussed in research literature (Kambo and Dutta, 2015, Xue et al., 2012), the research on clarification of relationship between treatment effectiveness and properties of hydrochar via HTC from different biomass residues and on development of the methods

to produce customised hydrochars for removal of different types of pollutants is still limited. Developing a specific protocol to employ for removing a specific pollutant is highly essential to enhance commercial application of hydrochar.

2.Overview of biochar

Thermal decomposition of biomass residues yields the solid product called "biochar", which is rich in carbon together with improved surface properties. There are four methods commonly used for thermal pre-treatments, namely, pyrolysis (slow and fast), gasification, dry torrefaction and hydrothermal carbonization. Pyrolysis is the temperature driven chemical decomposition of biomass without combustion (Demirbas, 2004). Pyrolysis is divided into two categories: slow and fast, based on residence time and heating rate of the process.

Fast pyrolysis is set with high heating rate (1000 °C/s) and low residence time (1 - 5 s) that yield around 70% biooil and 15% biochar from biomass (Kambo and Dutta, 2015). The main yield of the slow pyrolysis process which is defined by low heating rate (10 - 30 °C/min) and long residence time (5 min - 12 h) is biochar (35%) and syngas (35%), together with biooil fraction (Kambo and Dutta, 2015). Generally, the lower the temperature at which pyrolysis occurs, the higher the carbon recovery of the original biomass (Lehmann et al., 2006). The production of biochar is favoured when there is low temperature and low oxygen level inside the pyrolysis chamber. At equal to or greater than 400 °C, the biomass material is converted to fused aromatic ring biochar structures with around 10% syngas (a mixture of CO2, CO and H2) (Kambo and Dutta, 2015).

Partial combustion of biomass takes place in the gasification process that happens in the temperature range, 600 - 1200 °C with the low residence time (10 - 20 s) in order to produce syngas yield of 85% weight basis (Kambo and Dutta, 2015). Dry torrefaction which is just the beginning of pyrolysis process is performed in the temperature range, 200 - 300 °C (Kambo and Dutta, 2015). However, HTC which is the thermal decomposition of biomass in the presence of water is completed in the temperature range, 180 - 260 °C with an elevated pressure profile of 2 - 5 Mpa for 5 - 240 minutes to produce a hydrochar yield of around 70% wet basis (Kambo and Dutta, 2015). The end solid product of HTC process is called, hydrochar which is similar to biochar in its functions. The range of temperature for such thermal pre-treatment of biomass varies from 180 - 1200 °C (Kambo and Dutta, 2015). Different types of biochar are produced by various degrees of carbonization for adsorbing pollutants from water. Compared to activated carbon, biochar is produced with simple and economical processes (Mohan et al., 2014).

Pyrolysis, gasification and HTC are influenced by processing conditions and nature of feedstock used. Table 1 summarises the general features of these processes. Biochar is produced as by-product by fast pyrolysis, gasification and torrefaction as the majority of the biomass is converted to energy products like biooils and syngas. Currently, biochar is commonly produced by slow pyrolysis when the biomass is dry. However, there are some limitations in this process. It further emits harmful gases like CO, CH4 and polycyclic aromatic compounds into the environment (Kambo and Dutta, 2015). In addition, such process is expensive due to sophisticated production plant configurations. Moreover, induced microbial

activities in the storage piles of biochar can lead to fire accidents during their storage. Biochar production process further requires pre-drying arrangements for the biomass feedstock in order to have higher solid material yield at the end of the treatment process. Hence, this process is energy intensive.

Pre-treatment method	Operating temperature (°C)	Residence time	Rate of heating	Product distribution Solid
Fast pyrolysis	400 - 500	1 - 5 s	1000 °C/s	10-15
Slow pyrolysis	300 - 650	5 min - 12 h	10 - 30 °C/min	25-35
Gasification	600 - 1200	10 - 20 s	50 - 100 °C/s	<10
Dry-torrefaction	200 - 300	30 min - 4 h	10 - 15 °C/min	60-80
HTC	180 - 260	5 min - 12 h	5 - 10 °C/min	45-70

Table 1: Thermal pre-treatment methods with the product distribution (Kambo and Dutta, 2015)

3.Hydrochar - a biochar produced via HTC

HTC process for hydrochar production eliminates or alleviates the issues related to other biochar production processes. HTC process could be performed with available feedstocks like agricultural wastes and sludge regardless of their initial moisture content (Kambo and Dutta, 2015). In addition, it requires no pre-heating arrangements to convert biomass to hydrochar because the reaction phase of HTC is initialized by water hydrolysis. A large amount of harmful gases is not generated in HTC and char samples via HTC are not prone to ignite due to its concentrated surface functional groups.

The hydrochar produced via HTC has similar functional properties as biochar produced from other thermal processes. The HTC process further produces char-water-slurry (Mok et al., 1992). Initial moisture content of the feedstock does not affect HTC process because the process itself is carried out in the presence of water in the reaction system. The properties of char derived from HTC are strongly influenced by processing conditions and properties of raw materials. Proper drying is needed to prepare the hydrochar soon after production (Mensinger, 1980). Hydrochars are usually less stable against microbial decomposition than biochar (Kambo and Dutta, 2015).

The high degree of aromatization is found at hydrochar surface together with large number of oxygen containing functional groups that are responsible for water affinity and adsorptive capacity (Kambo

and Dutta, 2015). High affinity to water and the presence of concentrated surface functional groups make the hydrochar suitable for environmental remediation purposes and are important for binding organic and inorganic pollutants that are present in polluted water (Kambo and Dutta, 2015). Furthermore, hydrochar is used for soil amendment, carbon sequestration, fuel production and as a precursor for activated carbon as illustrated in Figure 1.

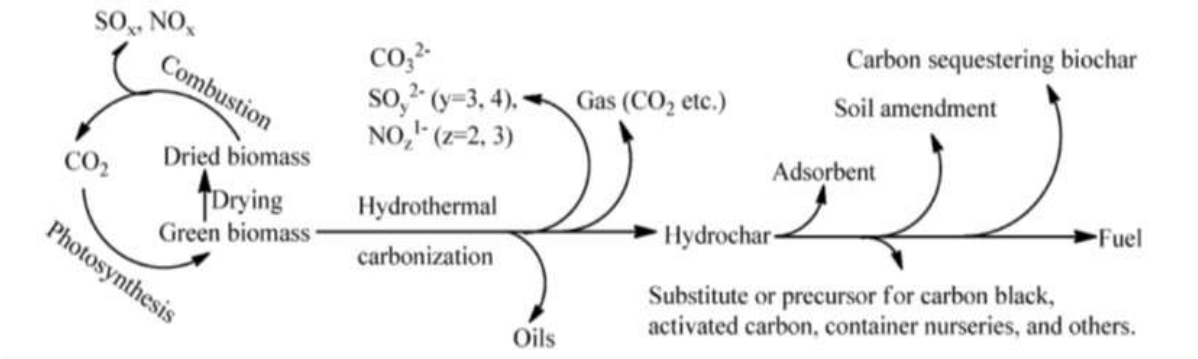


Figure 1: Possible application of hydrothermal carbonization of biomass (Kang et al., 2012)

3.1 Modification of conventional biochar

Biochar produced from conventional processes like pyrolysis has reduced surface functional properties needed for high adsorptive capacities (Rajapaksha et al., 2016). Additional activation steps are needed to increase the surface area and porosity in order to make chars suitable for adsorbing pollutants at low cost. Development of internal porous structure in biochars during modification process increases its surface area significantly (around 3000 m2/g) (Ahmad et al., 2014). Furthermore, chemical modification and physical activation are commonly used for the activation of chars (Ahmad et al., 2014). Chars are exposed to activating agents during modification in a well-defined environment for improving their functional properties. In addition to such methods, magnetic modification is also used to activate surface functional groups.

Chemical modification can be done either by one step process or two step process (Azargohar and Dalai, 2008). It has been reported that biochar performance is profoundly affected by modification (Kasparbauer, 2009). Acids and bases are used in chemical modification process. Hydrogen peroxide (H2O2), potassium permanganate (KMnO4), ammonium persulfate ((NH4)2S2O8) and ozone (O3) have been used successfully for deliberate oxidation to modify surface functional groups in order to activate functions of biochar (Cho et al., 2009). Furthermore, it has been reported that strong acids such as phosphoric acid (H3PO4), sulphuric acid (H2SO4), nitric acid (HNO3) and hydrochloric acid (HCl) could be used for the purposes of aqueous oxidation that can enhance surface properties of biochar (Li et al., 2012).

However, the use of HNO3 for surface oxidation has degraded surface porous structure due to its erosivity (Stavropoulos et al., 2008). Similarly, decrease in porosity of biochar from 10 - 40% and improvement in the size distribution of heterogeneous micro pore have been reported in biochar treated with H2SO4 (Guo et al., 2005). Generally, treatment with strong acids improves acid functional groups

like amine, carbolic groups to the biochar surface. These functional groups further enhance metal adsorptive capacity due to improved cation exchange on surface active sites (Rajapaksha et al., 2016). Figure 2 illustrates the modification of biochar.

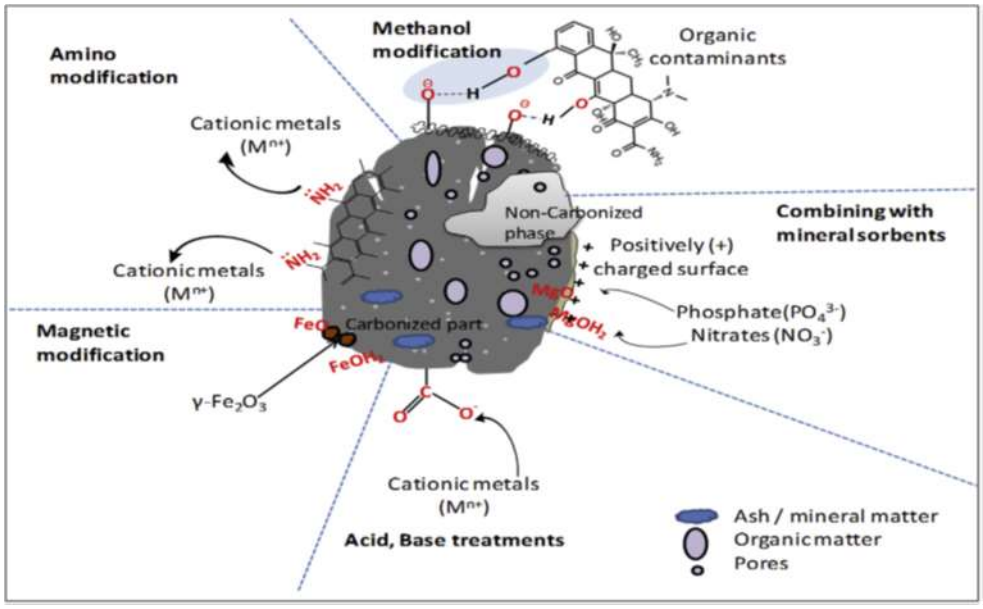


Figure 2: Schematic representation of biochar modifications (Rajapaksha et al., 2016)

Development of additional cation exchange sites and carboxyl groups on biochar surface during H_2O_2 oxidation can increase surface binding of Pb2+. This H2O2 modified biochar is superior to commercially available activated carbon (Tan et al., 2011). An increase in carboxylic content from 2 to 8.2% , due to the oxidation of carbonized biochar surface, during H2O2 modification has also been reported (Tan et al., 2011).

Furthermore, O-containing functional groups (carboxylic group) in biochars, responsible for heavy metal adsorption, has been increased during hydrogen peroxide modification of pea nut hull biochar surface (Xue et al., 2012). Moreover, some studies have focused on organic solvent modification (Gardea-Torresdey et al., 1990), surface modification (Paria, 2008), physical modification by steam activation (Makino et al., 2000) and magnetic modification (Chen et al., 2011) to activate the biochar for better efficiencies with different experimental variables and setups. Modified biochar show enhanced functional properties as shown in Figure 3.

Based on these findings, much work has been done on biochar modification with different methods such as chemical modification, physical modification and magnetic stimulations. The modification of biochar is needed to improve its active surface, porous structure and density of surface functional groups that are responsible for high adsorptive capacities. Chemical modification is commonly practiced to modify the biochar compared to other methods. However, care must be taken to avoid chemical toxicity in the modification process.

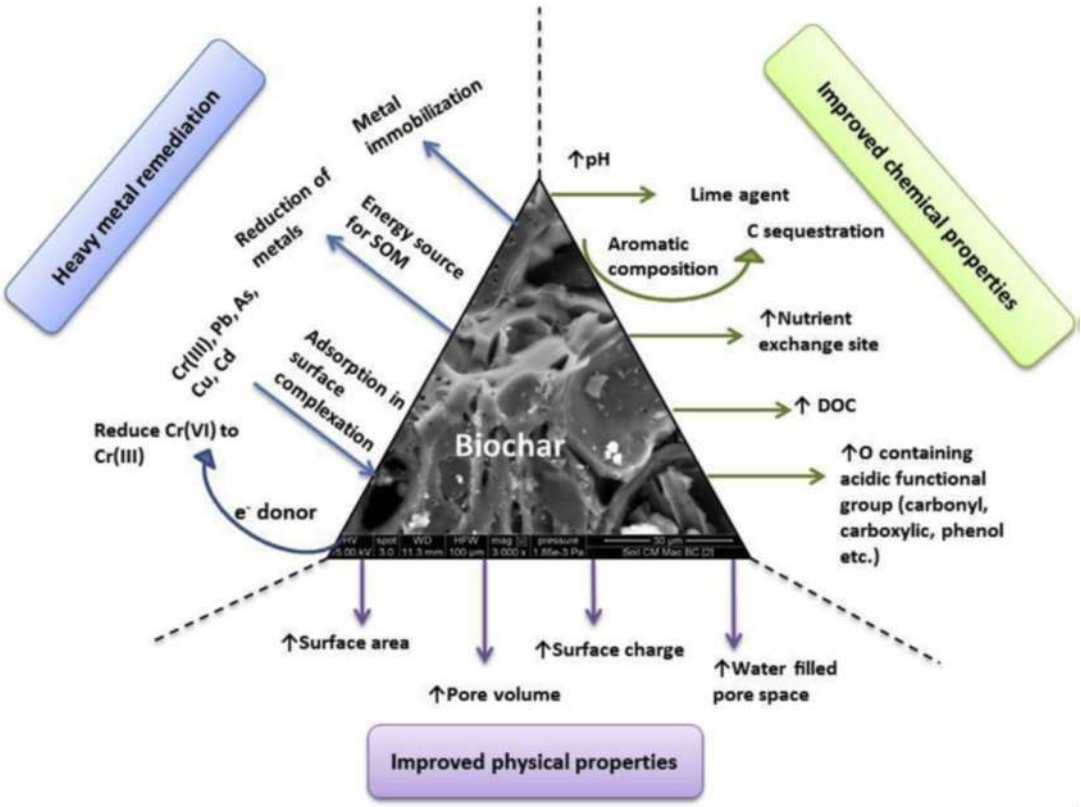


Figure 3: Improved performance of modified biochar (Rajapaksha et al., 2016)

3.2 Hydrochar improvement

Hydrochars could also be improved by using catalysts in the preparation process, optimization of process temperature and time and modification after preparation by using chemical agents. The work on modification of hydrochar is limited compared to biochar. Hydrochar samples have been improved by adding citric acid monohydrate as a catalyst for improving their adsorptive capacity (Xu et al., 2013). Temperature optimization study of HTC has been conducted with pam shell (Nizamuddin et al., 2016). Furthermore, post-modification has been done by adding chemicals, physical activations and magnetic stimulations for promoting surface functionalities of hydrochar (Rajapaksha et al., 2016).
There is a need to enhance surface area and porosity of hydrochar samples produced via HTC for improved functionalities (Kambo and Dutta, 2015). A study, using pine wood, stated that the samples prepared via HTC and slow pyrolysis recorded surface area of 2 m2/g for and 29 m2/g respectively (Liu et al., 2010). The surface area and porosity of hydrochar samples are improved when temperature in HTC is increased. As hydrochar samples have low surface area and porosity compared to biochar, modification of hydrochar by modifying agents are important to improve their adsorptive capacity.

3.3 Biochar for water treatment

Biochar has a wide range of applications in the field of water treatment engineering. Its application has become popular all over the world because of its ecofriendly nature. Biochar applications can be divided into two broad groups based on organics and inorganics remediation. Organics can be further divided into dyes, phenolics, pesticides, and polynuclear aromatics and antibiotics removal (Mohan et al., 2014). Inorganics remediation can be divided into cations removal and anions removal. Many in-

depth investigations are being undertaken in this field to explore future applications. Most of the application work has been done using conventional biochar or activated carbon.

Biochars and activated carbon materials have been used for the removal of various industrial dyes and heavy metals of different concentrations. Removal rates of these compounds vary for different biochars because of the differences in the production process and raw material characteristics. Furthermore, the use of biochar for removal of anions is not efficient as the repulsive force developed between negatively charged biochar surface and anion. Though hydrochars have enhanced surface properties like biochar, limited attention has been provided for water remediation applications. Hydrochar with improved functional properties can therefore be considered for future research investigations that deal with the remediation of polluted water with industrial dyes and heavy metals.

3.3.1 Dye containing wastewater

Disposal of dye containing wastewater into waterbodies causes serious environmental problems, because such effluent has many toxic compounds that resist bio-degradation. Removal of dyes, generated by textile industries, from polluted water is difficult since they are stable against light, microbial oxidation and digestion. Reactive brilliant blue (RBB) and rhodamine B (RB) have been removed from water by activated carbon and biochars (Chun et al., 2004). Biochars produced trough slow pyrolysis from canola straw, peanut straw, rice hull and soybean straw were used successfully to remove methyl violet from water. Moreover, acid blue 25 and acid yellow 117 were removed by bamboo biochar produced via slow pyrolysis (Yang et al., 2014). Table 2 summarizes such research work conducted with biochars for removal of dyes from polluted water.

Table 2: Dye removal by biochars from polluted water

Adsorbent type	Target pollutant	Reference
Biochar and commercially activated carbon	Reactive brilliant blue(RBB) and Rhodamine blue (RB)	(Chun et al., 2004)
Canola straw biochar	Methyl violet (MV)	(Xu et al., 2011)
Peanut straw biochar	Methyl violet (MV)	(Xu et al., 2011)
Soybean straw biochar	Methyl violet (MV)	(Xu et al., 2011)
Rice hull biochar	Methyl violet (MV)	(Xu et al., 2011)
Bamboo biochar	Acid blue 25 (AB 25)	(Yang et al., 2014)

Kenaf fibre biochar Methylene blue (MB) (Mahmoud et al., 2012)

Bamboo biochar	Acid yellow 117 (AY 117)	(Yang et al., 2014)
Bamboo biochar	Methylene blue (MB)	(Mahmoud et al., 2012)
Kenaf fibre biochar	Methylene blue (MB)	(Mahmoud et al., 2012)

Adsorption of such dyes has been influenced by the temperature and pH of the medium, the condition of biochar production and surface configurations of biochar. All these factors influence the binding mechanism of the different dyes present in polluted water. This may be the reason why different biochars have different adsorptive capacities for pollutants.

3.3.2 Heavy metal containing wastewater

Low concentrations of heavy metals can cause serious health hazards. Some poisonous metals are accumulated in organisms exposed to their low concentration for long period of time. Discharge of heavy metals into water bodies through effluent is a serious threat to human and ecosystem health (Davydova, 1998). Table 3 summarizes research activities conducted with biochars for removing heavy metals from polluted water. However, adsorptive capacity of biochar differs from pollutant to pollutant. This may be due to their specific surface properties influenced, especially by production conditions.

Table 3: Heavy metal removal by biochar from polluted water

Adsorbent type	Target pollutant	Reference
Rice husk biochar	Cu^{2+}	(Pellera et al., 2012)
Olive pomace biochar	Cu^{2+}	(Pellera et al., 2012)
Orange waste biochar	Cu^{2+}	(Pellera et al., 2012)
Compost biochar	Cu^{2+}	(Pellera et al., 2012)
Peanut biochar	Cu^{2+}	(Tong et al., 2011)
Canola biochar	Cu^{2+}	(Tong et al., 2011)
Pig manure biochar	Cu^{2+}, Zn^{2+}, Cd^{2+} and Pb^{2+}	(Kołodyńska et al., 2012)
Cow manure biochar	Cu^{2+}, Zn^{2+}, Cd^{2+} and Pb^{2+}	(Kołodyńska et al., 2012)
Switchgrass biochar	Cu^{2+} and Zn^{2+}	(Han et al., 2013)
Hard and soft wood biochar	Cu^{2+} and Zn^{2+}	(Han et al., 2013)
Dairy waste biochar	Pb^{2+}	(Inyang et al., 2012)
Sugar beet biochar	Pb^{2+}	(Inyang et al., 2012)
Pine wood, pine bark, oak wood and oak bark biochar	Pb^{2+}, Cd^{2+} and As^{3+}	(Mohan and Pittman, 2007)
Sugarcane pulp biochar	Cr^{3+}	(Mohan et al., 2011)
Oak wood and oak bark biochar	Cr^{6+}	(Mohan et al., 2011)

Based on the findings in the literature, a variety of raw materials can be used to produce biochars via pyrolysis at different temperatures. Many heavy metals especially Cu2+ and Zn2+, Pb2+, Cr3+, Cd2+ and Cr6+ have been successfully removed from water by biochars of different origins. However, rate of such removal defers among biochars produced using different production conditions. The reason for these differences could be due to the variation in the macro and micro pore volumes of biochars together with different surface functional groups such as carbonyl, carboxyl and amino compounds that are responsible for higher affinities to metal ions. Therefore, modification of biochars is important to improve their adsorptive capacities for better removal of pollutants from water.

4. Conclusions

Considerable attention has already been given to biochar and its potential applications in water remediation. The use of biochar for removing pollutants is becoming popular due to its high adsorptive capacity and simple production process. Furthermore, functional properties of biochar are affected by characteristics of feedstock, production method, processing conditions and modification techniques. Different biochars have been produced from different feedstocks under various production conditions and have been tested for removing variety of industrial pollutants present in the polluted water. Results of these experiments state that biochar could be utilized effectively for the removal of harmful industrial pollutants such as heavy metals and dyes at low cost compared to presently available sophisticated methods.

Hydrochar, a group of biochar, has similar functional properties like biochar and could be utilized for removing water pollutants efficiently. However, research work on hydrochar for water remediation is still at embryonic stage. Furthermore, properties of hydrochar from biomass residues could also be improved by different activation methods used to enhance properties of biochar. Additionally, it is important to carry out in-depth scientific investigations in hydrochar, its properties and potential applications in water treatment to reach the level of research work done in biochar for water remediation. Filling this knowledge gap and development of application protocol by proper experimentation will promote the use of hydrochar for water remediation in future.

5. References

Ahmad, M., Rajapaksha, A. U., Lim, J. E., Zhang, M., Bolan, N., Mohan, D., Vithanage, M., Lee, S. S. & Ok, Y. S. 2014. Biochar as a sorbent for contaminant management in soil and water: a review. Chemosphere, 99, 19-33.

Azargohar, R. & Dalai, A. 2008. Steam and KOH activation of biochar: Experimental and modeling studies. Microporous and Mesoporous Materials, 110, 413-421.

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N. & Smith, V. H. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological applications, 8, 559-568.

Chen, B., Chen, Z. & Lv, S. 2011. A novel magnetic biochar efficiently sorbs organic pollutants and phosphate. Bioresource technology, 102, 716-723.

Cho, H.-H., Wepasnick, K., Smith, B. A., Bangash, F. K., Fairbrother, D. H. & Ball, W. P. 2009. Sorption of aqueous Zn [II] and Cd [II] by multiwall carbon nanotubes: the relative roles of oxygen-containing functional groups and graphenic carbon. Langmuir, 26, 967-981.

Chuah, T., Jumasiah, A., Azni, I., Katayon, S. & Choong, S. T. 2005. Rice husk as a potentially low-cost biosorbent for heavy metal and dye removal: an overview. Desalination, 175, 305-316.

Chun, Y., Sheng, G., Chiou, C. T. & Xing, B. 2004. Compositions and sorptive properties of crop residue-derived chars. Environmental science & technology, 38, 4649-4655.

Davydova, S. 1998. Heavy metals as main pollutants of the next century. Critical Reviews In Analytical Chemistry, 28, 377-381.

Demirbas, A. 2004. Effects of temperature and particle size on bio-char yield from pyrolysis of agricultural residues. Journal of Analytical and Applied Pyrolysis, 72, 243-248.

Gardea-Torresdey, J. L., Becker-Hapak, M. K., Hosea, J. M. & Darnall, D. W. 1990. Effect of chemical modification of algal carboxyl groups on metal ion binding. Environmental science & technology, 24, 1372-1378.

Guo, J., Xu, W. S., Chen, Y. L. & Lua, A. C. 2005. Adsorption of NH 3 onto activated carbon prepared from palm shells impregnated with H 2 SO 4. Journal of colloid and interface science, 281, 285-290.

Han, Y., Boateng, A. A., Qi, P. X., Lima, I. M. & Chang, J. 2013. Heavy metal and phenol adsorptive properties of biochars from pyrolyzed switchgrass and woody biomass in correlation with surface properties. Journal of environmental management, 118, 196-204.

Inyang, M., Gao, B., Yao, Y., Xue, Y., Zimmerman, A. R., Pullammanappallil, P. & Cao, X. 2012. Removal of heavy metals from aqueous solution by biochars derived from anaerobically digested biomass. Bioresource technology, 110, 50-56.

Kambo, H. S. & Dutta, A. 2015. A comparative review of biochar and hydrochar in terms of production, physico-chemical properties and applications. Renewable and Sustainable Energy Reviews, 45, 359-378.

Kang, S., Li, X., Fan, J. & Chang, J. 2012. Characterization of hydrochars produced by hydrothermal carbonization of lignin, cellulose, D-xylose, and wood meal. Industrial & engineering chemistry research, 51, 9023-9031.

Kasparbauer, R. D. 2009. The effects of biomass pretreatments on the products of fast pyrolysis, Iowa State University.

Kołodyńska, D., Wnętrzak, R., Leahy, J., Hayes, M., Kwapiński, W. & Hubicki, Z. 2012. Kinetic and adsorptive characterization of biochar in metal ions removal. Chemical Engineering Journal, 197, 295-305.

Lehmann, J., Gaunt, J. & Rondon, M. 2006. Bio-char sequestration in terrestrial ecosystems–a review. Mitigation and adaptation strategies for global change, 11, 395-419.

Li, Y., Wang, X., Zhu, Y., Wang, L. & Wang, Z. 2012. In situ preparation of biochar coated silica material from rice husk. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 395, 157-160.

Liu, Z., Zhang, F.-S. & Wu, J. 2010. Characterization and application of chars produced from pinewood pyrolysis and hydrothermal treatment. Fuel, 89, 510-514.

Mahmoud, D. K., Salleh, M. A. M., Karim, W. A. W. A., Idris, A. & Abidin, Z. Z. 2012. Batch adsorption of basic dye using acid treated kenaf fibre char: equilibrium, kinetic and thermodynamic studies. Chemical Engineering Journal, 181, 449-457.

Makino, T., Chia, C., Tuan, N., Segawa, Y., Kawasaki, M., Ohtomo, A., Tamura, K. & Koinuma, H. 2000. Exciton spectra of ZnO epitaxial layers on lattice-matched substrates grown with laser-molecular-beam epitaxy. Applied Physics Letters, 76, 3549-3551.

Mensinger, M. C. 1980. Wet carbonization of peat: state-of-the-art review. IIT Center, Chicago, IL.

Mohan, D. & Pittman, C. U. 2007. Arsenic removal from water/wastewater using adsorbents—a critical review. Journal of hazardous materials, 142, 1-53.

Mohan, D., Rajput, S., Singh, V. K., Steele, P. H. & Pittman, C. U. 2011. Modeling and evaluation of chromium remediation from water using low cost bio-char, a green adsorbent. Journal of Hazardous Materials, 188, 319-333.

Mohan, D., Sarswat, A., Ok, Y. S. & Pittman, C. U. 2014. Organic and inorganic contaminants removal from water with biochar, a renewable, low cost and sustainable adsorbent–a critical review. Bioresource technology, 160, 191-202.

Mok, W. S. L., Antal Jr, M. J., Szabo, P., Varhegyi, G. & Zelei, B. 1992. Formation of charcoal from biomass in a sealed reactor. Industrial & engineering chemistry research, 31, 1162-1166.

Nizamuddin, S., Mubarak, N., Tiripathi, M., Jayakumar, N., Sahu, J. & Ganesan, P. 2016. Chemical, dielectric and structural characterization of optimized hydrochar produced from hydrothermal carbonization of palm shell. Fuel, 163, 88-97.

Paria, S. 2008. Surfactant-enhanced remediation of organic contaminated soil and water. Advances in colloid and interface science, 138, 24-58.

Pellera, F.-M., Giannis, A., Kalderis, D., Anastasiadou, K., Stegmann, R., Wang, J.-Y. & Gidarakos, E. 2012. Adsorption of Cu (II) ions from aqueous solutions on biochars prepared from agricultural by-products. Journal of Environmental Management, 96, 35-42.

Rajapaksha, A. U., Chen, S. S., Tsang, D. C., Zhang, M., Vithanage, M., Mandal, S., Gao, B., Bolan, N. S. & Ok, Y. S. 2016. Engineered/designer biochar for contaminant removal/immobilization from soil and water: potential and implication of biochar modification. Chemosphere, 148, 6e291.

Shannon, M. A., Bohn, P. W., Elimelech, M., Georgiadis, J. G., Marinas, B. J. & Mayes, A. M. 2008. Science and technology for water purification in the coming decades. Nature, 452, 301-310.

Stavropoulos, G., Samaras, P. & Sakellaropoulos, G. 2008. Effect of activated carbons modification on porosity, surface structure and phenol adsorption. Journal of Hazardous Materials, 151, 414-421.

Tan, Z., Qiu, J., Zeng, H., Liu, H. & Xiang, J. 2011. Removal of elemental mercury by bamboo charcoal impregnated with H 2 O 2. Fuel, 90, 1471-1475.

Tong, X.-J., Li, J.-Y., Yuan, J.-H. & Xu, R.-K. 2011. Adsorption of Cu (II) by biochars generated from three crop straws. Chemical Engineering Journal, 172, 828-834.

Vörösmarty, C. J., Green, P., Salisbury, J. & Lammers, R. B. 2000. Global water resources: vulnerability from climate change and population growth. science, 289, 284-288.

Xu, Q., Qian, Q., Quek, A., Ai, N., Zeng, G. & Wang, J. 2013. Hydrothermal carbonization of macroalgae and the effects of experimental parameters on the properties of hydrochars. ACS Sustainable Chemistry & Engineering, 1, 1092-1101.

Xu, R.-K., Xiao, S.-C., Yuan, J.-H. & Zhao, A.-Z. 2011. Adsorption of methyl violet from aqueous solutions by the biochars derived from crop residues. Bioresource technology, 102, 10293-10298.

Xue, Y., Gao, B., Yao, Y., Inyang, M., Zhang, M., Zimmerman, A. R. & Ro, K. S. 2012. Hydrogen peroxide modification enhances the ability of biochar (hydrochar) produced from hydrothermal carbonization of peanut hull to remove aqueous heavy metals: batch and column tests. Chemical Engineering Journal, 200, 673-680.

Yang, Y., Lin, X., Wei, B., Zhao, Y. & Wang, J. 2014. Evaluation of adsorption potential of bamboo biochar for metal-complex dye: equilibrium, kinetics and artificial neural network modeling. International Journal of Environmental Science and Technology:(IJEST), 11, 1093.

CARBOHYDRATES FOR THERAPEUTICS

Dr.P.Sivasinthujah
Chairperson, Section C, Department of Pharmacy, University of Jaffna

INTRODUCTION

Biological macromolecules are large complex molecules; there are four major classes: DNA, proteins, carbohydrates, and lipids.[1] Carbohydrates are one of the most abundant classes of biological macromolecules. Their structural diversity leads to a complexity which is not observed in other macromolecules such as DNA and proteins.[2] This complexity is due to the isomerism resulting from variations of ring size, anomeric configuration, the linkage position between monosaccharide units, hydroxyl group stereochemistry, the adoption of either linear or branched sequences, branching positions, modification by sulfation/phosphorylation/ acetylation, and the identity of species attached to the reducing terminus of the carbohydrate. The majority of carbohydrates present in cells are covalently linked to proteins or lipids, and such ligated species are referred to as glycoconjugates. Natural glycoproteins fall into one of two main categories: N-linked glycans are covalently attached to proteins through asparagine (Asn) residues via an N-glycosidic bond and O-linked are attached to proteins mainly through either serine or threonine residues. [31]

Initially, the roles of carbohydrates were thought to be of a structural purpose, such as chitin and cellulose, or as a source of energy, such as glucose.4 However, Glycans play vital roles in many biological processes, such as the stabilisation of proteins,[5] the folding of newly synthesised polypeptides in the endoplasmic reticulum (ER), controlling protein solubility and conformation,[6] signal transduction,[7] and the control of cell development and differentiation[4] and immune defense. In the immune system, the structural pattern of carbohydrates present on the invaders are recognised as antigens; for example T cell-independent activation of B lymphocytes, which recognise the repeating unit of glycans as an antigen, are found on the surface of bacterial cells.[8] Further, the lectin activation pathway recognises the carbohydrate pattern present on the surface of the microorganism using pattern recognising receptors, such as mannose binding lectin (MBL) and ficolins.[9] In addition, zwitterionic polysaccharides can be processed by the antigen presenting cell and helper T cells can recognise this molecule as an antigen presented by MHC Class II molecules.[10,11] Beyond the pure carbohydrates, glycoconjugates show a great contribution in the immune system. For example, glycopeptides which can act epitopes for the T cell activation, are influenced by the glycan structure, the position of glycan in the peptide, and structure of peptide.[12]

After the understanding of biological role of carbohydrate, researchers focused on the development of carbohydrate containing drugs. Up to date around 200 of carbohydrate containing drug have been approved in worldwide specially 54 carbohydrate-based drugs have been approved in 2000-2022.[13] The presence of certain characteristics of carbohydrate facilitates the production of the carbohydrate containing therapeutics. Those are the presence of high density of functional groups (e.g., hydroxyl), diversity of structures based on different configuration and ideal biocompatibility as it is ubiquitous in the body. There are mainly five potential directions in development of the carbohydrate containing therapeutics (Figure 1).[14]

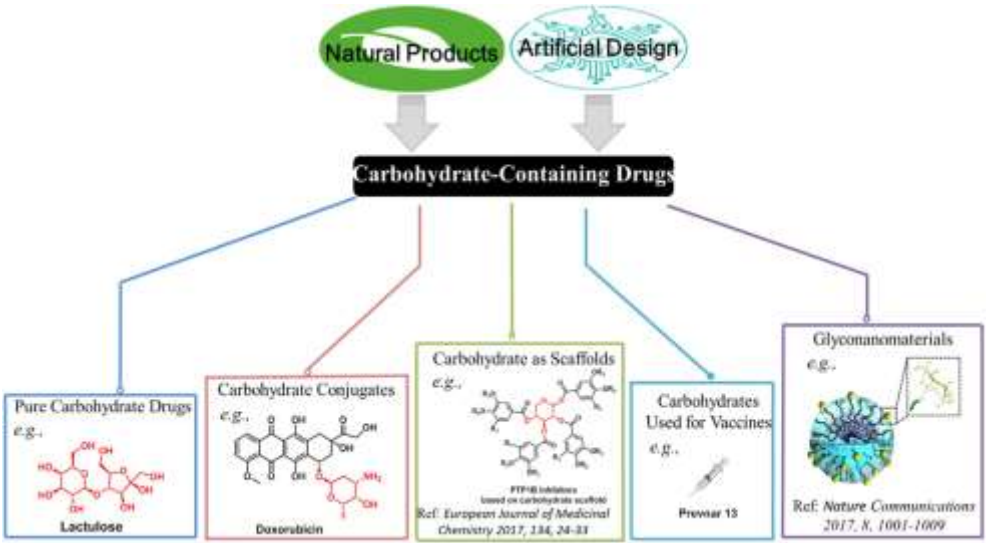


Figure 1: Potential directions in the development of carbohydrate-containing drugs.[14]

PURE CARBOHYDRATE DRUGS

Pure carbohydrates or carbohydrates used as the main body of drugs for the development of pure carbohydrate drugs. Carbohydrate shows high density of functional groups, and diversity of molecular structures which facilitates to use it as drug. For example, Heparin, anticoagulating agent.[15] It is unbranched heterogeneous polysaccharide, contains L-iduronic and D-glucosamine. It comprises antithrombin binding pentasaccharide which binds with antithrombin and changes the conformation of antithrombin and accelerate the inactivation of clotting enzyme.[15]

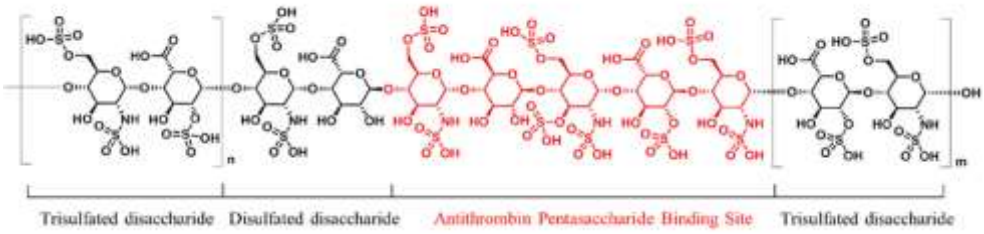


Figure 2: Structure of Heparin[14]

In addition, some modified form of monosaccharides could be used to monitor the various disease. For example: ^{18}F-fluorodeoxyglucose (^{18}F-FDG) injection.[16] It is a radioactive molecule, used to diagnosis the cancer using positron emission tomography. The concept behind is, the uptake of the glucose is higher in cancer cell compare to the normal cell, therefore ^{18}F-FDG is favorably up taken by tumors which facilitate the identification of position of tumor site, stage of cancer and monitor the cancer condition during the treatment (Figure 3).[16]

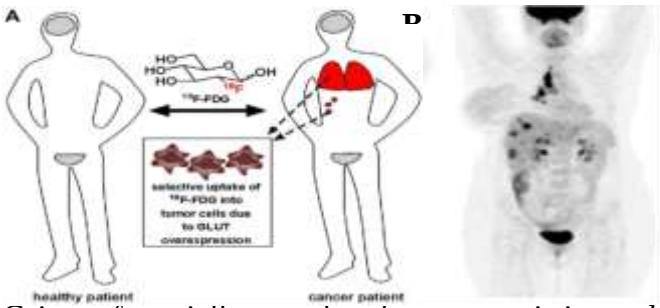


Figure 3: Since ^{18}F-FDG is preferentially up taken by tumors, it is used to identify tumor sites and metastases. (B) ^{18}F-FDG positron emission tomography (PET) imaging of a patient with metastatic breast cancer.[16]

The pure form of carbohydrates achieved through, natural extraction or semisynthetic approach or chemical synthesis. Natural extraction means extracting the bioactive compounds from the natural resource using different extraction, separation, and purification techniques. One of the example is the heparin, is extracted from porcine intestinal mucosa (Figure 4).[17] The Chemical synthesis means the chemical rection between the molecules, produced desired homogeneous form of the bioactive compound. Idraparinux is the one of the examples, synthesized from D-glucose and methyl a-D-glucopyranoside (Figure 5).[18] Semisynthetic means the combination of natural extraction approach and synthetic approach. High mannose tetrasaccharide is an example for that. Disaccharide, Man(β1-4) Man extracted from the locust bean gum which is extended as tetracchaide using the synthetic approach (Figure 6).[19]

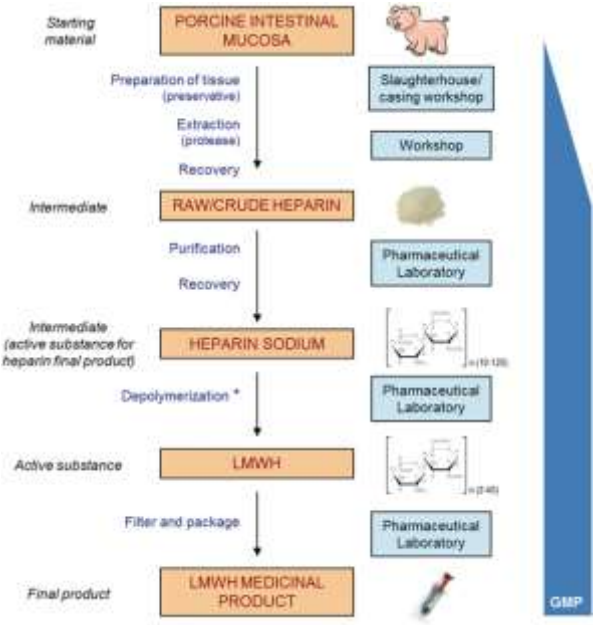


Figure 4: Extraction process of Heparin[17]

Figure 5: Synthesis of Idraparinux[18]

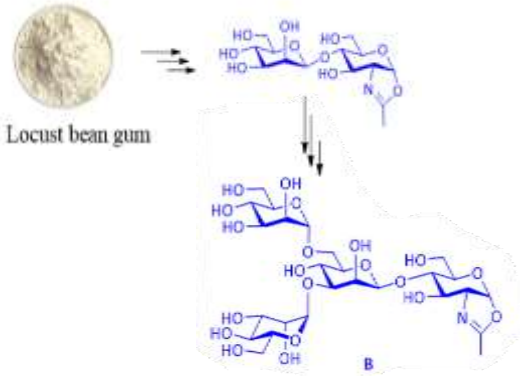


Figure 6: Synthesis of tetrasaccharide (B)[19]

These are following challenges to use pure carbohydrate as drug.

1. Heterogeneous mixture of polysaccharides causes side effects.
2. Isolation of enough amount of pure samples from biological sources is extremely difficult.
3. Construction of oligosaccharide is difficult due to the requirement of regio and stereo selective glycosidic bond formation.

CARBOHYDRATE CONJUGATES

Carbohydrate conjugates means carbohydrates that are used in the attachment of drugs which is not an active ingredient in the drugs. The presence of glycans in the drugs enhance their bioactivity, improve physical and chemical properties, or achieve targeting. Carbohydrate conjugates could be used as Drugs or use it for diagnosis. Example for the drug is Vancomycin; antibiotic (figure 7).[14] The presence of carbohydrate moiety in vancomycin does not affect the in vitro antimicrobial activity. Even though it is influencing in vivo antimicrobial activity by increasing water solubility and distribution properties.[20]

KSL11 is an example for the carbohydrate conjugate use for the diagnosis. It is a chemical probe, used to detect the Human senescence-associated β-galactosidase (SA-β-gal). SA-β-gal used as a biomarker of aging.[21]

Figure 7: structure of Vancomycin[14]

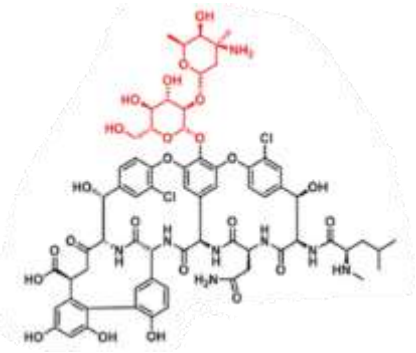
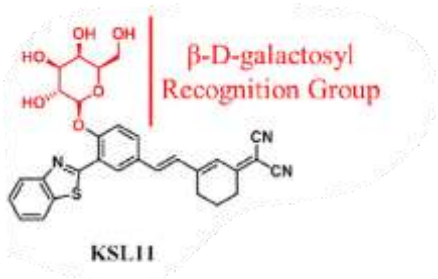


Figure 8: structure of KSL11[14]



Glycoconjugates synthesized through, natural extraction or enzymatic synthesis or chemical synthesis.[22,23] Enzymatic synthesis means using the enzyme in the organic synthesis. For example glycosyltransferases GtfE and GtfD catalyzed the glycosylation of the vancomycin aglycon.[20]

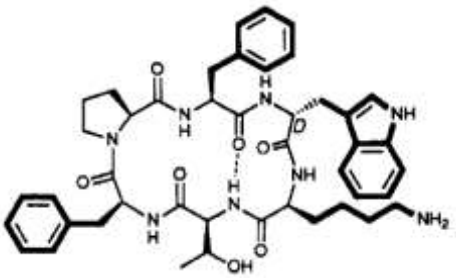
These are some following challenges in the production of glycoconjugates and strategy to design the drugs.[14]

1. Select the suitable coupling position of carbohydrate is difficult.
2. Enzymatic synthesis of glycoconjugates is expensive.
3. Glycoprotein remodeling is a difficult process.
4. There is no clear picture about the mechanism of the uptake of glycoconjugates by the cell and mechanism of action.

CARBOHYDRATE AS SCAFFOLDS

Carbohydrate as scaffolds means the desired substituents are attached at selected positions around the sugar ring to make the bioactive compounds.[24] Carbohydrates are excellent scaffolds as it has high functional group density, diversity of functional group orientations and rigid molecular structure. It has been used in the production of peptidomimetics as it enhances the stability and permeability for the peptide. For example, β-D-glucoside scaffold. Hirschmann *et.al* study showed that nonpeptidal

peptidomimetic (structure I) is the first antagonist of somatostatin (SRIF). Then the structural modified structure I (structure III) showed great binding affinity to SRIF and it (D-Glucose derived mimics) recognized as the SRIF mimic.[25]



I

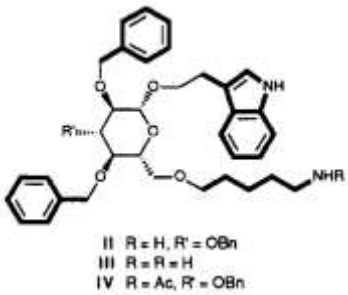


Figure 9: Structure of somatostatin receptor agonist (I) and D-Glucose derived mimics[25]

Carbohydrate as scaffolds synthesized using Chemical Synthesis or Solid phase synthesis. The challenges in the usage of carbohydrate as scaffolds are to ensure that the positions and orientations of the functional groups of the mimetics are the same as those of the original ligand and the usage of suitable protecting groups. These issues could be sort it out by producing a diverse library of molecules and screen the biological activity and find out the bioactive compound.

CARBOHYDRATES USED FOR VACCINES

Carbohydrates have also been used for the development antimicrobial and anticancer vaccines, rare used it as antiviral vaccine. The concept behind the carbohydrate used for the vaccine development for the antimicrobial is the presence of glycan on the surface of the cell in the microorganism acts as epitope for the immune system.[26] The idea behind the carbohydrate used as anticancer vaccine is the expression of the carbohydrate in cancer cell is different than the normal tissue (tumor-associated carbohydrate antigens), the abnormal carbohydrates used it as epitope for the immune system.[27]

The following is an example for the carbohydrate used as vaccine; Haemophilus influenzae type b (Hib) is a glycoconjugate vaccine and acts against the Haemophilus influenzae.[26]

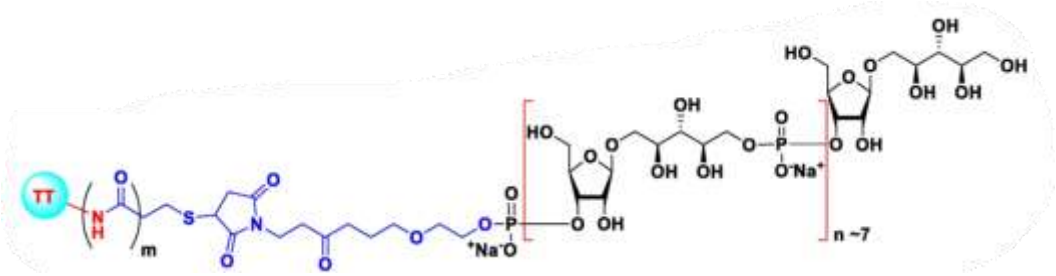
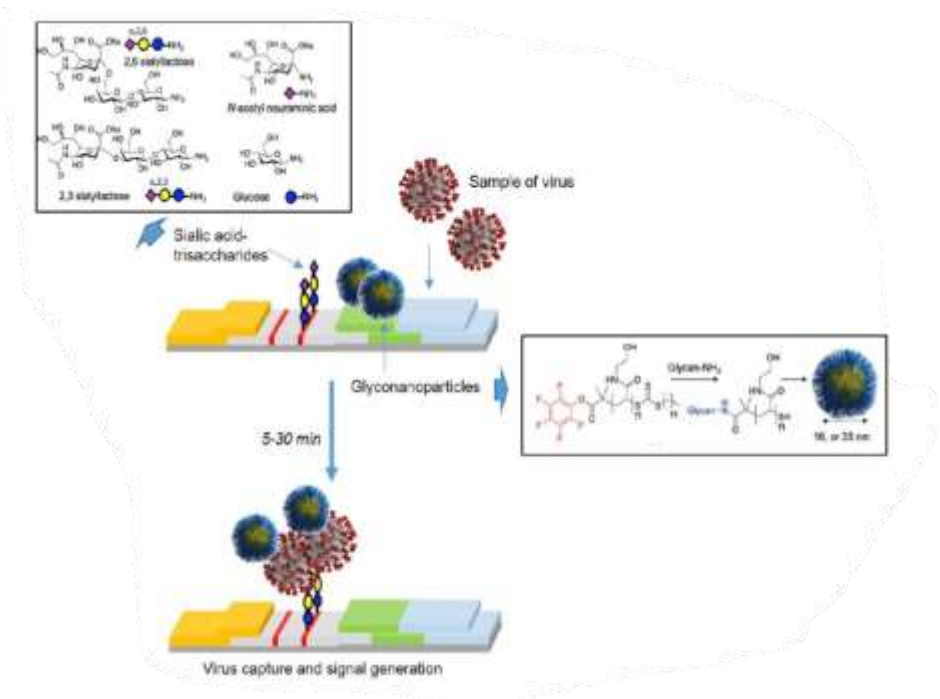


Figure 10: Structure of QuimiHib Vaccine.[26]

Among the carbohydrate vaccine, Polysaccharide vaccines are T cells independent antigens and glycoconjugate vaccines are T-cell dependent (TD) antigens.[28]

There are two major types of carbohydrate vaccines:[29]

1. Natural carbohydrate vaccines
2. Synthetic carbohydrate vaccines



Natural carbohydrate vaccines are extracted from the natural resources, exist as heterogeneous form and might contains small impurities. Synthetic vaccines are produced using the synthetic approach or semisynthetic approach, exist as homogeneous form and in pure form.[29] Carbohydrate used for the vaccines can be achieved through the natural extraction or semisynthetic approach or fully synthetic approach.

These are following challenges to use the carbohydrate as vaccine:

1. Polysaccharide vaccine shows poor immunogenicity.
2. Structural heterogeneity of native carbohydrates may result in batch-to-batch variation and efficiency of the glycoconjugate vaccines.
3. Carbohydrate antigens need to obtain with sufficient quantity, high purity, and structural integrity.
4. Purifying native carbohydrates involves complicated, expensive, and time-consuming steps required for a successful and safe vaccine manufacturing process.
5. Elaborate procedures to synthesis the compound and need to produce stereo and regio selective glycosidic bond.

GLYCONANOMATERIALS

Glyconanoparticle means carbohydrates have been coupled to nanomaterials for diagnostics biomedical imaging and therapeutics.[14,30] It used in nano delivery systems as cargos for enhancing drug efficacy, reducing nonspecific toxicity or improving targeting.[31] The attachment of sugar to nanomaterial enhancing water solubility, increasing the biocompatibility of nanomaterial and enabling the improvement of affinity for receptors.[31] For example, glycol-lateral flow devices (Figure 11). This device used to detect the SARS-COV-2. The spike glycoprotein from SARS-CoV-2 have interaction with gold nanoparticles bearing sialic acid derivatives. This interaction used as the detection unit in a prototype lateral flow rapid diagnostic. The test strip is immobilized with the glycan (BSA-glycoconjugate) and also in the mobile phase onboard gold nanoparticles, providing multivalence (and hence affinity) for dissecting SARS-CoV-2 binding and for the LFD.[32,33]

Figure 11: Concept for glycolateral flow devices.[32]

Glyconamaterial can be synthesized using the different approach based on the type of the nanoparticle. A critical step in the preparation of glyconanomaterials is the surface coupling chemistry for attaching carbohydrates to the nanomaterial.[34] For example glycol-goldnanomaterial could be synthesized using three different methods: Direct synthesis, ligand exchange, and ligand modification methods (Figure 12).[35]

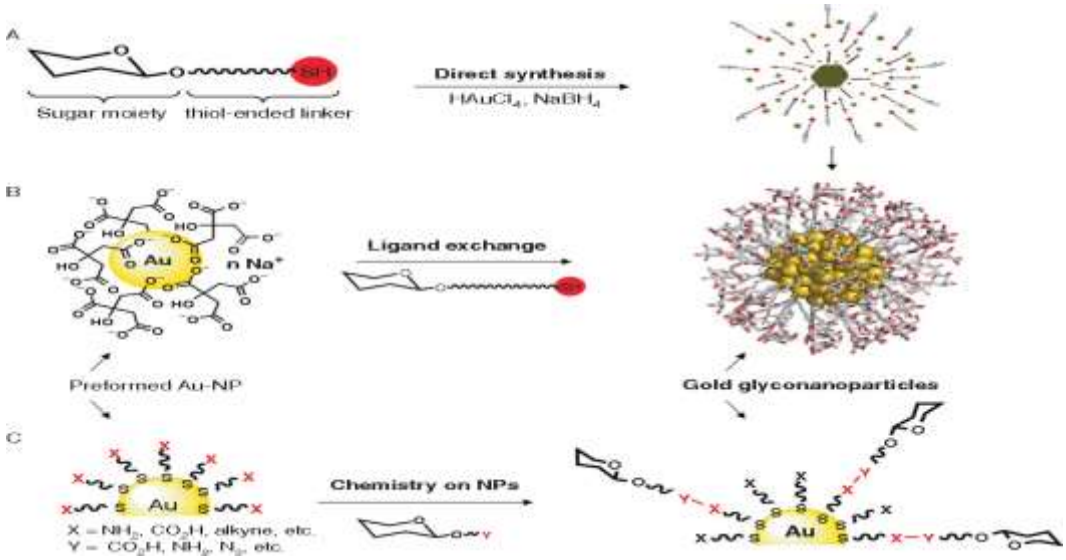


Figure 12: Common methods for the preparation of gAuNPs. (A) Direct synthesis, (B) ligand exchange, and (C) ligand modification methods[35]

These are following challenges to synthesis the glyconamaterial and use it for the medicinal application:

1. Proper selection of carbohydrate ligands, the type and length of the spacer linkage, and the ligand density is needed which influences bioactivity.
2. It is difficult to control the number of carbohydrate ligands conjugated to relative nanomaterials.
3. It is difficult to produce consistence results due to the change in the ratio of glycan and nanoparticle.

Conclusion

This article given the possible directions of carbohydrate-containing drugs based on the internal characteristics of carbohydrates, synthetic approaches, and the challenges to use it as drug. In future, biological functions of carbohydrates need to be investigated more using natural products or synthetic compounds. This understanding might give an opportunity to produce more carbohydrate containing therapeutics in future.

References:

1. Maureen E. Taylor and Kurt Drickamer. *Introduction to Glycobiology*. (Oxford University Press, 2011).
2. Dwek, R. A. Glycobiology: Toward understanding the function of sugars. *Chem. Rev.* **96**, 683–720 (1996).
3. Adams, W. G. *et al.* Decline of Childhood Haemophilus influenzae Type b (Hib) Disease in the Hib Vaccine Era. *JAMA J. Am. Med. Assoc.* **269**, 221–226 (1993).
4. Parodi, A., Cummings, R. D. & Aebi, M. *Chapter 39 Glycans in Glycoprotein Quality*

Control. *Cold Spring Harbor (NY* vol. 039 (Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press, 2017).

5. Wyss, D. F. *et al.* Conformation and function of the N-linked glycan in the adhesion domain of human CD2. *Science (80-.).* **269**, 1273–1276 (1995).

6. Zhang, X.-L. Roles of Glycans and Glycopeptides in Immune System and Immune-Related Diseases. *Curr. Med. Chem.* **13**, 1141–1147 (2006).

7. J., B. The Role of Glycosylation in Receptor Signaling. *Glycosylation* (2012) doi:10.5772/50262.

8. Nutt, S. L., Hodgkin, P. D., Tarlinton, D. M. & Corcoran, L. M. The generation of antibody-secreting plasma cells. *Nat. Rev. Immunol.* **15**, 160–171 (2015).

9. Fujita, T. Evolution of the lectin - Complement pathway and its role in innate immunity. *Nat. Rev. Immunol.* **2**, 346–353 (2002).

10. Cobb, B. A., Wang, Q., Tzianabos, A. O. & Kasper, D. L. Polysaccharide processing and presentation by the MHCII pathway. *Cell* **117**, 677–687 (2004).

11. Cobb, B. A. & Kasper, D. L. Coming of age: carbohydrates and immunity. *Eur. J. Immunol.* **35**, 352–356 (2005).

12. McIntosh, J. D. *et al.* Convergent chemo-enzymatic synthesis of mannosylated glycopeptides; targeting of putative vaccine candidates to antigen presenting cells. *Chem. Sci.* **6**, 4636–4642 (2015).

13. Cao, X. *et al.* Carbohydrate-based drugs launched during 2000−2021. *Acta Pharm. Sin. B* **12**, 3783–3821 (2022).

14. Wang, J., Zhang, Y., Lu, Q., Xing, D. & Zhang, R. Exploring Carbohydrates for Therapeutics : A Review on Future Directions. **12**, 1–9 (2021).

15. Qiu, M. *et al.* Pharmacological and clinical application of heparin progress: An essential drug for modern medicine. *Biomed. Pharmacother.* **139**, 111561 (2021).

16. Ben-Haim, S. & Ell, P. 18F-FDG PET and PET/CT in the evaluation of cancer treatment response. *J. Nucl. Med.* **50**, 88–99 (2009).

17. Isabel, R., Sofía, C., Concepción, A., Antonio, G., Mulloy, G. *Low Molecular Weight Heparins, Biological Drugs close to Non-Biological Complex Drugs*. (Springer, Cham., 2015).

18. Chen, C. & Yu, B. Efficient synthesis of Idraparinux, the anticoagulant pentasaccharide. *Bioorg. Med. Chem. Lett.* **19**, 3875–3879 (2009).

19. Paramasivam, S. & Fairbanks, A. J. Rapid synthesis of N-glycan oxazolines from locust bean gum via the Lafont rearrangement. *Carbohydr. Res.* **477**, 11–19 (2019).

20. Nakayama, A. *et al.* Enzymatic glycosylation of vancomycin aglycon: Completion of a total synthesis of vancomycin and N- and C-terminus substituent effects of the aglycon substrate.

Org. Lett. **16**, 3572–3575 (2014).

21. Li, X. *et al.* First-generation species-selective chemical probes for fluorescence imaging of human senescence-associated β-galactosidase. *Chem. Sci.* **11**, 7292–7301 (2020).

22. Marqvorsen, M. H. S., Paramasivam, S., Doelman, W., Fairbanks, A. J. & van Kasteren, S. I. Efficient synthesis and enzymatic extension of an N -GlcNAz asparagine building block. *Chem. Commun.* **55**, 5287–5290 (2019).

23. Srikokulan, S. & Fairbanks, A. J. Synthesis of N-Glycans for Immunological Studies. (University of Canterbury, 2019). doi:10.26021/9097.

24. Le, G. T. *et al.* Molecular diversity through sugar scaffolds. *Drug Discov. Today* **8**, 701–709 (2003).

25. Hirschmann, R. *et al.* Nonpeptidal Peptidomimetics with a β-d-Glucose Scaffolding. A Partial Somatostatin Agonist Bearing a Close Structural Relationship to a Potent, Selective Substance P Antagonist. *J. Am. Chem. Soc.* **114**, 9217–9218 (1992).

26. Mettu, R., Chen, C. Y. & Wu, C. Y. Synthetic carbohydrate-based vaccines: Challenges and opportunities. *J. Biomed. Sci.* **27**, 1–22 (2020).

27. Astronomo, R. D. & Burton, D. R. Carbohydrate vaccines: Developing sweet solutions to sticky situations? *Nat. Rev. Drug Discov.* **9**, 308–324 (2010).

28. Zasłona, M. E., Downey, A. M., Seeberger, P. H. & Moscovitz, O. Semi- And fully synthetic carbohydrate vaccines against pathogenic bacteria: recent developments. *Biochem. Soc. Trans.* **49**, 2411–2429 (2021).

29. Doshi, G. M., Shanbhag, P. P., Aggarwal, G. V., Shahare, M. D. & Martis, E. A. Carbohydrate vaccines-A burgeoning field of glycomics. *J. Appl. Pharm. Sci.* **1**, 17–22 (2011).

30. Crucho, C. I. C. & Barros, M. T. *Stimuli-Responsive Glyconanomaterials for Sensing Applications*. *Nanomaterials Design for Sensing Applications* (Elsevier Inc., 2019). doi:10.1016/B978-0-12-814505-0.00008-4.

31. Senanayake, T. H., Warren, G. & Vinogradov, S. V. Novel anticancer polymeric conjugates of activated nucleoside analogues. *Bioconjug. Chem.* **22**, 1983–1993 (2011).

32. Baker, A. N. *et al.* The SARS-COV-2 Spike Protein Binds Sialic Acids and Enables Rapid Detection in a Lateral Flow Point of Care Diagnostic Device. *ACS Cent. Sci.* **6**, 2046–2052 (2020).

33. Losada-Garcia, N., Garcia-Sanz, C., Andreu, A., Velasco-Torrijos, T. & Palomo, J. M. Glyconanomaterials for human virus detection and inhibition. *Nanomaterials* **11**, (2021).

34. Kaur, V. & Mahajan, R. Synthesis of Glyconanomaterials: A Review. *Int. J. Nanomater. Chem.* **2**, 53–74 (2016).

35. Marradi, M., Martín-Lomas, M. & PenadÉs, S. Glyconanoparticles: Polyvalent Tools to Study Carbohydrate-Based Interactions. in (ed. Horton, D.) vol. 64 211–290 (Academic Press, 2010).

"SMALL BUSINESSES AND THEIR CHALLENGES DURING COVID – 19 PANDEMIC IN JAFFNA DISTRICT"

Thevaranchany Sivaskaran
Chairperson, Section D, Department of Human Resource Management, University of Jaffna

Sri Lanka is an island with an area of 65,610 sq. km and a total population of 21.67 Million (mid-year 2020). The country has a good average literacy rate of 91.71% and the average life expectancy at birth is 76.8 years. Government expenditure on health and education is 1.6% and 1.9% of GDP respectively where the health sector is predominantly operated by the government and the health services are offered free. Sri Lanka's GDP was estimated at US $ 84.0 billion in 2019 covered with key sectors of Services, Industry, and Agriculture with contributions from 57.4%, 26.4%, and 7% respectively. The tourism sector in the country has integrated extensive backward and forward linkages to other economic activities under Services and Industry. Micro, Small, and Medium Enterprises (SMEs) are the prime business sectors in Sri Lanka. The Government of Sri Lanka recognizes SMEs as the backbone of the economy, as it accounts for more than 75% of the total number of enterprises, provide 45% of the employment and contribute to 52% of the Gross Domestic Production (GDP) (National Policy Framework for SME Development, 2020). SMEs promote broad-based equitable development and provide more opportunities for women and youth participation in the economic development of the country. SMEs are an essential source of employment opportunities.SME is used to denote micro, small, and medium enterprises. Different countries use different definitions for SMEs, based on their level of development. SMEs are defined in a variety of ways by various countries using different parameters such as the number of persons employed, amount of capital invested, amount of turnover, or nature of the business. There are huge challenges faced by women entrepreneurs can be categorized into two phases

Phase One

- Poor Educational Literacy
- Technology knowhow
- Financial inability
- No network
- Communication barrier
- Less competition

Phase two Sever war period

No Transport Facilities

- Closed Environment
- No material transactions
- No outside customers
- Risk environment
- Displacement

- Financial inability
- uncertainty of life,
- economic instability
- security threats. When the sudden curfew was imposed they had to stay in their shops or they had to run home taking the bypass road. When their business places were destroyed they were determined to restart the business. There are a variety of businesses are registered under the SME type.Such as Contractors 1.9%, Textile 3.6 %, Pharmacy 1.7%, Grocery Shop 13.6%, Jewellery Shop 7.2%, Sales centre 6.6%, Hardware Stores 1.9%, Food and Drinks 7.5%, Mill 1.7%, Import and Export .6%, Communication 8.3%, Hospital 1.4%, Studio 1.9%, Tobacco .6%, Restaurant 2.5%, Hotel .8%, Welding 3.6%, Production 3.3%, Bakery 1.7%, Media .6 %, Carpentry 4.7%, Printing 2.5%, Tailoring 2.5%, Security Service .3%, Transport .6%, Beauty Parlour and Saloon 2.2%, Vehicle Service Centre 2.8%, Education Centre .8%, Liquor Sales outlets 3.9%, Aluminium Fitting .3% , Poultry Farm .8% and Other entrepreneurs consist of 7.8%. Based on the investment of these entrepreneurs in Jaffna district 21.1% of entrepreneurs have invested Rs. 10,000 - Rs. 100,000, whereas Rs. 100,000 - Rs. 500,000 - 29.1 %, Rs. 500,000 - Rs. 1,000,000 - 22.2 %, Rs. 1,000,000 - Rs. 1,500,000 - 10.2 %, Rs. 1,500,000< - 17.5 %. In investment, Jaffna District medium-scale entrepreneurs were found 17.5%, whereas 29.1% of the small-scale entrepreneurs were found to the popular.

Challenges faced by SME Entrepreneurs

- Small-scale entrepreneurs face numerous problems which are when they try to get bank loans bankers to ask for two guarantors who are government servants, therefore, no one comes forward to sign for their bank loan, and no one comes forward to sign for bank loans.
- As the price of the raw material is high in Jaffna, entrepreneurs have to go to Colombo to purchase them, the traveling expenditure and transportation cost is high for them and they are unable to import them from abroad, as they don't have the knowledge and financial background to do imports
- Marketing is another problem faced by some entrepreneurs, They have some difficulties to market their products because the same products which are available at low prices in the market are unable to be competitive price because the production cost is higher.
- Some face labeling issues, and some standard issues some of them don't know what are the procedures needed to be followed when exporting their products to other countries.
- Some entrepreneurs find it difficult to register their businesses due to land ownership problems.
- Rules and regulations imposed by government authorities for business registration are very tight. For business registration, one person has to go to numerous government offices.
- When an entrepreneur goes for registration officials try to charge penalties for the delay of the business registration.
- Because of this many entrepreneurs are hesitant to register the business.
- Even though the government has offered some loan facilities without granters.

Popular Lecture - Section A

Insect vectors of plant disease causing agents

Professor Mrs R.Gnaneswaran
Department of Zoology, University of Jaffna.

Insects are small fascinating creatures, important to ecosystem and human life, because of their diversity, ecological role and influence on agriculture, human health and natural resources. Most of them are beneficial- as pollinating plants, producing honey, silk, several dyes and resins, recycling dead organisms, regulating harmful organisms as being their natural enemies. Some are harmful- as destroying valuable crops and products, transmitting diseases to human, animals and plants by their feeding activities. Thus they must be very familiar to the general public. But, the world of insect is not that much of small to get familiarize by everyone.

Healthy plants are essential for sustainable food production and to maintain the balance of nature. Generally plant health is affected by either environmental stresses, diseases or by feeding of phytophagous insects (pests).

Plant diseases are a major yield and quality constraint for farmers throughout the world. These diseases are caused by a microscopic and sub microscopic organisms such as bacteria, phytoplasmas, fungi ,nematode and virus and viroid etc.

Plants are immobile and unable to spread plant pathogens, therefore, the pathogens are dependent on various agents for their spread and survival. Transmission of plant pathogen from a diseased plant to a healthy plant can be either vertical mode by – pollen , propagation or horizontal mode by biotic and abiotic factors in the environment (Fig. 1) Among the various transmitting factors like pollen, seeds and animals, phytophagous insects are frequently involved in the transmission of pathogens from plant /part to another. The way of transmission is depend on both the insect species and the pathogen.

The knowledge on the insect vectors and their interaction with host plants or with the pathogens has an important role in managing and preventing vector borne diseases successfully.

This review is pointing out one of the ecological role of insects – ie. Vectors as transmitting disease causing agents (pathogens) among plants

Insects transmit plant pathogens in three ways.

1) *Passive transmission:* This happens incidentally. When an insect feed or walk on the diseased plant surface, sticky fungal spores or bacteria may stick on the insect body parts and will be carried by it to other plants or parts of the same plant, where they may start a new infection. Eg: some bacterial diseases as bacterial bean blights, fire blight of apple and pear, citrus canker, cotton boll rot, crown gal, bacterial spot and canker of stone fruits

2) *Contact transmission:* Certain bacteria, fungi, and viruses will be carried on the mouthparts of insects after their feeding on infected plant tissues, and when they visit and feed another plant or plant part , it may enter in to a new plant. Eg: non- persistent stylet- borne viruses Fig.3-A

3) *Biological transmission:* specific viruses, phytoplasmas, protozoa (phytomonas), nematodes and xylem and phloem- inhabiting bacteria will be ingested by the insect vectors with the plant sap they suck. Then the pathogen circulates through the body of the insect with or without multiplication, will reach the salivary gland, and will be injected with the saliva, in to another plant while the insect is feeding. Eg. Non persistent foregut borne viruses, Persistent Circulative viruses Persistent propagative viruses Fig.3- B,C &D

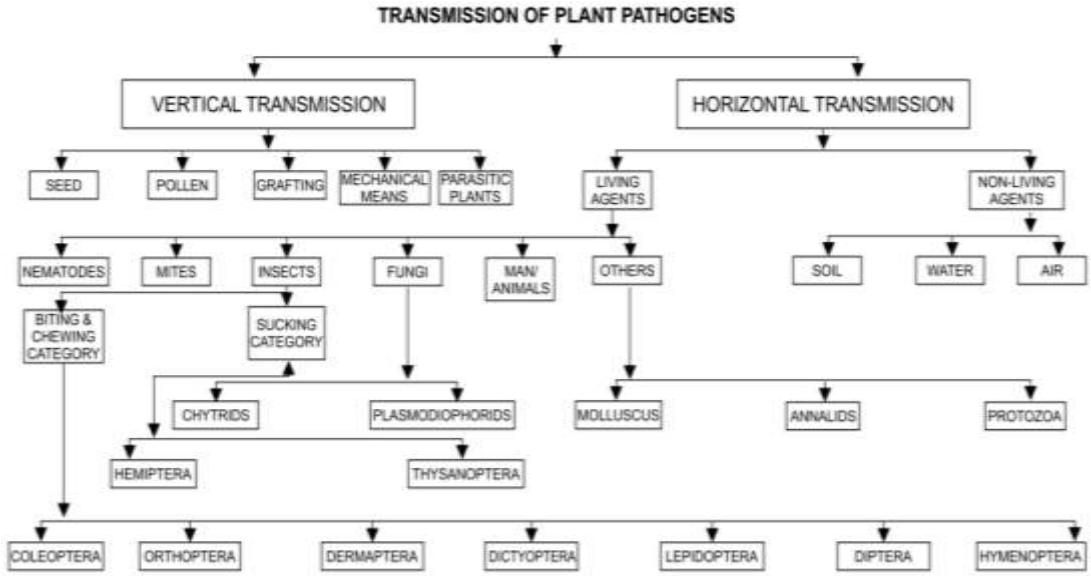
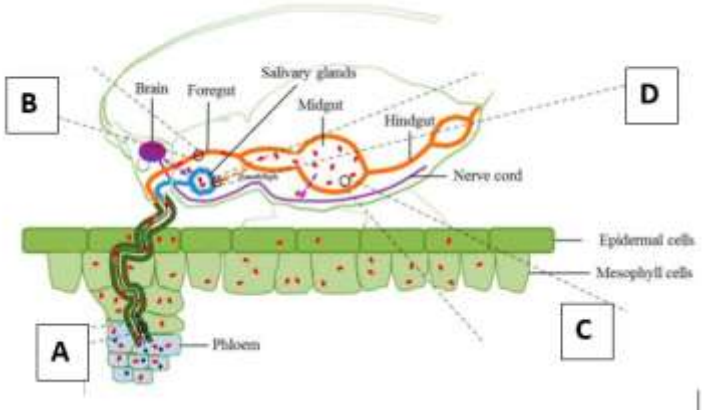


Fig:1 Modes of transmission of plant pathogen (Source: Butter,2018)

Diversity of insect vectors

Members in certain families of the following seven insect orders from the total thirty-two, have already been reported as vectors of plant disease (Butter,2018).

- ✓ The families Piesmidae (bugs), Aphididae (aphids), Cicadellidae (leafhoppers), Pseudococcidae (mealybugs), Psyllidae (psyllids) in Hemiptera.
- ✓ Thripidae (thrips) under Thysanoptera,
- ✓ Tephritidae (fruit flies), Anthomyziidae (maggots), Agromyzidae (leaf miners) and Diopsidae under Diptera,
- ✓ Chrysomelidae (leaf beetles), Scolytidae (bark beetles), Curculionidae (snout beetles), Melonidaee (blister beetles), Coccinellidae (lady bird beetles) under Coleoptera
- ✓ and Apidae (honey bees) and Formicidae (ants) under Hymenoptera
- ✓ and Acrididae, Tettigonidae, Tetrigidae, Pyrgomorphidae, Gryllidae under orthoptera
- ✓ and Blattidae (cockroaches) in the order Dictyoptera are families which contain vectors of plant pathogens.



✓

Fig: 3 Plant virus transmission strategies in insect vectors (Ralf, et. al 2016).

A) Non-circulative, non-persistent viruses are retained in the distal tip of the insect stylet (small blue hexagons) through two strategies, capsid-only or helper-dependent

(B) Non-circulative, semi-persistent viruses are retained within the insect foregut

(C) Circulative, non-persistent viruses are non-replicating and require invasion of multiple insect organs to reach the salivary glands for transmission

(**D)** Circulative, propagative viruses replicate and systemically invade several insect organs and tissues with the primary goal of entering the haemolymph or neuronal tissues in order to reach the salivary glands for transmission.

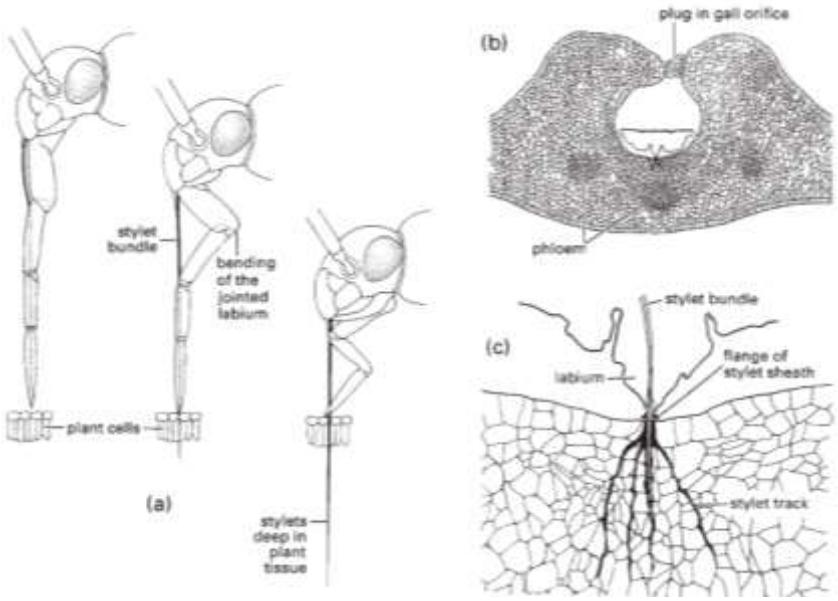


Fig.4. Piercing and sucking mode of feeding by phytophagous Hemipteran bugs

(a) penetration of plant tissue by a heteropteran mirid bug, showing bending of the labium as the stylets enter the plant; (b) transverse section through a eucalypt leaf gall containing a feeding nymph of a scale insect, *Apiomorpha* (Eriococcidae); (c) enlargement of the feeding site of (b), showing multiple stylet tracks formed by solidifying saliva, resulting from probing of the parenchyma. (Source:. Gullan and Cranston, 2014)

Among the insect vectors, hemipteran species alone are known to transmit about 90 % of the plant diseases, due to their mode of feeding, wide host range and rapid reproduction.

Hemiptern bugs feed plant sap from various tissues like parenchyma, xylem and phloem by piercing and sucking mechanism using their modified mouthparts with elongated strong stylets (Fig. 4). Aphid, leafhoppers and Planthoppers are the most important vectors of plant diseases.

				
Myzus persicae aphid-winged adult	*Orosius orientalis-leafhopper*	*Stirellus bicolor Leafhopper*	*Peregrinus maidis Planthopper*	*Nilaparvata lugens* Plant hopper

Plate-1 Hemipteran bugs as insect vectors of plant pathogens

Aphids

Aphids are included in the family Aphididae of suborder Sternorrhyncha of Hemiptera. There are only 227 in the total 4700 described species have been considered as vectors of plant pathogens and transmit more than 50% of plant viruses, including 208 non-persistent/stylet-borne, 25-five semi-persistent/ foregut-borne, 33 persistent circulative type and 09 persistent propagative type plant viruses.

Aphis are soft-bodied, pear-shaped small sized insects of 2 mm long and possess long antennae and jointed rostrum. It has two long, tubular structures called cornicles (siphunculi) borne on the 5th or 6th abdominal segment on the dorsal surface of the posterior end of the abdomen. These structures are unique to Aphids, responsible for the secretion of fluid containing tryglycerols. The abdomen tapers toward the posterior end and is tipped with a cauda that covers the anus meant to produce waxy material. **(Plate 1)**

Eg: *Myzus persicae; Aphis gossypii, Aphis craccivora*

Sophonia longitudinalis

Maiestas dorsalis

Orosius albicinctus

Scaphoideus morosus

Macrosteles vaga

Goniagnathus(*T.*) *puntifer*

Hishimonus phycitis

Nephotettix virescencs

Exitianus nanus

Plate: 1 Leafhopper vector species (Fam. Cicadellidae) recorded from coconut plantation in Weligama region, Sri Lanka (Gnaneswaran, *et. al* 2009)

Aphids are known to spread viruses from all the four categories : Non-persistent stylet-borne viruses are from genera *Alfamovirus, Carlavirus, Cucumovirus, Fabavirus, Macluravirus and Potyvirus*, non-persistent/foregut-borne viruses are from genera *Caulimovirus, Closterovirus, Sequivirus Trichovirus, and Waikavirus*, persistent-circulative viruses are from genera *Enamovirus, Luteovirus, Nanovirus, Polerovirus and Umbravirus*, while persistent propagative viruses belong to genera *Cytorhabdovirus, Nucleorhabdovirus and Reovirus* (Link and Fuchs, 2005)

Aphids are rarely act as vectors for pathogenic bacteria , but they are associated with them in nature , and act as primary host for them in such a way the aphid help in their spread. *Acyrthosiphon pisum* Harris, is a primary host of several bacteria known to cause diseases in plants.

The bacterium, *Pseudomonas syringae PV syringae* (PsyB728 a), is rod-shaped, gram-negative, obligate, aerobic bacterium known to infest wheat, barley, peas, etc. It causes cankers and galls.. The pea aphid, *Acyrthosiphon pisum* Harris acquires the bacteria while feeding on colonizing bacteria of the infected plant. These bacteria reach the digestive tract where they propagate and are later on excreted in the honeydew (Stavrinides et al., 2009).

Leafhoppers

Leafhoppers are included in the family Cicadellidae of suborder Auchenorrhyncha of Hemiptera

They are identified from their wedge shaped body, bristle-like antennae, beak-like labium, the presence of a double row of large spines on hind tibiae and a cover of waxy, water repellent material (brochosomes).

They are diverse in their feeding behavior as they feed on phloem, xylem and mesophyll tissues. Thus they can transmit semi-persistent, persistent and propagative viruses or Spiroplasma. The mouthparts of leafhoppers are stout so their stylets require less time to reach the target tissues than aphids. The stylets of leafhoppers reach the phloem in thirty seconds and the path is intracellular. But the species Cicadulina *storeyi* feed intercellularly in the vascular tissues.

Some species of leafhoppers salivate prior to ingestion, while others release saliva during/after ingestion. Usually their feeding lasts for five to thirty minutes. But some species continue to feed for hours together. Species with larger stylets are responsible for the destruction of sieve elements and some cells may remain undamaged, with that the pathogens are able to spread.

The stylets of nymphs are smaller and do not cause the destruction of sieve cells, therefore, they are considered to be more efficient vectors of plant pathogens than the adults.

The plant sap sucked by leafhoppers is nutritionally poor- contains carbohydrates as sucrose with very less lipids and proteins. To supplement their protein demand, they used endosymbiosis to enrich the diet with essential components. These are mainly two types of bacterial symbionts viz. obligate and facultative ones. Such as *Wolbachia*, Rickettsia, *Burkholderia*,

The pathogens belong to non-persistent foregut-borne, persistent circulative and persistent propagative categories of transmission, are transmitted by leafhoppers.

Eg: non-persistent foregut-borne Viruses belong to Caulimoviridae and Sequiviridae families of plant viruses.

Rice tungro disease is a complex disorder causedby Rice tungro Bacillus virus-RTBV and Maize chlorotic virus and Rice tungro spherical virus-RTSV together. Of these, RTBV is from the Caulimoviridae family while RTSV belongs to Sequiviridae. Tungro disease causing viruses are located in the phloem but the Rice tungro bacillus virus is detected in the xylem. As these viruses are located in deeper layers they require comparatively more time to be acquired by leafhopper vector, *Nephotettix virescens* (Plate-2)

Eg, Persistent circulative virus

Proutista moesta
Family Derbidae

Stephanitis typica
Family: Tingidae

Plate: 2 Hemipteran vectors of coconut root wilt disease caused by phytoplasma

Chickpea chlorotic dwarf virus is transmitted by *Orosius orientalis* (Plate-1). ChCDV (Curtovirus) under the family Geminiviridae is an ssDNA virus with a longest genome of 2.9 kb size and circular in shape. The potential vector is *O. orientalis* which can acquire the virus and inoculate it within two hours of acquisition and inoculation access each. The latent period is less than two hours. The transmission level is 80% with acquisition access of two hours. In Pakistan, this virus is transmissible by *O. albicinctus* (Plate: 2), which is commonly found in agro and plantation ecosystem in Sri Lanka (Gnaneswaran, 2009).

Eg Persistent propagative virus

The viruses included in this category are marafiviruses, nucleorhabdoviruses, phytoreoviruses and tenuiviruses and all transmissible by leafhoppers.

Under marafiviruses, Maize rayado fino virus (MRFV) is transmissible by many species of leafhoppers. Eg. *Dalbulus maidis, D. elimatus, Stirellus bicolor* (Plate -1) and *Graminella nigrifrons*. The study on virus and vector *Dalbulus maidis* showed acquisition and inoculation thresholds of six and eight hours, respectively. The retention of virus is for 1-20 days in the body of vector. Males and females equally important in transmission of MRFV. The first instar nymphs (13.5%) are much more efficient than adults (3.5%) in the transmission. The latent period is of seven days or more. When MRFV virus is injected in the hemocoel of vector, the latent period is reduced to between 1-3 days and the transmission rate was increased (Nault et al., 1980). There was no transovarial transmission through *D. maidis*.

Plant hoppers

Planthoppers are included in the family Fulgoridae of suborder Auchenorrhyncha of Hemiptera

They are very much resemble leafhoppers with respect to morphological characteristic features and feeding apparatus. But absence of ocilli and rows of spines in the tibia and presence of long antennae with egg shaped pedicel will be used to separate them from leafhoppers.

The planthoppers are associated with the spread of plant viruses belong to propagative category. Eg: Maize mosaic virus (MMV) is from Rhabdoviridae family of plant viruses. As in the plant cell, in vector also, the virus emerges out of nuclear membrane and gathers in perinuclear spaces. From the secretary cells of salivary glands, virus emerges via plasma membrane and passes into inter nuclear and extracellular spaces, to be passed on to the salivary ducts though that it will be successfully transmitted. The only vector is the adult and nymphs of *Peregrinus maidis* (Plate 1). The acquisition access is one day, or less than one day, and the incubation period is between 11 days to 07 seven weeks. The virus multiplies in the vector body.

Further under the category of Tenuivirus, European wheat striate mosaic virus, Maize stripe virus, Rice grassy stunt virus, Rice hoja blanca virus, Rice stripe virus, and Rice wilted stunt virus are transmitted by Delphacids.

Rice grassy stunt virus, transmitted by Brown plant hoppers *Nilaparvata lugens* (Plate I) in a propagative manner. Both nymphs and adults transmit the virus and, once acquired, the insect will retain the virus throughout its life. The acquisition and inoculation thresholds are thirty and nine minutes, respectively.

Management of insect vectors

Not like insect pests, the vectors are much more serious and difficult to manage because a very small population of vector can spread the pathogen particularly the plant viruses. Therefore control options for insect vectors should be focused to manage the disease not the vector populations and economic threshold levels as practice in pest management.

For any successful vector management programme, all the tactics such as cultural (mulching, sticky trapping), biological (predators, parasitoids and pathogens), resistance verities against vector, chemicals- systemic, botanicals) should be combined carefully, based on the pathogen, vector and the interaction of both. For this integrated strategy to be effective, identification of the plant pathogens as well as insect vectors is very important along with knowledge of their biology and ecology. Sampling methods should be developed and monitoring techniques adopted to assess the effect of the tactic, periodically. Integrated strategies should be adopted to manage the vectors.

References:

Butter, N.S (2018) Insect Vectors and Plant Pathogens Taylor & Francis Group, LLC, 470Pp

Gnaneswaran, R. Viraktamath, C.A. and Hemachandra, K.S. (2009) Taxonomic studies on Deltocephaline leafhoppers (Hemiptera: Cicadellidae: Deltocephalinae) of Sri Lanka. Presented at 14th International Forestry and Environment Symposium 2009, Nugegoda, Sri Lanka. 18th - 19th December 2009. Proceedings Part. I abstract p.62.

Gullan, P.J and P.S. Cranston (2014) The Insects – An Outline of Entomology, 5th Edition.Wiley Blackwell, 595Pp

Nault L.R and E.D. Ammer (1989) Leafhopper and Planthopper transmission of plant viruses. Annual Review of Entomology, 34:503-529

Ralf G. D., K. S. Mann and K. N. Johnson (2016) Plant Virus–Insect Vector Interactions: Current and Potential Future Research Directions, Viruses PP

Popular Lecture - Section B

Greening the Agri-Food Sector – Present Status and Future Directions

Professor D. A. Nimal Dharmasena
Department of Agricultural Engineering, University of Peradeniya, Sri Lanka

Introduction

During past few decades industrial development was substituted with sustainable development. Among these executives especially in developed countries look for procedures to support environment and also their organization performance. Harmonic strategy for productivity increase along with green management is green productivity that has been determined as the key point of sustainable development. In this way green supply chain is a basic tool. In different industries urgency for evaluation and choosing technology for reducing industrial effects on environment is increasing. At present, more consumers have the choice of environment compatible products. Increasing environmental issues and resource depletion problems have caused regulators at various levels to enact strong regulations. Simultaneously, the public's environmental awareness has been increased through formal and informal environmental education channels. This has become a hot topic in the Sri Lankan society at the moment as the government of Sri Lanka has a national policy on "sustainable agriculture to ensure food security and prosperous farming community" to initiate "Climate Smart Agriculture" and Sri Lanka to be converted to the "Green Home Garden in the World". A significant fraction of industries in the country are either in agriculture or agriculture related. When considering the status of Sri Lankan industrial sector, micro, small and medium (MSME) industries accounts for more than 90% of the enterprises,

MSME provides 45% employment and contributes 52% to the GDP (Ministry of Industry and Commerce, 2011, 15 &16). According to the industry trade and services sectors in 2016, there are 1.017 million economic establishments are reported and 25-32% of them fall under the industry category in which the Agri-food sector is also included (Dharmasena & Gammanpila, 2012). The central environmental authority (CEA) reported that out of 6222 industries listed, 247 (4%) are food processing industries (CEA, 2012). Although, it is very difficult to find up to date statistics on the industries in the food and allied sectors, the main food processing industries in the country are: rice and rice based foods (rice, flake, noodles, rice flour etc.), dairy processing, meat processing (chicken & pork), bakery and biscuit products, fruit and vegetables based products, nut based products: Cashew & Coconuts, fish processing industries (dried fish & fresh fish and seafood for export), and Breweries. Organic manure production has becoming a growing industry for local use at present due to the import restrictions of inorganic fertilizer to the country.

At the beginning of industrialization, waste was not an issue and sometimes the raising smoke column in the sky was a proud mark of the factory owner. There are literally hundreds of words for different types of wastes today but waste is waste. It took long years to realize the damage course by industries to the environment due to various types of waste generated from industries. Climate change was among the most critical global issue due to industrial pollution and became a hot topic at the global level. As a result, passive environmental strategies like 'dilute and disperse' was introduced and then

reactive environmental strategies like 'end of the pipe treatment' and 'on site reclining' were introduced. Finally the most sustainable and proactive environmental strategy of Cleaner Production (CP) was introduced. The concept of greening industries and supply chains was started as a successor to cleaner production initiatives taken by UNEP in 1982 to minimize greenhouse gas emissions from industries as a proactive environmental strategy and to increase profits through minimization of waste. Both these strategies considered similar approaches like good housekeeping, input substitution, better process control, equipment modification, technology change, on-site recovery/reuse, production of a useful by-products, product modification etc. to minimize waste and GHG emission.

Different concepts of greening

There are number of different strategies developed to promote the concept of greening in relation to different sectors. Some of them are green productivity, carbon footprint, green economy or inclusive green economy, greening factories, green buildings, circular economy etc.

Green industry is defined as a manufacturing firm that commits to conducting business in an environment friendly and socially responsible way to achieve sustainable growth by continuously developing and improving their production process and environmental management system. The United Nations Environment Program (UNEP) defines Green economy as an economy that results in improved human well-being and social equity, while reducing environmental and ecological impact. When environmental needs and expectations are incorporated into productivity, it is then termed as "Green Productivity" (GP) – APO -2013.
Green factory concerns three elements, first the factory itself, second, the environment, and lastly the community. Companies may have some adaptations of the concept like Honda (Japan), green factory means the factory that minimizes waste generation by maximizing resource efficiency and continually improving towards zero waste. Honda has taken many initiatives to reduce GHG emissions under this plan.

A carbon footprint is defined as the total amount of greenhouse gases produced directly and indirectly to support human activities, usually expressed in equivalent tons of carbon dioxide (CO2e/yr). Average Sri Lankan emits 0.95 t CO_2e/yr, whereas in the USA it is 14.86 t CO2e/person/yr. Although it is a relatively lower value for Sri Lanka, we have increased it from 0.2 t to 0.95 during last 70 years while USA is reducing it from 17.16 to 14.86t. Greening food industries was mainly considered in reducing GHG gas emissions during its processes.

Greening related global initiatives and frameworks

Climate change has been the most concerning environmental issue during the past decades.
In June 1992, initiated the UNFCCC (UN Framework Convention on Climate Change) to reduce and regulate the global emission of anthropogenic GHGs. In December 1997, Kyoto Protocol was signed to reduce the emission of GHGs by 5.2% compared with the 1990 level between 2008 to 2012. The Kyoto Protocol was put in action in February 2005 via the approaches of the clean development mechanism, and emission trading but emission reduction from developed countries was not successful. In 2015 'Paris Agreement' was proposed and activated in 2016. PR China and India were included and

targeted to control the rise of temperature by 1.5 ^{o}C and there were +ve results in transportation, power generation etc. The UN Sustainable Development Goals (SDGs) were adopted by all UN members in 2015 as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. Out of 17 SDGs, 7, 11, 12, and 13 are closely associated with Greening.

- SDG 7: Affordable and clean energy Ensure access to affordable, reliable, sustainable, and modern energy for all.
- SDG 11: Sustainable cities and communities Make cities and human settlements inclusive, safe, resilient, and sustainable.
- SDG 12: Responsible consumption and production Ensure sustainable consumption and production patterns.
- SDG 13: Climate action Take urgent action to combat climate change and its impacts.

Greening related local initiatives and frameworks developed by different stakeholders

National environmental action plan (1998-2001), establishment of a National Council for Sustainable Development directly under the President of Sri Lanka, Haritha Lanka Action Plan (targeting up to 2013) are the prime initiatives taken by the government at the initial stage.
Establishment of Sustainable Energy Authority in 2007 and development of national energy policy in 2019 to reduce fossil fuel dependency to 50% by 2030 from 2015 level with the target of becoming a carbon neutral country by 2050 are significant developments related to greening the industries in general. Introduction of annual smoke test for vehicles in 2008 is a revolutionary measure and then Enterprise Sri Lanka proposals in 2015 proposed electric vehicles and renewable energy, etc. for reducing environmental pollution.

In the service sector, introducing Leadership in Energy and Environmental Design (LEEDS) certificate especially in the export industries, Greening Sri Lankan Hotels programme (Envt & Tourism) are positive drives towards greening.

In the Industrial sector, cleaner production & Resource Efficient Cleaner Production (RECP) were promoted by the National Cleaner Production Center together with public Universities. Green building concept and green rating has just started and on the move. Voluntary standards like ISO 14001certification are also becoming popular in the industries. Ministry of environment introduced the National Green Reporting System in the year 2011 for the industries and it was a practical policy and a motivation for the industries to implement proper waste management strategies together with the monitoring organizations. The switch Asia programme, is other initiative taken to reduce carbon foot prints of IT, ceramics and organizations but no influence on the food sector.

On top of all regulatory and voluntary initiatives, there are pressurizing groups like NGOs working on environmental issues, public and private TV channels, FM radio channels and
community based organizations against environmental pollution issues. This is also a driving force to minimize all forms of pollution and motivate industries to adopt greening concepts in their industries.

GHG emission from the Agricultural sector

The International Panel on Climate Change (IPCC) estimates that agricultural production accounts for about 12% of man-made (anthropogenic) GHG emissions, which can go up to 24% when considering land use and change activities. Production of synthetic nitrogen fertilizers alone accounts for approximately 2% of the world's energy use (Kongshaug, 1998; Sutton et al., 2013). The most prevalent GHG emissions are nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2). Agriculture contributes more than 80% of the anthropogenic emission of N_2O, around 40% of anthropogenic CH_4, which comes mostly from enteric fermentation (Bouwman et al., 1997; Davidson and Kanter, 2014; IPCC, 2014; Zhang et al., 2010).

In the Sri Lankan context, agriculture accounts for 25.1% (4.71 megatons CO_2 equivalent) of the country's total GHG emissions, significantly less than the energy sector (61.5%), but more than the waste management (10.8%) and industrial sectors (2.6%) (Fig 1).

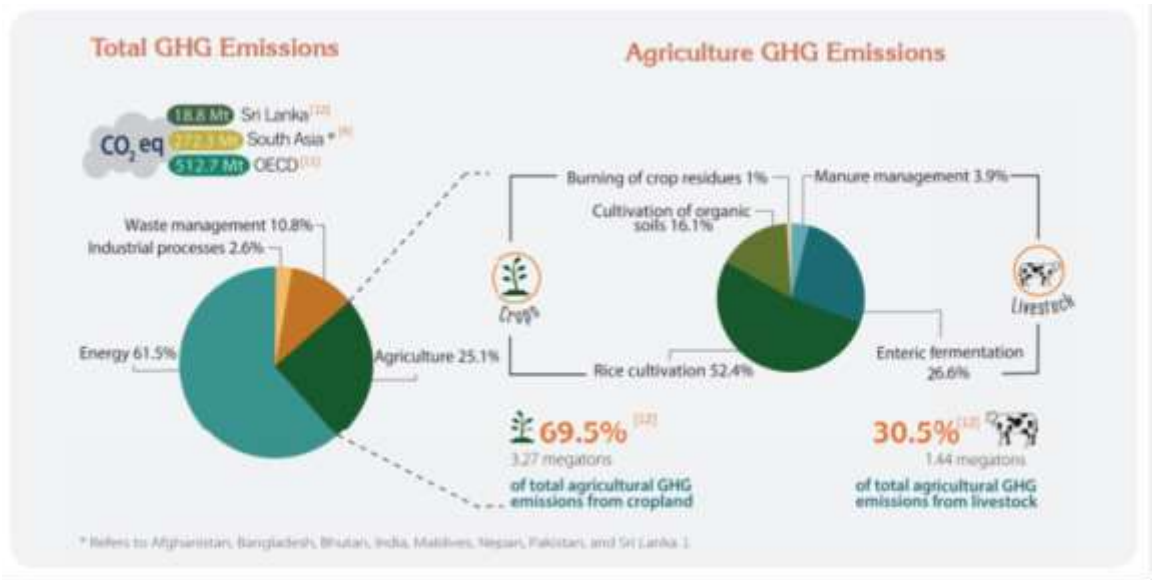


Fig. 1 GHG emission status of Sri Lanka
source: https://www.researchgate.net/publication/321162441_World_Bank_and_CIAT_2015_Climate-smart_Agriculture_in_Sri_Lanka

The carbon footprint of farming and foods

Carbon footprint of a food is associated with the greenhouse gas emissions during growing, rearing, farming, processing, transporting, storing, cooking and disposing of the food on your plate. The carbon footprint of food is around 25% of each household's total carbon footprint.

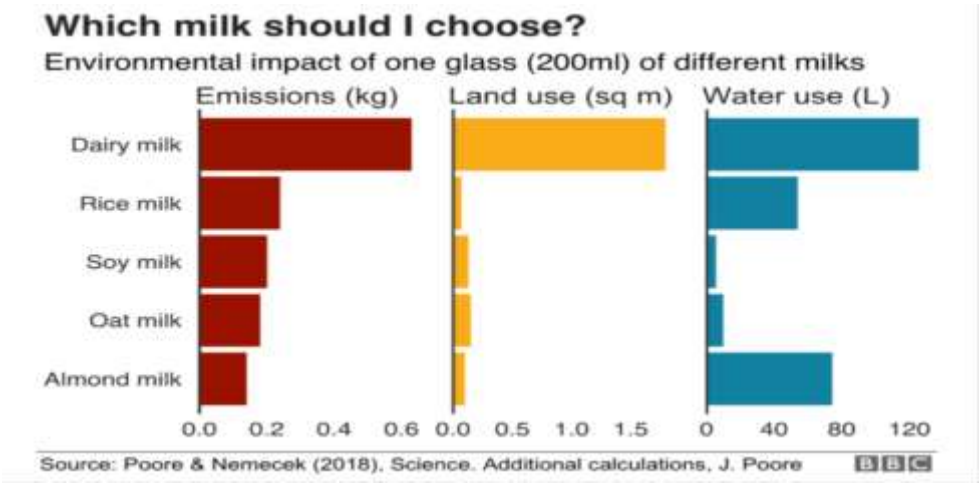
Changing your habits can have a big impact on your overall contribution to global warming and reduce pollution, preserve natural landscapes, save water and help animals. Many of these changes will also save you money, improve your health and even keep you fit (http://www.greeneatz.com/foods-carbon-footprint.html). A U.N. study released in 2006 reports that raising livestock for food produces more CO2 emissions than transportation does for the entire planet (http://www.thegreengrapevine.com/archive.php?f_id=58&choice=Feature).However, this fact has been criticized by many others. The livestock sector accounts for 9% of CO2 deriving from human-related activities, 65% of human-related nitrous oxide and most of this comes from manure. It accounts for 37 percent of all human-induced methane produced by the digestive system of ruminants. Roughly 30 percent of the earth's surface is devoted to rearing livestock, and about 33 percent of the

arable land is dedicated to produce crops for livestock feed. We need to rethink about our food habits like “Eat less Meat or Vegetarian Fridays” or “Vegetarian Full Moon Days” etc. The carbon footprint of the dairy industry is an eye opener. Fresh milk 1120 g CO_2e/L in which the production of raw milk is responsible for 843 g of CO_2e/L (75.27%), product transportation 38 g of CO_2e/L (3.39%) dairy processing 173 g of CO_2 /L (15.45%) and disposal of waste and packaging 66 gCO_2e/L (5.89%). A guide to select ecofriendly milk is given in the figure 2 below. Coconut milk is almost one half the emission value of soy milk.

Few interesting facts

The carbon footprint of a Big Mac cheeseburger is 4 kg of CO_2 equivalent gases and equivalent to ½ gallon of petrol. The calculations showed that a 100 g bar of dark chocolate produces 150-180 g of CO_2 emissions, of which 60% is from milk. EU cars produce 120.4 g CO_2e/km in 2019 and therefore, a 100g choco is equivalent to 1-1.5 km car drive and one burger is equivalent to 38 km car run.

Figure 4 illustrates the GHG emissions of selected food items during production and post-production phases. It is very clear that the production stage is critical than post production stages. At the same time the production of meat, fish and dairy have much higher greenhouse gas emissions than fruit and vegetables.



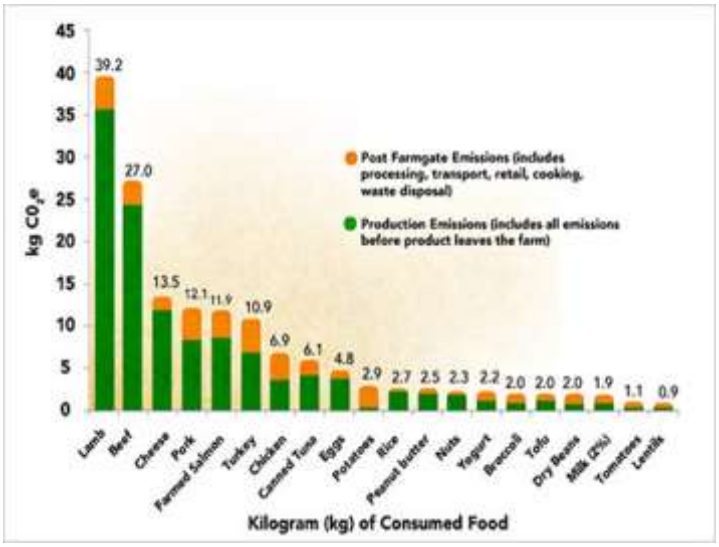


Fig. 4 GHG emission from common selected foods

Reducing food carbon footprint in Sri Lanka

According to available data, rice cultivation is responsible for 52.5% of total agricultural GHG emissions in the country as we practice wetland paddy cultivation. Paddy lands occupy 46% of total land area under cultivation (Fig. 5). Carbon foot print for rice production is reported as 5,566.8 kg CO_2e/ha/yr or (0.7/kg) (Awanthi and Navarathne, 2010) in Sri Lanka but the emission is twofold in China (11,881 CO_2e/kg/ha) (CAO Liming, Maobai, WANG XinqiShow, ZHAO Zhipeng, PAN Xiaohua, 2014). Similarly it is more than two fold in Egypt (1.9/kg) (Farag et al., 2013). Field CH_4 emission is the highest (77%) and fertilizer contributes 16.5%. This is unavoidable as rice is the staple diet in Sri Lanka but proper water management strategies may reduce the emissions further.

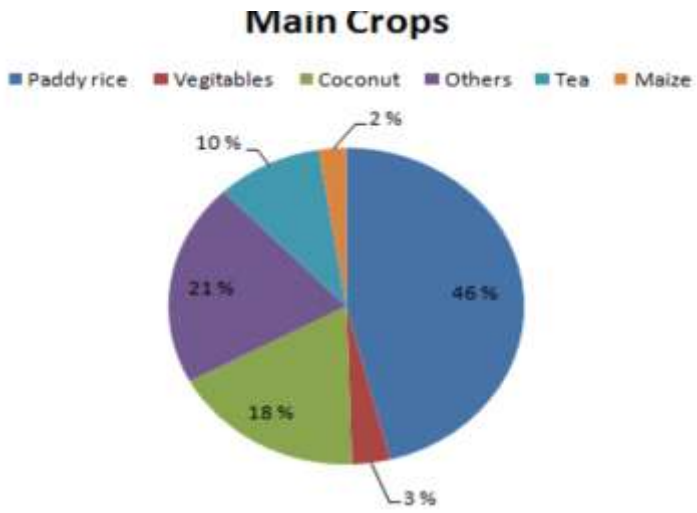


Fig. 5 Percent area of main crops cultivated in Sri Lanka
Source:https://www.researchgate.net/publication/321162441_World_Bank_and_CIAT_2015_Climate-smart_Agriculture_in_Sri_Lanka

Success story of greening: OGM Food Product (pvt) Ltd

This is a SME located at Mawanella, had a daily production of 3000 kg rice flour products using a work force of 10. Central Environmental Authority rejected their EP license due to Envt. pollution complains with respect to wastewater pollution, noise and air pollution. We have conducted a CP audit to assist them in getting their EPL. The following issues were identified & modifications were done accordingly. Rice dust (10 kg/day) washed off with wastewater per day and introduced a new pre-settling tank, collected them and sold as animal feed. There was a huge rice flour wastage due to carelessness of workers & using an inappropriate sieving machine. We introduced a rewording system for workers and a new and efficient flour sieving machine to minimize the loss. Thermal inefficiency of flour roasting process using coconut shell as the fuel was identified and therefore the stove was appropriately improved. Very high noise and dust loading created from the old sieving machine disappeared with the new machine introduction. The wastewater quality improvement is shown in the table 1 below. The ambient air quality could also be improved as shown in Table 2. Annual rice flour wastage prevented was 6405 kg (Rs. 586,000.00) and the reduction of the GHG emission was 9351 kg

CO_2e/yr. Annual coconut shell fuel wastage prevented was 2460 kg (Rs. 16,000) with the GHG reduction of 4674 kg CO_2e/yr. Annual electricity wastage prevented was 6751 kWh (Rs. 80,132.00) with a GHG reduction of (9273kg CO_2e)/yr. The total GHG emission reduction under the greening project was 23.3 t CO_2e/year with an approximate monitory saving of 5259 $/year.

Table 1. Wastewater quality improvement

Parameter	SLSI 654:1984 Tolerance Limit		Before Treatment	After Treatment
pH		6.0-8.5	5.8	6.65
Temperature	^{o}C	40	30	30
Total Suspended Solids	mg/L (max)	50	250	8
COD	mg/L (max)	250	1235	32
BOD	mg/L (max)	30	1225	24
Oil & Grease	mg/L (max)	10	-	-

Table 2. Ambient air quality improvement after CP

POLLUTANT	Permissible value (mg/ m^3)	Measurement (mg/m^3)
Nitrogen Dioxide(NO_2)	0.250	0.032
Carbon Monoxide (CO)	30	22
Particulate Matter (SPM)	0.500	0.057

In the coconut processing industry, we have limited data on GHG emission and greening. It is reported that the GHG emission for coconut oil is 2.1 kg CO_2e/1kg and for coconut milk also has the same value of 2.1 kg CO_2e/1kg or 100 g/ 200 ml milk. The soy milk has a much higher value of 195 CO_2e/200 ml. Recently developed a (virgin) coconut oil recovery (1% recovery) system from effluent in desiccated coconut mills and the process has been commercialized (Mannapperuma, 2014). In addition, development of coconut-water based beverages and introduction of vinegar production from coconut water minimize GHG emissions. However, the reduction of GHG emissions has not been calculated for these applications.

Intervention into Sri Lankan Milk industry

Reusing clay pots (Fig. 6) used for curd packaging has been tested and two re-burns of the same pot save about 1.7 MJ/kg (per pot). Total energy saving in pot manufacture in Sri Lanka is estimated as 85 TJ per year. In real terms it is about 6500 t of fire wood saving *(Dharmasena, Kottapola, & Silva, 2012).*

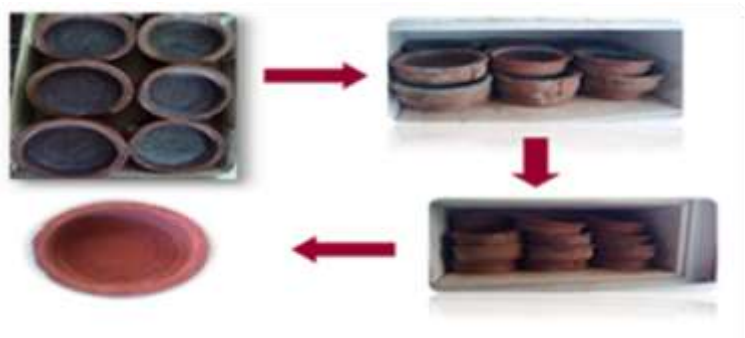


Fig. 6 Reburning of clay pots for packaging of curd

Issues need to be addressed on greening of agri-food industry

Inefficient usage of natural resources, raw materials, energy and water needs to be addressed from micro level to the macro level industries and improve resource use efficiency. We need to promote the best practices of sustainable consumption and production and stimulate the community. Non-compliance with international food safety standards like HACCP and ISO 22000 is also affecting the GHG emissions and need to motivate industries to go for certifications as much as possible. Similarly attempts should be made to motivate industries to maintain local environmental certifications (EPL) and additional environmental management certifications like ISO 14001 as people have less concern on the environment when looking for the profits. Practical difficulties in successful implementation of sustainable policies in Sri Lanka needs to be rectified at national level and proper inclusions should be done.

What we can do as researchers?

Change the mindset of industrialists creating the awareness and interest on the benefits of greening agri-food industry through Resource Efficient Cleaner Production (RECP) Research jointly with industries. Even small interventions could make a big impact to the industry and the environment in future.

Bibliography

Abeygunawardena, S. I. G. D. n.d. Management of wastewater in DC industry in Sri Lanka, Indo Sri Lanka cooperation project on biotechnology. http://www.neeri.res.in/pdf/Dr_I_Abeygunawardena.pdf

Athukorala, R. 2010. Daily Ft. SMEs generate US$ 30 b+ to Sri Lankan economy (online) http://www.ft.lk/2010/11/09/smes-generate-us-30-b-to-sri-lankan-economy/

Athukorala, R. 2012. Industry strategies for Rio 20+…., 24th Anniversary Convention 2012. 127-135

Awanthi, M. G. G. and Navaratne, C. M. 2010. Carbon footprint of an organization: a case study, faculty of agriculture, university of Ruhuna. Proceedings of the 15th International Forestry and Environment Symposium, 26-27 November 2010. pp 366-377.

CEA, 2012. Part III, Environmental setting. www.cea.lk/pdf/part3-environmental%20Settings.pdf

Chamber of commerce, 2012. Brief description, Switch Asia Programme of the chamber of commerce. (Online) www.chamber.lk/switchasia

Davidson, E. A. and Kanter, D. (2014) Inventories and scenarios of nitrous oxide emissions, Environ. Res. Lett., 9, 105012, http://iopscience.iop.org/1748-9326/9/10/105012, 2014.

Department of census and statistics, (2011) Provisional Estimate, Paddy – Statistics extent, Sown, Harvested, Average yield and production by District - 2011 (online) www.statistics.gov.lk/.../Paddy%20Statistics/PaddyStats.htm

Dharmasena, D.A.N and Gammanpila, H.M. 2012. Greening Processed Food Chains, Country Case Study – Sri Lanka. Proceedings of the workshop on Greening the supply chain for processed food products, organized by the APO and Korean Productivity Centre, 12-16, November, 2012

Dharmasena, D.A.N., Kottapola, J.P. & Silva, K.F.S.T. 2012. Reuse potential of clay pots for packaging of curd. Proceedings of the 2nd international conference on sustainable built environment (ICBSE 2012) 14-26, December, 2012. Kandy, Sri Lanka.

Farag, A.A.; Radwan, H.A.; Abdrabbo, M.A.A.; Heggi, M.A.M.; McCarl, B.A. Carbon footprint for paddy rice production in Egypt. Nat. Sci. 2013, 11, 36–45.

Index Mundi, 2011. Sri Lanka economy profile 2012. (online) www.indexmundi.com/sri_lanka/economy_profile.html.

IFA Technical Conference - International Fertilizer Association

Kongshaug, G (1998) Energy consumption and greenhouse gas emissions. in fertilizer production, International Fertilizer Association.

Krishnasway, 2012. Lanka to achieve self-sufficiency in milk by 2016. http://www.sundayobserver.lk/2012/06/10/new05.asp

Mannapperuma, J. (2014) Consultancy report, Unpublished.

MCNDSL, 2012. Media Center for National Development of Sri Lanka. http://www.development.lk/news.php?news=768 (accessed on 24.10.2012).

Ministry of Environment, 2011. National Green Reporting System of Sri Lanka, Reporting guidelines. Ministry of Environment, Sri Lanka.

Palipane, K. B., (n.d.) Milling and quality improvement in rice, Institute of Postharvest Technology, Anuradhapura, (Online) http://www.goviya.lk/agri_learning/Paddy/Paddy_Research/Paddy_pdf/AM2.pdf (accessed on 25.10.2012).

Ranasinghe, D. M. S. H. K. 2010. Climate change mitigation: Sri Lanka's perspective. Environment Sri Lanka Blog. http://environmentlanka.com/blog/category/sympo2010/ (accessed on 24.10.2012).

Senanayake, S. S., Basnayake, B.F.A and Mowjood, M.I.M. (2001). Aerated soaking of paddy for rice parboiling and its effect on effluent kinetics. Annual Research Sessions–November 2001, University of Peradeniya, Peradeniya, Proc: 6: 12

Senanayaka, D.P., Danaragama.U and Fernando, M.D. (2005) .Technical note of institute of postharvest technology.

SLEJF, n.d. Marketing Executive Sri Lanka Environmental Journalists Forum, PO Box 26 434/3 Sri Jayawardanapura Sri Lanka. http://www.environmentaljournalists.org/images/Sri_Lanka_Directory_of_Environmental_NGO.pdf

UN Human development reports, 2011. International human development indicators, (online) hdrstats.undp.org (accessed on 31.10.2012).

World bank, 2011. Small and Medium Enterprises: Engines of Growth in Post Conflict Sri Lanka. Story Highlights, (online) http://www.worldbank.org/en/news/2010/09/30/small-medium-enterprises-engines-growth-post-conflict-sri-lanka (accessed on 24.10.2012).

Popular Lecture - Section C

Carbon foot printing in surgical practice

Professor. S. Rajendra
Consultant Surgeon, Teaching Hospital Jaffna

Health professionals, provide health service to community. Do they do any harm to planetary health?

Climate change is the long-term shifts in temperatures and weather patterns, by natural means and by human activities. It is one of the greatest health threats of the 21st century. Human activities such as burning of coal, oil and gas increased exponentially since the industrial revolution that took place in 1800. As a consequence, greenhouse gases (GHG) accumulate in environment and they trap heat in the atmosphere to cause rising temperatures leading to global warming and climate change. Carbon dioxide (CO_2) is the most common GHG produced by human activities. CO_2 emission is the key event in climate change. The burning of coal and fossil fuel, deforestation and land utilization, transportation and the industrial functions are some factors contributing to rising CO_2 emission rates. Projected CO_2 emission in 2100 will be 90% to 250% levels seen in the year 1750 (1).

Climate change can have multitude of effects on social determinants of health. Air pollution and increasing allergens lead to respiratory and cardiac diseases. Changes in vector ecology and water quality would result in parasitic and microbial infections. Extreme weather conditions and environmental degradation could play role in heat related illnesses and also have impact on cardio vascular and mental health (2).

GHG can be measured by estimating the amount emitted using activity data (such as the amount of fuel used) and applying relevant conversion factors. Department of Environment, Food, and Rural Affairs (DEFRA) greenhouse gas life-cycle conversion factors for waste disposals allow organizations to calculate and measure the GHG emissions from a range of activities such as energy use, water consumption, waste disposal and recycling and transport activities (3, 4, 5).

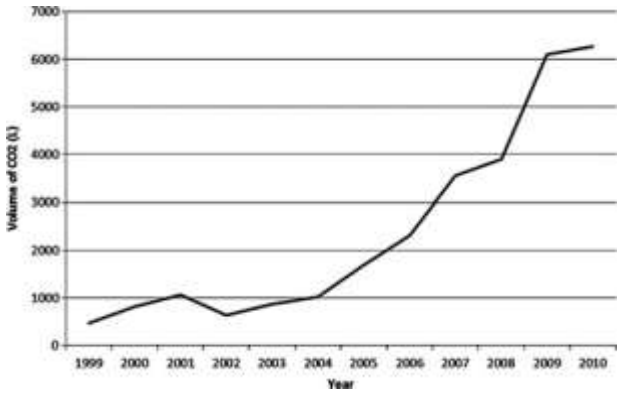
Carbon footprint is the amount of GHG (CO_2) released into the atmosphere as a result of the activities of a particular individual, organization or community. Carbon footprints can be calculated by applying DEFRA greenhouse gas life-cycle conversion factors. The calculation takes in to account , both, the GHG emissions generated upstream in the supply chain and also the GHG emissions generated in the downstream disposal (6,7).

Apart from CO_2 , hospitals also emit other GHG such as methane, nitrous oxide, chlorofluorocarbons and anaesthetic gases. These together with CO_2, can be converted into carbon dioxide equivalents (CO_2e). The summation of all these different gases is a carbon footprint. Review of published data on this topic reveals that 655 million tonnes of CO_2 e per year is produced from health care institutions in USA and this is about 8%–10% of all national GHG emissions. In the UK 22.8 million tonnes of CO_2 e produced from NHS per year and this would be about 6% of UK net CO_2 emissions (7, 8).

Operation theatres were found to be three to six times more energy-intense than the hospital as a whole and thus theatres proportionately contribute more to the carbon foot printing of hospitals. Operation theatre infrastructure, capital machinery, maintenance of the theatre environment with heating, ventilation, air-conditioning, laminar flow and lighting would all contribute to carbon foot printing of operation theatres. Apart from that electronic equipment energy, anaesthettic gases and pharmaceuticals and reusable & disposable items would further contribute to carbon foot printing of theatres. A carbon foot printing study of operation theatres in health systems in USA, Canada and UK was carried out to assess the impact of surgery on global climate. Overall, the carbon footprint of surgery in the three countries studied is estimated to be 9·7 million tonnes of CO_2e per year. This 9.7 million tonnes CO_2e per year is equivalent to CO_2 emission from 2 million passenger vehicles! (7, 8)

The carbon footprint of different operations will vary depending on the invasiveness of the procedure, patient factors, operative time and consumables used. The carbon footprint of a single operation ranged from 6 kg CO_2e (for cataract surgery in India) to 814 kg CO2e, (for a robotic hysterectomy in the US). The highest carbon foot print value was equivalent to driving up to 2273 miles in an average petrol car. Emissions of CO_2e per average case in hospitals were 146 kg, 173 kg and 232 kg in Canada, UK and USA respectively (7).

Technological advances have developed minimal access surgical procedures which are practiced all over the world. Laparoscopic surgeries and robotic surgeries utilize CO2 insufflations of abdominal cavity for surgery. The graph below shows the increasing use of CO_2 in minimal access surgeries in USA.



Several factors will influence the carbon foot printing of minimally access surgeries. These are CO_2 gas used for insufflations, emissions related to capture, compression, and transportation of CO_2 to hospitals and disposal of single-use equipments. In a study in USA, the total estimated CO_2 emission from minimal access surgeries was found to be 355,924 tonnes per year. This highlights the impact of minimal access surgery on carbon foot printing (9).

Nearly 50% of emissions associated with surgical care are attributable to waste anaesthetic gases. Desflurane and nitrous oxide have higher global warming properties than CO_2. One hour of desflurane use would be equivalent to the amount of CO_2 emission by driving a car for 235-475 miles (3, 10)

Carbon foot printing studies help to understand the impact on climate change by health system. It is the right time to look ahead and to take a step towards planetary health. Decision making to mitigate the impact of carbon foot printing by health care institutions needs to come from stakeholders at different levels, including patients, health care workers, surgeons and administrators. Educating surgical colleagues, medical officer and medical students about the adverse consequences of carbon foot printing is an important armamentarium to achieve the goal. Research activities to highlight the impact of surgical practice on carbon foot printing and climate change will have to be encouraged. Advocacy and public policy will have to be made at local, regional and national levels for this. Optimizing surgical consumables with re-usable instruments will have effect on supply chain and would reduce operative GHG emission by 50%. Use of total intravenous anaesthesia, regional anaesthesia and peripheral nerve blocks would cut down the waste anaesthetic gases. Use of LED lights, renewable energy sources, Heating, Ventilation and Air Conditioning setbacks and using solar panels will reduce the carbon foot print of energy sources in health institutions. These steps towards climate smart surgery have financial benefits also (11).

All industries must develop strategies to reduce greenhouse gas emissions in order to avoid a global temperature rise beyond 2°C and subsequent climate disturbances. United Nation's sustainable development goals aim to halve global emissions of CO_2 by 2030 and to reach net zero emissions by 2050(12).

One pragmatic approach to bring down the carbon foot printing by any organization is to plant trees. It has been suggested that planting 32-46 trees might bringdown 1 tonne of CO_2 in atmosphere. Let's begin to contribute towards environmental health in order protect our future generation.

References:

1) Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change. Lancet 2009; 373: 1693–733.

2) Watts N, Adger WN, Agnolucci P, et al. Health and climate change: policy responses to protect public health. Lancet 2015; 386: 1861–914.

3) Roa L, Velin L, Tudravu J, McClain CD, Bernstein A, Meara JG. Climate change: challenges and opportunities to scale up surgical, obstetric, and anaesthesia care globally. The Lancet Planetary Health. 2020 Nov 1;4(11):e538-43.

4) Chung JW, Meltzer DO. Estimate of the carbon footprint of the US health care sector. *JAMA 2009; 302: 1970–72.*

5) Eckelman of the U.S. health care system and effects on public health. PLoS One 2016; 11: e0157014

6) NHS Sustainable Development Unit (2008, updated 2009, 2016). NHS England carbon emissions carbon footprinting report. Available at http://www.sdu.nhs.uk/documents/publications/1263313924_ jgyW_nhs_england_carbon_emissions_carbon_footprinting_r.pdf (accessed Dec 18, 2010).

7) MacNeill AJ, Lillywhite R, Brown CJ. The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems. The Lancet Planetary Health. 2017 Dec 1;1(9):e381-8.

8) Rizan C, Steinbach I, Nicholson R, Lillywhite R, Reed M, Bhutta MF. The carbon footprint of surgical operations: a systematic review. Annals of Surgery. 2020 Dec 1;272(6):986-95.

9) Power NE, Silberstein JL, Ghoneim TP, Guillonneau B, Touijer KA. Environmental impact of minimally invasive surgery in the United States: an estimate of the carbon dioxide footprint. Journal of endourology. 2012 Dec 1;26(12):1639-44.

10) Taylor T, Mackie P. Carbon footprinting in health systems: one small step towards planetary health. The Lancet Planetary Health. 2017 Dec 1;1(9):e357-8.

11) Collins A, Dilger A, Tummala N. Climate Change, Health and Surgery: A Call to Action.

12) Jennings N, Rao M. Towards a carbon neutral NHS. bmj. 2020 Oct 8;371.

Popular Lecture - Section D

Changes in the order of world politics: After Covid-19

Professor K.T.Ganeshalingam
Department of Political Science, University of Jaffna,

INTRODUCTION

The Corona virus, which was detected in China's Wuhan province in December, 2019 is emerging as a Global challenge. It is widely believed that Corona virus will have adverse Socio-Economic and political impact for generations to come. The virus which spread from China to world countries like Spain, Britain France, Brazil, and India has badly affected the United States of America. The spread has now resulted in more than billion deaths and affected more than trillion people in the world. This Article aims to analyze the Global impact, the politics of caused by COVID-19.

The post-cold war period saw United States of America emerging as a global power. Till the attack on the Twin towers, United States of America continued to holds its global position as a "Super Power". The Twin tower attack weakened United States of America's global supremacy and saw emergence of multi polar order. The economic challenge witnessed in United States of America in the year 2008 further widened the formation of multi polar system. Although China could not be equated with United States of America, yet China has emerged as a challenge to United States of America. The formation of Multi polar nations has witnessed a step by step growth in which China, Russia, North Korea and Iran constitute an ally and United States of America, the European Nations, Britain, Australia, India, Japan and Israel constituting another ally. This period saw an America versus China like situation. The conflict between these two nations is more predominant in the Economic front rather than the Political and Military Front. The Economic War between these two nations is at its helm. It is during this period the Corona virus spread began in Wuhan in China. It spread globally and altered global economic and political order. Military equations were relegated behind. United State of America's position as a global economy has been put to question. Because of these reasons, this Virus is termed as a "Political Virus." It is a Political Virus. It has relegated the Western Countries and helped China and its allies to hold their ground. Although America and the Western Countries accuse China of suppressing its casualties, yet it could be seen that China is successful in containing the Virus from spreading to other provinces and restoring normalcy in Wuhan. The same trend could be witnessed in Russia, North Korea and Syria, where the Virus had been contained the deaths minimized.

Henry Kissinger, former Security Advisor to United States of America in his article "The corona virus pandemic will forever Alter the World Order" has pointed the following:

1) While starting the urgent work of planning for a new epoch.
2) While the assault on human health will – hopefully – be temporary the political and economic upheaval it has unleashed could last for generations.

He envisages political changes lasting over generations. Indian analyst, Arundhati Roy, while concurring with these views states as follows:

"Historically, pandemics have forced humans to break with the past and imagine their world anew. This one is no different. It is a portal, a gateway between one world and the next. We can choose to walk through it, dragging the carcasses of our prejudice and hatred, our avarice, our data banks and dead ideas, our dead rivers and smoky skies behind us. Or we can walk through lightly, with little luggage, ready to imagine another world. And ready to fight for it"

Discussion

Geo-economy

Geo economic gives us a list of strengths, how it affects the structure of power. Geo economic is defined as the combination of economic and geographic factors. Therefore a governmental policy guided by geo-economics. The first known use of geo economic was in 1981. The distinction of geo-economics separately from geo politics is often attributed to Edward luttwak, an American economist and political scientist.

Azerbaijani economist Vusal Gasimli defines geo-economics as the study of the inter relations of economics, geography and politics in the infinitive cone rising from the center of the earth to outer space (including the economic analysis of planetary resources). Sanjaya Baru assumes that the geo economy has a dual analytical sense. On the one hand, it assess the geo political implications of the economic phenomenon, on the other hand it analyzes the economic implications of geo political trends.

The Ideals of globalization which flourished on trade and market now stands collapsed on account of the Corona Political mystery. Ideals like "Growth opposed to nature is bound to fail" are now gaining strength. Economic growth built on available resources relegating indigenous growth are now being challenged. It is prophesied that, in the Private Sector, there would be large scale unemployment rate, shutting down of the industries, and fall of the GDP are the current scenario in the world.. In US, as on 01.May, 2020, 26 million workers have applied for government aid citing loss of job. The International Labor Commission has warned that 1.6 billion would lose their jobs and life security.

It has assessed that in the first month of corona spread, there had been 60% loss in income. During the same period America's economic growth has drooping by 4.8%. The Covid 19 pandemic of 2020 will have lasting effects on the geo economic of the Middle East the gulf and beyond. West Asia and North

Africa was hit particularly hard by the Covid pandemic's economic effect. Across the region GDP is expected to fall by 4.7%. But in states that are fragile or in conflict this could reach 13% (Gurett Nada, 2020). The COVID-19 pandemic has put the health and security of humankind in grave danger while wreaking immeasurable harm to the world economy, the reconstruction of a global trade order, and international people-to-people relation. In other words, the COVID-19 pandemic has seriously disrupted the progress in the development of human society.

Belt and Road Initiative and Indo-Pacific Strategy

China's promotion of construction under the Belt and Road Initiative (BRI) demonstrates an unique commitment to preventing the collapse of economic globalization, exploring a new economic and trade order, and boosting new types of international cooperation. Over the past six years, the Belt and Road Initiative has gained worldwide recognition in many countries and sectors. Practice has proven, and will continue to prove, that China's Belt and Road Initiative is not only a Chinese approach to contributing to global comprehensive development, but also a new pattern leading the world onto the path of win-win cooperation and mutual benefit. Despite the potential major changes taking place after the pandemic, and lasting differences in social systems and ideologies, it is still possible for countries to conduct equal, extensive and sustainable cooperation under the framework of the Belt and Road Initiative. In the process, they can enhance of their development concepts, policies and regulations, and institutional mechanisms to the greatest extent.

As an embodiment of China's willingness of enhancing its own economy through opening up to the world, the Belt and Road Initiative is China's successful choice cooperate with the international community in difficult times. China is not in a rush for quick success with instant benefits, nor does it impose pressures upon others. Instead, it is strengthening its overall planning capability and keeping a dynamic balance on Belt and Road construction. In global anti-epidemic cooperation and economic reconstruction in the post-epidemic era, we have strong confidence in the Belt and Road Initiative to achieve great success.

Indo-Pacific Strategy

Indo-Pacific originally a geographic concept that spans two regions- Indian ocean and the Pacific Ocean -is a new concept in itself. It has initially been outlined by the Former Japanese Prime Minister Shinzo Abe in 2007. In his visit to India, he delivered the speech in the Parliament of India. According to his words:

"The Pacific and the Indian Oceans are now bringing about a dynamic coupling as seas of freedom and of prosperity. A "broader Asia" that broke away geographical boundaries is now beginning to take on a separate form. Our two nations have the ability - and the responsibility -to ensure that it broadens yet further and to nurture and enrich these seas to become seas of clearest transparence."

The Indo-Pacific used by former US President Donald Trump means that India, the US and other major Asian democracies, especially Japan and Australia, will join in **curbing China** in the new framework of growing Cold War influence.

Quad Organization

Known as the 'Quadrilateral Security Dialogue' (QSD), the Quad is an informal strategic forum comprising four nations, namely United States of America (USA), India, Australia and Japan. One of the primary objectives of the Quad is to work for a free, open, prosperous and inclusive Indo-Pacific region. The Indo-Pacific spans two oceans and several continents, making it important to U.S. maritime interests. In 2019, $1.9 trillion worth of U.S. trade passed through the region. This year, 42 percent of the world's exports and 38 percent of global imports are expected to pass through, according to a SIPRI year book.

Regional Comprehensive Economic Partnership- RCEP

RCEP is a regional free trade agreement that will complement and build upon Australia's existing free trade agreements with 14 other Indo-Pacific countries sign 15 November 2020. It is a modern and comprehensive free trade agreement covering trade in goods, trade in services, investment, economic and technical cooperation, and creates new rules for electronic commerce, intellectual property, government procurement, competition, and small and medium sized enterprises.

RCEP entered into force on 1 January 2022, for ten countries, Australia, New Zealand, Brunei Darussalam, Cambodia, China, Japan, Laos, Singapore, Thailand and Vietnam, with Australia as an original party. RCEP will enter into force for the Republic of Korea on 1 February 2022 and for Malaysia on 18 March 2022.The Bay of Bengal Initiative for Multi-Sector Technical and Economic Cooperation- BIMSTEC

Military Emerge

The 1 February, 2021 Coup ended a brief, decade-long experiment in democracy in the South Asian Nation of shattering hopes that it would emerge from more than half a century of military rule in Myanmar. On 14 April 2021, President Biden confirmed that it was "time for American troops to come home" and that the US would honor its commitments under the February 2020 deal. However, the process of withdrawal would be delayed. The US military presence in Afghanistan will end on 31 August 2021. However, the US will retain a counterterrorism presence in the region. US diplomatic, humanitarian and development assistance to the Afghanistan Government, and "over the horizon" support to the Afghan National Security Forces (ANSF) from US assets based elsewhere in the region will also continue beyond withdrawal.

On October 25, 2021, Sudan's military carried out a coup against the civilian authorities. Army chief, General Abdel Fattah al-Burhan, dissolved the government and the sovereignty council, suspended

critical parts of Sudan's Constitutional Charter of 2019, and imposed a nationwide state of emergency, thereby orchestrating the biggest political crisis in Sudan's two-year-old transition. Prime Minister Abdalla Hamdok and some of his cabinet ministers were arrested. Al-Burhan then declared the military would establish a new government, promising elections would take place in July 2023.

Russia and Belarus will be the site of what could be the biggest military exercises in Europe in decades, which comes as Alyaksandr Lukashenka moves to integrate Belarus even closer not only militarily but politically with Russia, triggering fears he is bargaining away the country's sovereignty to its much bigger neighbor.

For the second time in 2021, a massive Russian military build-up and increasingly hostile rhetoric point to a planned attack on Ukraine. Whereas the previous build-up ended in April with the withdrawal of most troops, this time the signs are more worrying. Russia is demanding a halt to NATO activity in and around Ukraine. The US and the EU are threatening harsh new sanctions against Russia if the attack goes ahead. Furthermore increase military control by civil government of countries are Chat, Male and Guinea. After the covid-19, military intervention of democratic government are all the countries. This is move towards step by step military role in the world. Emerging China and Russian rule impose military or authoritarian in the world politics.

Conclusion

The world is sickened by the pandemic. After the loss of many lives and so much suffering, the international community needs to recuperate, rebuild trust, and renew cooperation. The pandemic is a major test for all countries. We need to reform institutions and enhance our capacities whether in response to economic losses or governance dilemmas. This should be the direction in which the international landscape should change after the pandemic. Now is moving towards of bi-polar world politics as two block of imperialist world.

Reference

Baru Sanjay: (2012), Geo-economics and strategy: Journal of Survival, vol:54, issue:3, Pp 47-58.

Cristina Magdaleno,(2020) Chomsky on COVID-19: The latest massive failure of neo-liberalism: La Prensa Latina, New Yourk, 25 April 2020.

Kissinger. Henry. A, (2020), The corona virus pandemic will forever Alter the world order, The Wall Street Journal, English Edition, USA, April 3 2020.

Luttwak,. Edward.N. (1990), From Geo-politics to Geo-economics: logic of conflict, Grammar of Commerce, JSTOR, national interest, Pp 17-23.

Manning . Rebort A.: (2018) US Indo-Pacific Strategy: Myths and Reality, Valdai Discussion Club, Moscow , Russia.

UNCOVERING AN ARRAY OF ESSENTIAL SKILLS FOR TEACHING AND LEARNING DURING THE CRISIS

A.Niththilavarnan,

Department of Education, University of Jaffna

Introduction

The COVID -19 was reported from Wuhan Province, China, in December 2019. It has affected education system worldwide leading to the widespread closures of preschools, schools, colleges and Universities. The pandemic impacts 1.5 billion students (80%). Education institutes are forced to online media to deliver education.

Impacts of COVID-19 on Education

Schools temporarily closed in Sri Lanka on 13th March 2019. Schools reopen with safety measures in Sri Lanka on 13th August 2020 after 04 months of closures. The Schools were open 111 days in 2020 and 50 days in 2021. New learning environment with distance mode introduced. China delivered Education to 180 million students via Television but in Sri Lanka less than 30% of students were reached via TV.

Sri Lanka's COVID-19 Education Crisis

Online learning platforms have been ineffective due to issues of access, quality and logistics. Less than 50% of students were reached online and less than 30% via TV. Government's education recovery strategy for the longer-term remains unspecified.

Learning Loss

In 2020, half of the study programs were affected. In 2021 also, half of the study program were affected. On average 2 years /2 Grade learning hours lost. Students were promoting class without learning outcomes.

Impact of COVID-19 on Pre- school and Primary school Education

- Learning loss
- Loss of basic literacy – Decreasing the reading skills, writing skills & Mathematical skills
- Less interaction between the students and teachers
- Excess TV watching & SMART phone usage
- Psychological problems
- Physical health problems

Importance of face-to-face school provision

The negative impact from a lack of face-to-face school provision is likely to be particularly large for younger children. Mitigate the impact of pre-school closure, including those with disabilities from minority ethnic communities & new residents.

COVID -19 and University Education

The 89% of University presidents expressed "serious concern" about their entire institutions' financial future. 92% of University Presidents are most concerned about the mental health of their students and staff.

Effects of COVID-19 on access and provision of TVET

- Closures of TVET centers
- Obstacles to continuing in the provision of training to TVET learners
- Lack of effective and user friendly distance learning platforms.
- Lack of staff capacity to support distance learning through quality pedagogical resources.
- Financial resource constraints

Conclusion

In crisis, it is acceptable to have more questions than answers. In crisis, there's no room for 'not – invented – here'. In crisis, we should all be learners.

Uncovering an array of essential skills for health education during the crisis

Dr. B. Balagobi

Department of Surgery, University of Jaffna

The COVID-19 pandemic has highlighted the critical role of health education in promoting public health and preventing the spread of infectious diseases. Here are some essential skills for health education during the COVID crisis:

1. Effective communication: Health educators must be able to communicate complex information clearly and effectively to a diverse audience, including individuals from different cultural backgrounds, age groups, and educational levels. They must also be able to adapt their communication style to suit different communication channels, such as social media, websites, and print materials.
2. Disease prevention and control: Health educators should have a thorough understanding of the principles of disease prevention and control, including the use of personal protective equipment, hand hygiene, social distancing, and vaccination.
3. Epidemiology: Health educators should understand the basic principles of epidemiology, including disease transmission, outbreak investigation, and surveillance.
4. Cultural competence: Health educators should have cultural competence, which means understanding and respecting the beliefs, values, and practices of different cultural groups. This can help to improve health outcomes by promoting culturally appropriate health behaviors.
5. Health promotion and behavior change: Health educators should be skilled in designing and implementing health promotion programs that are evidence-based and effective in promoting healthy behaviors.
6. Data analysis: Health educators should be able to analyze data related to health outcomes, behavior change, and program effectiveness.
7. Technology skills: Health educators should be familiar with the use of technology in health education, including virtual learning environments, social media, and mobile health applications.
8. Leadership and collaboration: Health educators should be able to work effectively in teams and lead health promotion initiatives at the community or organizational level.

Overall, these skills are critical for health educators to be effective in promoting public health and preventing the spread of infectious diseases during the COVID-19 crisis.

ESSENTIAL SKILLS FOR SCIENTIFIC SUCCESS DURING CRISIS

Professor T.Velnampy
Department of Accounting, University of Jaffna

INTRODUCTION

There was a need to play a vital role in post- pandemic economic recovery through various sectors including educational system at schools and universities/higher educational institutions. Due to Covid- 19 pandemic, students were requested to study via zoom and sit online examinations, whereas people who work for state and private sectors were allowed to work from home, still the system is going on in most of the places. In this juncture, educational managers/administrators, and career development practitioners/office in charges had to revisit/re-think how they can provide/receive services with essential skills towards accomplishment of goals/targets.

Anyhow, workers faced a lot of difficulties to provide their services with the immediate changes. Therefore, support should be provided for students/workers to build up their skills for success in their studies/workplace. A proper system/training programme can be set up to improve the essential skills for the success of students/workers. That is why; the present talk is delivered on "Essential Skills for Scientific Success during Crisis".

WHAT IS ESSENTIAL SKILLS

Essential skills are the original foundational skills identified as integral to successful participation in the labour market. These are the skills that provide people with a foundation for learning other skills and needed for work, learning and life. It helps people to perform task required by their jobs and enhance the ability to adapt changes.

Essential skills are the skills that people need for learning, work and life. They are used in the community and the workplace, in different forms and at different levels of complexity (Human Resources and Skills Development, Canada 2009).

Key Essential Skills for The Workplace

The government of Canada and other national and international agencies have identified and validated the following nine key essential skills for the workplace.

1. Numeracy	6. Writing
2. Oral communication	7. Thinking
3. Working with others	8. Document use
4. Continuous learning	9. Digital.
5. Reading text	

SKILLS FOR SUCCESS

Skills for success are the skills needed to participate and thrive in learning, work and life.

Skills for success include skills that are foundational for building new skills and knowledge and important for effective social interaction. These skills overlap and interact with each other, and with other technical and life skills. (Boris palameta, cam nguyen, wendy lee, hua que, and david gyarmati, 2021). They identified the following as the skills for success.

1. Reading 2. Writing 3. Numeracy 4. Digital 5. Problem solving	6. Communication 7. Collaboration 8. Adaptability 9. Creativity and innovation.

ESSENTIAL SKILLS APPROACH INTRODUCED BY IREX (2022)

IREX (2022) used the essential skills approach to train youth in 18 countries across Africa, the Middle East & North Africa, and The United States.

1. Higher-order Thinking 2. Collaboration 3. Positive Self-concept 4. Adaptability 5. Interdisciplinarity 6. Resilience	7. Entrepreneurial Thinking 8. Communication 9. Empathy 10. Inclusiveness 11. Learning To Learning.

During a great recession in the period of December 2007 to June 2009, young people faced difficulties to get jobs and experience in United States. Unemployment rate for young people especially between the age group of 15 to 24 years increased from 10.7 percent to 18.7 percent during that recession. It means greater competition for the positions available that require young people more skills to stand out from the huge amount of people who faced interview. Therefore, soft skills and personal characteristics were highly emphasized to be succeeded in the interviews. Interestingly, the following were the reasons for youth not are selected by the employers which may be a good lesson for our present youths.

Candidates with …….	**Percent of employers who would not hire the candidates**
Poor personal hygiene	90.8
Inappropriate attire	74.8
Facial piercing other than ears	74,3
Inappropriate footwear	70.8
Visible tattoos	60.6
Unnatural hair colour	39.2

Professional and soft skills identified by Center for Professional Excellence

1. Interpersonal skills 2. Appropriate appearance 3. Punctuality and regular attendance 4. Communication skills 5. Honesty 6. Focus/attentiveness 7. Critical thinking and problem solving	8. Leadership 9. Professionalism 10. Strong work ethic 11. Team work and collaboration 12. Flexibility 13. Preparation for work

professional and soft skills identified by the Laura García-Pérez, Marina García-Garnica, and Eva María Olmedo-Moreno (2021).

1. Sensemaking, 2. Social Intelligence 3. Innovative and Adaptive Thinking 4. Intercultural Competence, 5. Computational Thinking	6. Digital Literacy 7. Multidisciplinarity 8. Design Mentality 9. Knowledge Management 10. Virtual Collaboration.

Skills identified by market (World Bank and education, 2021).

- **Cognitive skills:** Encompass the ability to understand complex ideas, adapt effectively to the environment, learn from experience, and reason. Foundational literacy, numeracy, creativity and critical thinking.
- **Socio-economic skills:** Describe the ability to navigate interpersonal and social situations effectively, and include leadership, team work, self-control, and grit.
- **Technical skills:** Refer to the acquired knowledge, expertise, and interactions needed to perform a specific, including the mastery of required materials, tools, or technologies.
- **Digital skills:** Cross-cutting and draw on all of the above skills, and describe the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately.

Essential skills identified by the Bob Violino

Bob violino identified the following as the essential skills

1. Critical thinking
2. Numeric
3. Deep learning
4. Communication
5. Risk analysis
6. Problem solving and good business intuition.

Essential skills identified through the literature

1. Numeracy	21. Resilience
2. Communication	22. Entrepreneurial thinking
3. Working with others	
4. Continuous learning/ learning to learning	23. Interpersonal skills
	24. Appropriate appearance
5. Reading text	25. Punctuality and regular attendance
6. Writing	
7. Higher-order thinking	26. Honesty
8. Document use	27. Focus/attentiveness
9. Digital	28. Leadership
10. Problem solving	29. Professionalism
11. Collaboration	30. Strong work ethic
12. Adaptability	31. Self-control
13. Creativity and innovation	32. Team work
14. Emotional intelligence	33. Flexibility
15. Resourcefulness	34. Preparation for work.
16. Dependability	35. Sense making
17. Critical thinking	36. Intercultural competence
18. Positive self-concept	37. Design mentality
19. Empathy	38. Knowledge management
20. Interdisciplinarity	39. Risk analysis

Numeracy: Refers to the workers' use of numbers and their capability to think in quantitative terms. This skill is used when doing numerical estimating, money math, budgeting and analyzing measurements.

Communication skills: It refers the ability to effectively express oneself which covers oral, written, nonverbal and listening skills. It includes active listening, knowing how to reach audience, storytelling, making a case, and communicating in a professional way, and reading text. Communication skills are recognized as a gateway to developing other skills. We use this skill to greet people, take messages, reassure, persuade, seek information and resolve conflicts.

Working with others: It refers to the extent to which employees work with others to carry out their tasks. This skill is used when we work as a member of a team or jointly with a partner, and when we engage in supervisory or leadership activities.

Continuous learning/learning to learning: Continuous learning may be learning relevant text books, professional/business magazines, business related reports, or learning from the work or from co-workers. Further it may be possible when we undergo training in the workplace or off-site. All workers are expected to continue learning to keep or to grow their jobs.

Reading text: It refers to the ability to understand reading material in the form of sentences or paragraphs. This skill can be used to scan for information, skim overall meaning, evaluate what we read and integrate information from multiple sources.

Writing: It refers to the ability to write text and documents. Non paper – based writing eg: typing on a computer can also be included in it. Generally we use this skill while we organize, record, document, provide information to persuade, request information from others and justify

a request such as writing texts and writing in documents. This is very much essential for workers to execute their works well.

Higher-order thinking: The ability to see an issue, take in information about it, consider the options available, and organize those options by order of priority to reach a reasonable conclusion. It includes problem solving, critical thinking, and reasoning.

Document use: It involves a variety of information displays in which words, numbers, icons, and other visual characteristics. This skill can be used when we read and interpret graphs, charts, lists, tables, blueprints, schematics, drawings, signs, and labels.

Digital skills: Digital skills are skills needed to understand and process information from digital sources, use digital systems, technical tools, and applications. Digital sources/devices include cash registers, word processing software, and computers to send emails and create and modify spreadsheets. It emphasizes the interplay between technology and society, as well as the importance of understanding the technological principles needed to solve complex problems and face the challenges of a knowledge society.

Problem solving: Problem solving is the ability to identify, analyze, propose solutions, and make decisions. Problem solving helps you to address issues, monitor success, and learn from the experience. Problem-solving is a process of solving any kind of problem. This process is acted upon in some steps. These steps start from identifying the problem and determining the cause of the problem. After the problem and its cause are identified, the next step is to select alternatives for the solution and implement the solutions.

Collaboration: the ability to work effectively and respectfully with diverse individuals. It includes coordination, collaborative decision-making, conflict resolution, negotiation, and communication with teams.

Adaptability: Adaptability is the ability to achieve or adjust goals and behaviours when expected or unexpected change occurs. Adaptability is shown by planning, staying focused, persisting, and overcoming setbacks. The ability to recognize, understands, learn from, and adjust to changes in people, places, and circumstances. It includes the ability to embrace and make the best of the unknown.

Emotional intelligence: Emotional intelligence is a learned ability requiring a systematic experience-based approach to learning. Emotional intelligence consists of specific skills, behaviors, and attitudes that can be learned, applied, and modeled by people to improve personal satisfaction, achievement, and career effectiveness (Nelson and low, 2011).

Resourcefulness: Resourceful is the ability to overcome problems or to make do with what is available to create a solution. This is the ability and creativity to cope with difficulties. It means, able to deal well with new or difficult situations and to find solutions to problems.

Creativity and innovation: Creativity and innovation is the ability to imagine, develop, express, encourage, and apply ideas in ways that are novel, unexpected, or challenge existing methods and norms. It can be defined in terms of the capacity to generate new ideas and solutions (Scott, 2015). It is the production of novel and useful ideas in any domain.

Dependability: Recognizes the relative importance of certain tasks and responsibilities and has the ability to prioritize to ensure that deadlines are met. It refers to actively demonstrates commitment by maintaining a consistent and predictable work schedule. It can be called as reliable. Reliable and dependable in performing job-related tasks, finishing assigned projects, meeting deadlines and appointments.

Critical thinking: Critical thinking involves accessing, analyzing and synthesizing information. It draws on other skills such as communication, information literacy and the ability to examine, analyses, interpret and evaluate evidence. Critical thinking is the process of independently analyzing, synthesizing, and evaluating information as a guide to behavior and beliefs.

Positive self-concept: The ability for a person to demonstrate an understanding of their own strengths and potential. It includes self-awareness, self-confidence, self-efficacy, self-esteem, self-worth, and a sense of well-being and being valued.

Empathy: Refers to the ability to feel and understand what someone else is feeling. It involves putting yourself in another person's shoes to understand their perspective. It includes naming emotions and understanding a person's environment.

Inclusiveness: Refers to the ability to consider or involve diverse people and treat them in a fair and equal way. It includes considering who is present, who is missing, and who something is intende

Interdisciplinary: the ability to draw connections between different types of experiences and information. It includes applying knowledge from one area of life to another.

Resilience: the ability to continue working towards goals and tasks despite difficulties. It includes developing connections with others, seeking support when dealing with challenges, and asking for help.

Entrepreneurial thinking: the ability to see and experience problems as opportunities to create value for oneself and others. It includes understanding the needs and interests of people who are affected by a problem or an opportunity. It requires obtaining available resources, thinking creatively about solutions to a problems, and embracing risk and things that are unknown.

Appropriate appearance: It refers to the state, condition, manner, or style in which a person appears; outward look or aspect.

Interpersonal skills: In terpersonal skills are the behaviors and tactics a person uses to interact with others effectively. It is the employee's ability to work well with others. This skills range from communication and listening to attitude.

Honesty: It refers to the quality of being fair and truthful. It is the fairness and straightforwardness of conduct.

Focus/attentiveness: Focus is the careful attention that is given to something such as a task, or the ability to give full attention to something.

Leadership: leadership skills are the strengths and abilities individuals demonstrate that help the oversee processes, guide initiatives and steer their employees toward the achievement of goals. Leadership skills are the abilities and the capabilities that an individual demonstrates while leading a team, a situation, or life.

Professionalism: Professionalism is commonly understood as an individual's adherence to a set of standards, code of conduct or collection of qualities that characterize accepted practice within a particular area of activity. Professionalism refers to a person's commitment to act in a professional manner in relation to how they look, talk, and present themselves. It also refers to someone's commitment to learning every aspect of their position and performing to the best of their ability when at work.

Strong work ethic: Work ethic is an attitude of determination and dedication toward one's job. Those with a strong work ethic place a high value on their professional success. A strong work ethic allows focusing on tasks, acting in a professional manner, being persistent in trying situations, and

demonstrating responsibility and dependability in the workplace. People with good work ethic are often better employees than those without it.

Team work: Teamwork is "the process of working collaboratively with a group of people in order to achieve a goal. Teamwork is often a crucial part of a business, as it is often necessary for colleagues to work well together, trying their best in any circumstance. Teamwork means that people will try to cooperate, using their individual skills and providing constructive feedback, despite any personal conflict between individuals.

Flexibility: It refers to the ability and willingness to adjust one's thinking or behavior: it is the quality of being easily adapted or of offering many different options.

Preparation for work: It refers to the action or process of making something ready for use or service or of getting ready for some occasion, test, or duty.

Sense making: Sense-making is the ability or attempt to make sense of an ambiguous situation. Sense-making is the process of creating situational awareness and understanding in situations of high complexity or uncertainty in order to make decisions.

Intercultural competence: intercultural competence is the ability to function effectively across cultures, to think and act appropriately, and to communicate and work with people from different cultural backgrounds.

Design mentality: Design thinking is an iterative process in which we seek to understand the user, challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might not be instantly apparent with our initial level of understanding. At the same time, design thinking provides a solution-based approach to solving problems. It is a way of thinking and working as well as a collection of hands-on methods.

Knowledge management: knowledge management is the collection of methods relating to creating, sharing, using and managing the knowledge and information of an organization. It refers to a multidisciplinary approach to achieve organizational objectives by making the best use of knowledge.

Self-control: It refers to the ability to exercise restraint or control over one's feelings, emotions, reactions, etc. Self-control, an aspect of inhibitory control, is the ability to regulate one's emotions, thoughts, and behavior in the face of temptations and impulses. As an executive function, it is a cognitive process that is necessary for regulating one's behavior in order to achieve specific goals.

Risk analysis: Risk analysis is the process of identifying and analyzing potential issues that could negatively impact key business initiatives or projects. This process is done in order to help organizations avoid or mitigate those risks. Risk analysis is the process of analyzing, determining, and defining the risk of danger to government agencies, and businesses, as well as individual.

Success

Success is the ability to achieve personal professional and life goals. This is done through proper planning, hardworking, and will. The successful person who is capable of making the critical, bold decision to reach his/her desired goals.

Qualities required for Success

- Ambition
- Courage
- Commitment
- Willpower:
- Integrity
- Patience
- Drive
- Optimism
- Resilience

Ambition: to be successful, you need ambition. Ambitious people will see that they are capable of doing their best and being the best and what they do.

Courage: most people do not achieve success because of fear. Many people have fear of failing and this is what can stop them from achieving. Some successful people say that failing is the key to succeeding. Having this mindset is a quality required for success. Mistakes and failures can be lessons learn from which can encourage a person to keep going and try to succeed. One can avoid fearful of failing if he/she has courage.

Commitment: success and commitment are interconnected. Most successful people will believe in themselves and their goals for success, they will become committed to achieving them.

Willpower: it is a great trait to have success in life. Those who have great willpower can focus and strive for their goals, solely focusing on achieving.

Integrity: integrity is the practice of being honest and showing a consistent and uncompromising adherence to strong moral and ethical principles and values. It is regarded as the honesty and truthfulness or accuracy of one's actions.

Drive: having the drive and determination to work harder, to keep going, and try new things.

Patience: It refers to the self-control. If you can be more patient (self-control-techniques) it will be helpful to be successful. Patient will help for success when it comes to making any mistakes or having to deal with problems on the journey to success. If one has little or no patience, he/she can't deals with the obstacles very well.

Optimism: Optimism is the feeling of being hopeful about the future or about the success of something in particular. Optimism is an attitude reflecting a belief or hope that the outcome of some specific endeavor or outcomes in general, will be positive, favorable, and desirable. Optimistic attitude is a great trait for success

Resilience: Resilience is a key trait for success. We, in our life, can face obstacles and things that might hinder our success. Resilience can really help us to bounce back from these things quickly.

Traits of successful people

• Adaptability • Emotional intelligence • Perseverance • Discipline • Humble self-awareness • Curiosity • Authenticity • Risk-taking capabilities • Accessibility • Observant decisiveness • Accountability • Genuine respect • Self-reliance • Optimism • Passion	• Viewing failures as learning curves/willingness to learn • A growth mindset • Customer centricity • Leadership • Self-confidence • Aspiration • Drive • Patience • Communication • Integrity • Responsibility • Creativity • Resilience • Connection

Essential skills and traits of successful people are identified from various literatures. It is clearly observed that essential skills that we discussed so far are contributed to the success as these are the traits of successful people. Anyhow, it is important to note that successful people perfectly applied their skills during crisis period. They never feel tension and not failed to take risk whenever they faced any difficulties and obstacles. From this discussion we can conclude that skills are important for success.