UNDERSTANDING BIOSECURITY

AND

QUARANTINE

34th Annual Sessions of the Institute of Biology Sri Lanka

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SUPPLEMENTARY BOOKLET

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Message by the President
Institute of Biology Sri Lanka

International movement of plants and plant materials as well as animals and animal materials is of benefit to a country and it is necessary to allow import of organisms and materials for purposes of scientific and medical research, biotechnology, commerce as well as agriculture. However, such imports can affect human and animal health as well as the agricultural economy of a country in a deleterious manner. Animal and Plant biosecurity and quarantine are the ways in which the risk of transmission of animal and plant pests and diseases during movement of organisms and live and dead materials can be reduced significantly.

Biosecurity has multiple meanings and is defined differently according to various disciplines. The original definition of biosecurity started out as a set of preventive measures designed to reduce the risk of transmission of infectious diseases in crops and livestock, quarantined pests, invasive alien species, and living modified organisms. The term was first used by the agricultural and environmental communities. Starting from the late 1990s, in response to the threat of biological terrorism, biosecurity encompasses the prevention of the intentional removal (theft) of biological materials from research laboratories. However, in any context, all biosecurity measures require the cooperation of scientists, technicians, policy makers, security engineers, and law enforcement officials.

As such, various biosecurity measures are in place in countries for the protection of their own flora and fauna as well as the natural ecosystems. Sri Lanka being a biodiversity hot spot,

should and does have a system in place to exercise extreme care and practice highly stringent measures of biosecurity in order to protect the species rich ecosystems of the country.

One of the most effective methods of biosecurity is achieved through quarantine measures and these are practiced in many countries. Acts and ordinances is a preventive measure that intends to address biosecurity issues effectively whilst increasing international trade of high quality plants and plant materials as well as animals and animal materials. The Sri Lankan government is primarily responsible for development of legislations on biosecurity and quarantine sometimes guided by and based on international legislative practices. However, these legislations have to be changed from time to time so as to strengthen the current biosecurity system in the country. Hence, strong quarantine and biosecurity legislations protect Sri Lanka's unique and highly valued natural ecosystems.

In Sri Lanka, the National Plant Quarantine Service is entrusted with the responsibility of enforcing the implementation of Plant Protection Act No.35 of 1999 and regulations in relation to plant quarantine activities. Through their activities, they facilitate the international movement of healthy plants and plant products for the development of national agriculture and related industries thus achieving their objectives of preventing introduction, establishment and spread of dangerous alien pests within the country, developing treatment technologies to eradicate pests of quarantine importance and most importantly promoting export of healthy plants and plant products.

In addition to plant quarantine measures, the booklet also provides concise accounts on biosecurity measures pertaining to culture and trade as well as quarantine aspects related to international trade of fish and other aquatic animals which include molluscans and crustaceans, domestic and other animals as well as humans.

Although biosecurity has such important implications, awareness of the measures to be undertaken and procedures for ensuring plant and animal health through the system in place in Sri Lanka is not widely known by many. Therefore, the 2013/2014 council of Institute of Biology Sri Lanka decided that it was timely and of significant importance that this information is available to all stakeholders such as researchers, agriculturists, horticulturists, educators, students as well as to any individual who wishes to acquire knowledge in these matters. With this in view, the compilation of this booklet was undertaken and we have been fortunate that the experts of this field consented to share their knowledge and vast experience by writing individual chapters relevant to their expertise. I take this opportunity to commend and appreciate the selfless contributions of the authors who ensured the successful compilation of the booklet voluntarily in spite of their busy schedules. The Bio Diversity Secretariat is acknowledged for realizing the importance of this venture and funding the printing of this booklet. The commitment and dedication of the Editors of the booklet should also be highly appreciated.

Prof. Nelum Deshappriya
President, Institute of Biology Sri Lanka

Editor's Note

We are proud to present to you a booklet that will provide information and understanding on a currently important subject "Biosecurity and Quarantine". "Biosecurity" is a relatively new term that is significantly broader than "quarantine", and together they provide the protection of the economy, environment and human health from the negative impacts associated with entry and spread of pests and diseases. The booklet intends to give an introduction to biosecurity and quarantine, provide information on biosecurity and quarantine of plants, animals and humans and discuss biosecurity and quarantine strategies in Sri Lanka.

We thank the contributors to the booklet: the authors; Ms. R.H.M.P. Abeykoon, Director, Biodiversity Secretariat, Ministry of Environment and Renewable Energy for sponsorship; Dr. D.R.T.G. Ratnayake, the Director General, Department of Animal Production and Health, Peradeniya; Ms. Suramya Ekanayake, Biodiversity Division; and the council of the Institute of Biology. Without their efforts this booklet would never have become a reality. A special thanks to Prof. Nelum Deshappriya who has offered great support, advice and encouragement.

We hope that you will gain information and enjoy reading this booklet as much as we enjoyed compiling it.

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Biosecurity and Quarantine: An Introduction

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Four trends that have increased the risks posed by biological threats to international security in the guise of both human security and health security at present include, (i) advances in science and technology, (ii) the emergence of new diseases, (iii) globalization, and (iv) the changing nature of conflict[1]. Although each trend poses distinct challenges, it is the convergence of these trends that has driven biological threats onto the international agenda.

Biosecurity

A comprehensive definition of the term "Biosecurity" provided by the National Academies of Sciences, USA reads as "security against the inadvertent, inappropriate, or intentional malicious or malevolent use of potentially dangerous biological agents or biotechnology, including the development, production, stockpiling, or use of biological weapons as well as outbreaks of newly emergent and epidemic disease" [2]. This definition is characterized by the inclusion of both deliberate and natural sources of disease outbreaks, the threats posed by pathogens as well as biotechnology, and the vulnerability of humans, plants, and animals to biological threats[3]. Biosecurity is sometimes used interchangeably with the term "biosafety," despite important differences in these terms.

Biosecurity Taxonomy

Biosecurity includes a spectrum of threats posed by (i) naturally occurring infectious disease that include both emerging and re-emerging diseases, (ii) accidental or inadvertent harm generated by research, encompassing unintended consequences of research, laboratory accidents, lack of awareness and negligence, and (iii) the deliberate use of disease as a weapon[4]. A taxonomy of biological threats as proposed by Koblentz[1] categorizes threats based on the source of the threat and the group most at risk from the threat (Figure 1).

<table>
<tr><td rowspan="2">At-Risk Group</td><td colspan="3">Source of Threat</td></tr>
<tr><td>State</td><td>Nonstate Actors</td><td>Nature</td></tr>
<tr><td rowspan="2">State</td><td rowspan="2">Cell 1
Biological warfare (e.g., former Soviet and Iraqi biological weapons program)</td><td>Cell 3a
Biological terrorism (e.g., Aum Shinrikyo, al-Qaida, and 2001 anthrax letter attacks)</td><td rowspan="2">Cell 5
Pandemics (e.g., HIV/AIDS and pandemic influenza)</td></tr>
<tr><td>Cell 3b
Dual-use research (e.g., genetic engineering and synthetic biology)</td></tr>
<tr><td rowspan="2">Individual, Community, or Society</td><td rowspan="2">Cell 2
Biological warfare (e.g., South Africa's apartheid-era biological weapons program)</td><td>Cell 4a
Biocrimes (e.g., puffer fish toxin case)</td><td rowspan="2">Cell 6
Endemic and epidemic diseases (e.g., SARS, cholera, and West Nile virus)</td></tr>
<tr><td>Cell 4b
Laboratory accidents (e.g., Sverdlvosk and Pirbright)</td></tr>
</table>

Figure 1. Taxonomy of Biological Threats [courtesy: G. D. Koblentz (2010)]

Scope of Biosecurity

Comprehensive coverage of biosecurity includes food safety, zoonoses, the introduction of animal and plant diseases and pests, the introduction and release of living modified organisms (LMOs) and their products (e.g. genetically modified organisms or GMOs), and the introduction and management of invasive alien species [5]. Biosecurity therefore, is a holistic concept of direct relevance to the sustainability of agriculture, and wide-ranging aspects of public health and protection of the environment, including biological diversity.

Importantly, the life sciences and biotechnology are characterized by a dual-use dilemma: the facilities, material, and knowledge used for peaceful purposes such as biomedical research and pharmaceutical production can also be used for hostile purposes such as biological warfare and bioterrorism[1]. The rise in emerging and reemerging infectious diseases has resulted of a complex interaction between genetic and biological factors; environmental and ecological factors; and social, political, and economic factors[1] . Climate change can have a significant impact on changing risk of emergency disease outbreaks in plant and animal industries. Globalization has reduced trade barriers and transportation costs which in turn has created a global agricultural supply chain that has introduced more pathways for pathogens to cross borders.

Quarantine

Quarantine refers to a state, period, or place of detention imposed upon building, conveyance, cargo, persons, animals, plants or material on arrival at a port of entry and land border crossings, under enforced isolation, when

suspected of carrying / have been exposed to a dangerous, contagious disease agent to prevent disease from entering a country[6].

The increasing volumes and speed of international trade create greater challenges from introduced organisms, although technological changes in prevention, detection and eradication have helped to reduce some threats. Invasive organisms pose an environmental threat, that imposes major economic impacts on agriculture, human health, and the value of the natural environment. Significant efforts have been invested in quarantine to prevent, detect and control invasive organisms as well as food contaminants.

"There are important issues of risk and responsibility, the appropriate level of protection, opportunities and barriers for trade, preservation of resources for future generations, and the effectiveness, efficiency and fairness of quarantine approaches"[7]. Quarantine must therefore have the highest priority for Government service to the community and economy to overcome threats posed by ever increasing international movement of people and goods[8] .This would in the long run enable human security, health security as well as protection of the environment and of biodiversity of a country.

The ultimate goal of biosecurity is to prevent, control and/or manage risks to life and health as appropriate to the particular biological threat. This is achieved by the development of strong ethical and normative frameworks to compliment legal and regulatory measures that are being developed by states. Quarantine therefore, is a mandatory aspect of an effective state biosecurity framework. Conversely, the international biosecurity framework includes a lengthy list of conventions, treaties and agreements that cover the wide range of sectors encompassing biosecurity.

The Sri Lankan scenario: legislations, policy and regulations

Island biosecurity, as applicable to Sri Lanka, is ensured by functional quarantine and biosecurity acts and ordinances in operation such as the Animal Diseases Act, Quarantine and Prevention of Diseases Ordinance, Plant Protection Act, Plant Quarantine Act, and Flora and Fauna Protection Ordinance. The National Biosafety Policy adopted in 2005 "minimize possible risks to human health and the environment while extracting maximum benefits from any potential that modern Biotechnology may offer". The National Biotechnology Policy for Sri Lanka was approved in 2010. A futuristic addition to this list will be the Biosafety Act that is currently in draft mode with the Legal Draftsman, applicable to living modified organisms or genetically modified organisms resulting from modern Biotechnology.

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Biosecurity and Quarantine

Of Plants

Biosecurity and Quarantine of Plants: Bacteria, Fungi, Nematodes and Viruses

Biosecurity and Quarantine of Plants: Insects

Biosecurity and Quarantine of Plants: Bacteria, Fungi, Nematodes and Viruses

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Plants are essential and integral parts of ecosystems as they produce food through photosynthesis as well as absorb nutrients from soil and store in plant tissues. Most of the energy consumed in terrestrial ecosystems is therefore provided by plants and in the whole food chain, animals depend on them for their food.

Humans are dependent upon plants directly or indirectly as plants provide food, clothing, fuel, shelter and many other necessities of life. More importantly, humankind's dependence on crops is more obvious while livestock survive with grass, fodder and grain that provide people with food and other animal products. On the other hand, plants are useful in cooling the environments, provide conducive environments for human, animals and other plants as well as assist in decreasing global warming. Undoubtedly, plants pose in environmental, economic and social services which cannot be easily valued.

While different plant species have inherent adaptations, defense and protective mechanisms, they are vulnerable to various abiotic and biotic stress factors which intervene and interrupt in establishment, growth, reproduction and productivity. Hence, plant conservation is made necessary for

the whole world as such natural and manmade threats have been well identified.

Biosecurity has emerged as a major global issue as harmful pests and diseases of plants can impact on food safety, trade, market access, market development and sustainability of plant industries. Plant biosecurity is therefore a set of measures designed to protect a crop, crops or a sub-group of crops from emergency pests at national, regional and individual farm levels and at international trade and travel in connection with plant products and processed food.

Similarly, plant quarantine encompasses formal and official control of an organism or a pest of potential economic importance to the area endangered thereby and not yet present there, or present, but not widely distributed. Thus, plant quarantine is aimed at safeguarding agricultural crops and associated products and processed food and other plant species native to a country or region. Further, plant quarantine guarantees in avoiding invasiveness by any living organism which may either destroy or disrupt the native plant communities.

The following procedures are therefore enforced to ensure biosecurity and quarantine of plants.

a. Prevention where the organism is not present in the area yet; measures are limited to imports.

b. Eradication where the organism has been detected and it is supposed to be eradicated.

c. Containment where the organism has established itself in an area and its spread needs to be slowed down.

d. Suppression where the organism has practically established itself in an entire area and the measures need to aim at preventing other areas from being infested.

Hence, plant quarantine becomes a very useful technique in plant protection which uses legislative methods to prevent the spread of undesirable organisms. International quarantine concerns on preventing spread of such organisms from country to country while local quarantine addresses within a country to exclude organisms from smaller or larger areas and to assist in their eradication.

Since the occurrence of quarantine organisms is promoted usually by a wide spectrum of hosts and lack of natural enemies in the new territory, an effective plant quarantine system should require the following criteria.

a. Policies to make clear the intention of the system,

b. Laws to give statutory authority for its implementation,

c. An organization to give effect to the policy, by utilizing the authority of the laws,

d. Manual of Procedures to standardize and clarify the methods employed by the organization.

e. Facilities and techniques to enable the organization to carry out the procedures.

Plant quarantine organisms

Organisms harmful to plants are organisms that are plant or animal origin, viruses, mycoplasmas and other pathogens harmful to plants; plant products such as fungi; bacteria; nematodes; insects and weeds.

Besides, the above organisms causing plant diseases, living organisms such as parasites, marine animals and plants, noxious fish, invasive animals and plants are also declared as prohibited matter under quarantine systems in certain countries and areas owing to their potential threats to plant and tree growth and possible transboundary movements of products of plant origin.

In this text, bacteria, fungi, nematodes and viruses are described.

♦ Bacteria

Bacteria are microscopic, single-celled organisms (Figure 1) and multiply rapidly by simple cell division and absorb nutrients from their immediate environment. They have been found to survive in temperatures above the boiling point and in cold. Their food arena widens from sugar and starch to sunlight, sulfur and iron.

Plant associated bacteria may be beneficial or detrimental. The pathogenic bacteria spread through rain, wind, birds or insects and also through infected agricultural tools, improper disposal of infected plant material, improperly managed plants, introduction of infected plants etc. Bacteria require a wound or natural opening to get inside a plant to cause damage and kill the host cells.

Various bacteria are known to cause diseases, denitrification and desulphurication in agricultural lands and are responsible in food spoiling and poisoning. Nevertheless, they play a significant beneficial role in agriculture too. These include scavenging role by saprophytic bacteria, nitrification by *Rhizobium* bacteria, *Nitrosomanas* and *Nitrococcus, Nitrobacter* and *Nitrocystis* etc. in production of organic manure, preparation of ensilage, production of fuel converting animal dung and other organic wastes, disposal of sewage etc. In addition, dairy industry, production of organic compounds, antibiotics and vitamins, fibre rotting and curing of certain agricultural products are aided by specific bacterial species.

- **Fungi**

Fungi are eukaryotic organisms whose DNA is enclosed in a nucleus (Figure 2). Many of them may look plant-like, but fungi do not make their own food. The pathogenic fungi that cause diseases in plants and their products are economically important due to their potential losses as well as the quality.

Fungi are parasitic on almost all groups of eukaryotic organisms, ranging from cellular amoebae, protozoa, algae;

larger plant groups such as liverworts, mosses, ferns and seed plants; and animal groups. The plant diseases caused by fungi include rusts, smuts, needle casts, leaf curls, mildew, sooty molds, and anthracnoses; leaf, fruit and flower spots; cankers; blights; scabs; root, stem, fruit, and wood rots; wilts; leaf, shoot, and bud galls etc. All economically important plants apparently are attacked by one or more fungi.

Nevertheless, some fungi are beneficial in agriculture where some of the important nutrient cycles and breaking down and decomposing of dead materials depend purely on fungal species and in producing antibiotics and yeast etc. Several fungal species such as *Beuvaria bassiana* and nematode trapping fungi species act as natural enemies and biocontrol agents of insect pests and nematodes respectively.

♦ Nematodes

Nematodes are microscopic round worms that live in soil (Figure 3). Most nematodes are microscopic, free-living and feed on bacteria, fungi, protozoans and other nematodes. Some nematode species feed on plant roots and cause diseases rising to levels that cause economic damage. Reduced plant growth and yield result from the poor root development and function caused by nematode feeding.

Of the plant-parasitic nematodes, root-knot, cyst, root-lesion, lance, dagger, needle, stubby-root, stunt, ring, spiral, pin, stem, bulb, bud and leaf nematodes are economically important plant parasitic nematodes.

Plant parasitic nematodes are simple animals, often with less than 1,000 cells. They possess a stylet mouth part, used to pierce plant tissues, extract juices and secrete material that helps parasitize the plant. Typically, they are long and slender, but when mature, can appear swollen and not very worm-like. Nematodes although small, have a sophisticated nervous system and sensory organs, allowing them to find their host plants, locate the specific plant cells they need, mate and reproduce.

Endoparasites spend most of their lives inside plant tissues while ectoparasites live mostly in the soil without the benefit of protective plant tissues.

The damage caused to the above-ground plant is general in nature and related to root damage. Nutrient deficiency, wilt, stunting, yield depression and sometimes plant death can result. The main diagnostic signs and symptoms of nematode infestations are root cysts or root galls, and distortion of bulbs and corms.

The spread of nematodes from field to field usually involves farm equipment, contaminated plants or seeds, soil or mud transferred on the feet of people or animals, or surface water movement.

Soil dwelling free living groups of nematodes such as *Rhabditis* species play an important role in cycling plant nutrients and converting organic matter in soil. Also, insect parasitic nematodes belonging to order Rhabdita, the bacteria-feeding nematodes i.e. *Steinernema* and *Heterorhabditis* species are

known to cause diseases in insects and potentially being used as insect biocontrol agents in agriculture.

♦ Viruses

Plant viruses and viroids are diverse (Figure 4) and unusual groups of plant pathogens that infect and cause disease in many crop plants. Viruses are infectious pathogens that are too small to be seen with a light microscope (submicroscopic) composed of a protein coat and a nucleic acid core. They carry genetic information encoded in their nucleic acid, which typically specifies two or more proteins. Most viruses are restricted to a particular type of host. Some infect bacteria, and are known as bacteriophages, whereas others are known to infect algae, protozoa, fungi (mycoviruses), invertebrates, vertebrates or vascular plants. However, the viruses that are transmitted between vertebrate or plant hosts by feeding insects (vectors) can replicate within both their host and their vector.

Viruses cause many important plant diseases and are responsible for crop losses and quality. Infected plants may show a range of symptoms depending on the disease which include leaf yellowing, leaf distortion and/or other growth distortions etc.

Owing to the robust cell walls in plants, most plant viruses are transmitted by a vector organism that feeds on the plant or are introduced through wounds during cultural operations like pruning. The major vectors of plant viruses include insects, mites, nematodes and plasmodiophorids. A small number of viruses can be transmitted through pollen to the seed while

many that cause systemic infections accumulate in vegetatively-propagated crops.

Biosecurity and plant quarantine system in Sri Lanka

International Plant Protection Convention (IPPC) declares the lists of plant quarantine organisms as quarantine pests to be regulated by individual countries following the above criteria and through suitable sanitary measures. Based on the IPPC definition of a quarantine pest as 'a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely disturbed and being officially controlled', Plant Protection Act No. 35 of 1999 of Sri Lanka defines a quarantine pest as 'a pest of potential economic importance to any area within Sri Lanka and not yet present there, or present but not widely disturbed and being officially controlled'. Further, regulated non-quarantine pest is defined as 'a non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party'. The lists of regulated pests in Sri Lanka have been prepared by the Plant Quarantine Service of the Department of Agriculture (www.gic.gov.lk/gic/index.php). The names of the pests cover under different categories such as fungi, bacteria, nematodes, insects, mites, phytoplasma, protozoa, viroids, viruses, weeds and unknown aetiology for imposing appropriate and necessary phytosanitary safeguards to the country which will be updated as an obligation to the IPPC.

In addition, regulation of exports and imports of biological organisms for research or commercial purposes is enforced in view of genetic conservation of flora and fauna and intellectual property rights by the Department of Wild life Conservation of the Ministry of Environment and Natural Resources (http://www.dwc.gov.lk).

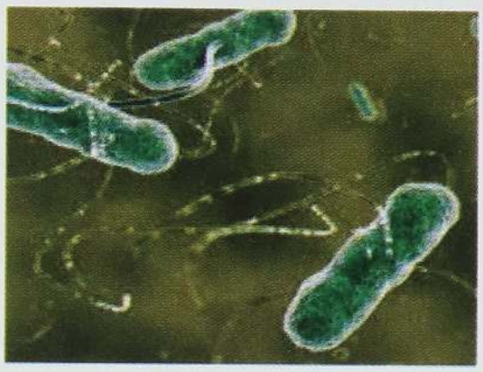

Figure 1. Single-celled plant pathogenic bacteria

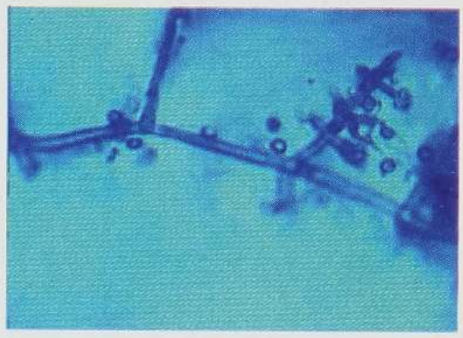

Figure 2. Spores of plant pathogenic fungi

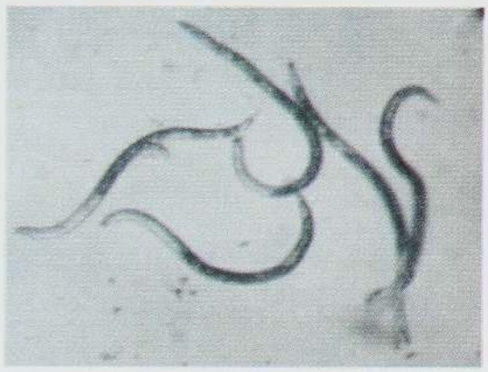

Figure 3. Plant parasitic nematodes with stylets

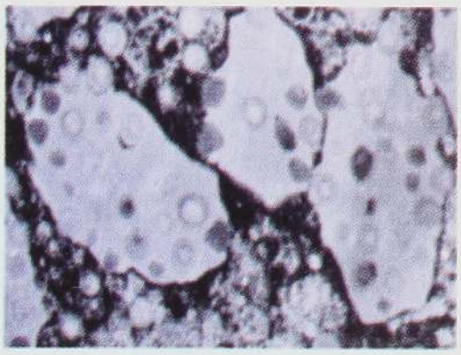

Figure 4. Plural oval shaped virions occluded (occlusion body)

Biosecurity and Quarantine of Plants: Insects

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Insects are small organisms that can spread as pests to many areas of the world by flying, carried by jet streams, typhoon, cyclone and human beings (migration of host plants by trade and tourism, hitchhike in container, box and packaging materials). Expansion in international trade has increased human involvement in introducing new insect pests into the country. Arrival of these new species should be concerned with care because they can rapidly develop into destructive proportions in the absence of natural enemies in the new environment. Plant biosecurity and quarantine plays an important role to prevent introduction and spread of insect pests from other countries and regions and it can be identified as the first important defense because once an exotic pest or disease is established it is difficult or impossible to eradicate.

According to the Plant Protection Act No. 35 of 1999 of Sri Lanka, any biotic agent capable of causing injury or damage or loss to plants or plant products including certain insects, nematodes, bacteria, fungi, phytoplasma, virus, and weeds should be identified as quarantine pests and Minister may declare by a gazette notification the quarantine pests which should not be imported to Sri Lanka as themselves or as infestations of any plant or plant product. The list of quarantine pests may vary from time to time and new species

can be added to the list by a gazette notification in concurrence with the Minister.

Objectives of plant biosecurity and quarantine

1) Control, prevention and eradication of plant pests, plant diseases and noxious plants (weeds)
2) Reduce damage to crop and yield loss caused by pest
3) Facilitate trade of agricultural produce
4) Prevent high quality/ threatened crop materials from being brought out of the country
5) Protect agricultural industries
6) Extend cooperation in the control of the movement of pests in international trade as well as to facilitate the trade

Main responsibilities in plant biosecurity and quarantine

1) Inspection of consignment
   The consignment should be inspected by a plant quarantine officer and or a representative from the Seed Certification and Plant Protection Center of the Department of Agriculture.
2) Surveillance of pest status and pest reporting.
3) Issue of Phytosanitary Certificate
   This is issued to indicate that consignments of plants, plant products or other regulated articles meet specified phytosanitary import requirements at importing / exporting to or from the country.
4) Action on non-compliance & notification.
5) Disinfestations / disinfection treatment

If deemed necessary by the plant quarantine officer, the consignment will be subjected to treatment or other suitable method of disposal. This will depend on the pest infestations detected in the consignment. Phytosanitary treatments for regulated pests should meet in accordance with international standards for phytosanitary measures -ISPM No. 28. Hot water bath, dry heat, vapor heat, cold treatment, chemical dip, micronized dust and fumigation (export consignment fumigation and import consignment fumigation) are the disinfection treatments used at the port of entry in Sri Lanka.

Export Consignments for insects

In Sri Lanka, this responsibility has been entrusted to the quarantine officers of the Seed Certification and Plant Protection Centre of the Agriculture Department. In order to export tea, coir products, wooden items, food items or wheat pellets we should ensure that these commodities are free from Khapra beetle (*Trogoderma granarium*). Other than that export commodities should be free from any regulated insect pests (some insect pests present in Sri Lanka may cause serious outbreaks and hence continuous control programs must be carried out) such as *Stegobium paniceum* and from timber pests.

Khapra Beetle (*Trogoderma granarium*) male and female adult

Stegobium paniceum adult

Import consignments for insects

In the recent past, a number of insect pests, suspected of entering the country from outside, have damaged local agriculture. Vegetables, fruits, seeds and part of plants to be imported should be free from quarantine insects as well as from quarantine bacteria, fungi, nematodes, phytoplasm, and weeds. The Plant Protection Act No. 35 of 1999 lists quarantine species to be inspected for importation goods under different product categories.

For example, in fruit importation, fruits should be produced in an area free from fruit flies of genera *Anastrepha*, *Bactrocera neohumeralis*, *Bactrocera papayae*, *Bactrocera philippinensis* and *Bactrocera tryoni*.

Some examples of the insects that are considered for quarantine at the port of entry to Sri Lanka are described below.

❋ The Papaya mealybug (*Paracoccus marginatus*)

Biology: This is a small, yellowish insect pest attacking papaya leaves and fruits. Its body is generally covered with thick waxy secretion which serves as meal for mainly small and big black ants, therefore, termed as mealybug. The papaya mealybug feeds on the sap of plants by inserting its stylets into the epidermis of the leaf, as well as into the fruit and stem while injecting a toxic substance into the leaves.

Paracoccus marginatus

Papaya mealybug infected papaya fruits

Symptoms: Chlorosis, plant stunting, leaf deformation, early leaf and fruit drop, a heavy buildup of honeydew, and death. Heavy infestations are capable of rendering fruit inedible due to the buildup of thick white wax. Papaya mealybug has only been recorded feeding on areas of the host plant that are above ground, namely the leaves and fruit.

Host plants: Papaya, hibiscus, avocado, citrus, cotton, tomato, eggplant, peppers, beans and peas, sweet potato, mango, cherry, and pomegranate. The papaya mealybug has been recorded on more than 55 host plants in more than 25 genera.

❋ Japanese Maple Scale (*Lopholeucaspis japonica*)

Biology: The adult female lay 35-60 eggs and the crawler larvae affixes themselves on the upper surface of the leaves, along the veins and leaf margin. *L. japonica* hibernates under the bark and leaves of trees in its second larval stage. Scales are also found on the bark of branches and sometimes on fruits.

Lopholeucaspis japonica

Lopholeucaspis japonica infected plant

Damage symptoms: Dieback and premature leaf fall. In the case of light attacks, the scales may be found in cracks in the bark, and are difficult to detect on superficial examination.

Host Plants: Citrus spp., apple (*Malus pumila*), cherry (*Prunus avium*), pears (*Pyrus pyrifolia*), persimmon (*Diospyros kaki*), figs (*Ficus* spp.), outdoor woody ornamentals (*Acer*, *Betula*,

Cytisus, Laurus, Magnolia, Rosa, Syringa, Tilia) and some glasshouse ornamentals (*Camellia*).

❋ Cacao-mosquito (*Helopeltis bergrothi*)

Damage symptoms: Discoloured, necrotic area or lesion around the point of entry of the labial stylets into the plant tissue. The lesion can be elongate or spherical and becomes darker with age as tissue around the stylet puncture dies as a result of salivary secretion by the insect. Curl and deformed leaves and dieback of young shoots. The damage on pods appears as dark, circular lesions that usually harden as scars on the husk.

Helopeltis bergrothi

Helopeltis bergrothi infected fruit

Host Plants: *Anacardium occidentale* (cashew nut), *Camellia sinensis* (tea), Cinchona, *Gossypium* (cotton), *Ipomoea*

(morning glory), *Manihot esculenta* (cassava), *Psidium guajava* (guava), *Ricinus communis* (castor bean), *Theobroma cacao* (cocoa).

✵ Bayberry whitefly (*Lopholeucaspis japonica*)

Biology: The adult is a small whitish-yellow moth-like insect that flits about when disturbed. The adults have a strong ovipositional preference for very young foliage in the "feather" stage. The adult will frequently place white eggs along the leaf margin and eggs will turn black in a few days.

Lopholeucaspis japonica

Lopholeucaspis japonica infected plant

Host Plants: *Camellia sinensis, Chiococca alba, Citrus* spp., *Diospyros kaki, Elaeocarpus serratus, Ficus carica, Gardenia jasminoides, Machilus* sp., *Maesa japonica, Morus alba, Myrica rubra, Prunus mume, Prunus persica, Prunus triflora, Psidium guajava, Quercus serrata, Rhododendron* sp., *Salix babylonica,*

and *Salix gracilistyla*. The most favored hosts are *Citrus* spp. and *Gardenia*.

❋ Banana spotting bug (*Amblypelta lutescens*)

Amblypelta lutescens adult

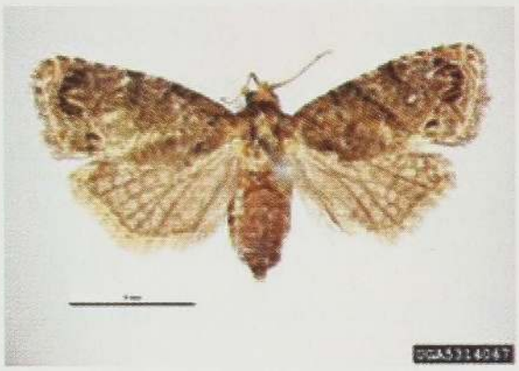
Damage symptoms: Feeds mainly on fruit, but also on the terminal growth of some of its host plants. Fruit damage is generally more common. Green, immature fruits are targeted from just after fruit-set until the fruit starts to mature and accumulate juice or oil. Very young fruit of most crops fall within a few days of being attacked.

Visible external symptoms are black spots and external marks. Fruit must be dissected to detect the lesions formed where the bugs have fed on the seed. As the fruit matures, these lesions may lead to many infections with fungus. This ensures that the fruit will be unmarketable even if bug damage was relatively minor and the fruit might have been damaged at the least edible part.

Host Plants: *Anacardium occidentale* (cashew nut), *Annona squamosa* (sugar apple), *Carica papaya* (papaw), *Citrus*, *Cocos nucifera* (coconut), *Dimocarpus longan* (longan tree),

Eriobotrya japonica (loquat), *Glycine max* (soyabean), *Litchi chinensis* (lichi), *Macadamia integrifolia* (macadamia nut), *Mangifera indica* (mango), *Manihot esculenta* (cassava), *Musa* (banana), *Passiflora edulis* (passionfruit), *Persea americana* (avocado), *Phaseolus* (beans), *Psidium guajava* (guava)

❋ False codling moth (*Thaumatotibia leucotreta*)



Thaumatotibia leucotreta adult

Thaumatotibia leucotreta infected Citrus fruit

Biology: Eggs are laid on the fruit surface, singly or in small numbers. Shortly after hatching, young larvae enter the fruit and feed internally. Fully grown larvae emerge from the fruit and pupate in the soil, in a cocoon of silk and soil fragments. Adult moths have variegated brown and grey forewings with a white spot in the centre, while hind wings are light brown to grey. In most areas of its distribution, the pest is present all year-round with overlapping generations feeding on the available fruits of its wild or cultivated host plants.

Damage symptoms: Damage is caused by larvae feeding inside fruits, nuts, maize ears or cotton bolls. Feeding damage

can also lead to the development of secondary infections by fungi or bacteria

Host Plants: Avocado (*Persea americana*), cacao (*Theobroma cacao*), carambola (*Averrhoa carambola*), citrus species (particularly *C. sinensis* and *C. paradise*), coffee (*Coffea* spp.), guava (*Psidium guajava*), litchi (*Litchi sinensis*), macadamia (*Macadamia ternifolia*), peach (*Prunus persica*), pepper (*Capsicum* spp.), persimmon (*Diospyros kaki*), pomegranate (*Punica granatum*). It is also a pest of field crops such as, beans (*Phaseolus* spp.), cotton (*Gossypium hirsutum*), castor bean (*Ricinus communis*), and maize (*Zeamays*).

T. leucotreta is a polyphagous pest which can feed on more than 70 host plants within 40 plant families.

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Biosecurity and Quarantine

Of Animals

Biosecurity and Quarantine of Fish and other Aquatic Animals

Biosecurity and Quarantine of Pets: Dogs, Cats, Birds

Biosecurity and Quarantine of Fish and Other Aquatic Animals

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Management of spread of pathogens has gained much attention worldwide in recent years. There have also been enhanced international concerns and efforts to develop modern practices of biosecurity in handling of animals, plants and microbes (Anon 2003).

As in other animals, all wild and most cultured fish and shellfish populations carry parasites, bacteria, viruses and other potential pathogens (Arthur 1996). When they are introduced to new areas, it is inevitable that disease agents are also transferred, a fact that has been increasingly reported in many studies describing the international spread of parasites and pathogens (Kanchanakhan 2005). This could mostly happen as a result of unintentional human activities or accidental release (Pulkkinen et al. 2010). Therefore, safe and secured use of aquatic organisms is a key aspect in local and international trade of food and pet trade in order to reduce the risk of pathogens and biological agents which could harm the user, co-workers and the outside environment.

This chapter provides a concise account on biosecurity measures pertaining to culture and trade as well as quarantine aspects related to international trade of fish and other aquatic animals which include molluscans and crustaceans. Hereafter,

the term "fish" is used as a common term to denote all such animals.

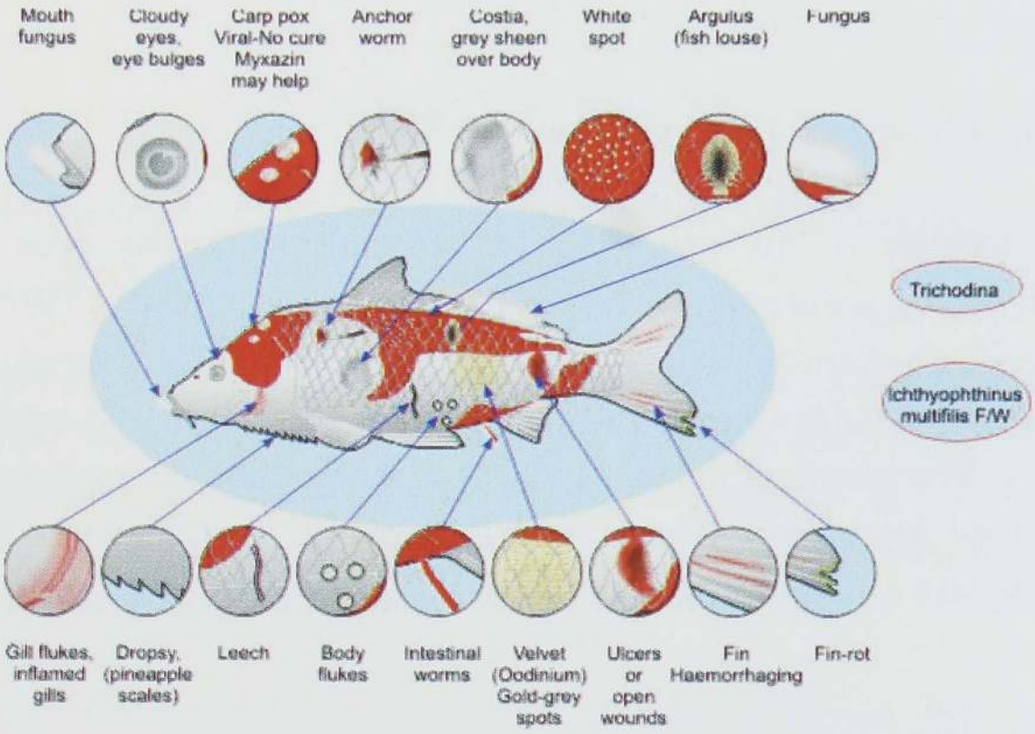
Why biosecurity and quarantine ?

Biosecurity is the protection of animals from any type of infectious agent: viral, bacterial, fungal, or parasitic (WHO 2004). Quarantine in general is defined as a state, period, or place of isolation in which people or animals that have arrived from elsewhere or been exposed to infectious or contagious disease are placed. Thus, through good biosecurity practices, adequate quarantining could be achieved.

Fish pathogens

Fish in captivity similar to their wild counterparts could suffer from a wide variety of diseases. Infections not only pose threat to economic returns of pet and food fish industry but also create disasters in the facility if adequate aquaculture biosecurity measures are not enforced. The following are some of the pathogens which can cause fish diseases (UF/IFAS 2014).

- viruses
- bacteria (eg. *Pseudomonas* sp., *Vibreo* sp.)
- fungi
- unicellular parasites (eg. *Ichthyophthirius* sp.)
- metazoan parasites such as copepods



Biosecurity in ornamental/ food fish trade

Prevention is better than cure! Thus, by practicing proper biosecurity guidelines and quarantine the risk could be minimized. In both of these processes, analyzing potential risk is of vital importance and adequate attention should be paid to "knowing and analyzing possible exposure to danger".

Risk analysis

Risk analysis involves several steps and could be divided into four interrelated categories. Personnel who are engaged in such processes should pay attention to the following.

Category	*Concerns*
Hazard Identification	What are the possible pathogens that could be found in the fish stock/ facility? What are the possible ways that microorganisms could arrive to the fish stocking facility? How to identify the pathogens? Is there a history of infections in the facility?
Risk Assessment	What is the probability of infection? What are the vulnerable stocks and where are they? What would be the result of spreading pathogens?
Risk Management	What are the steps taken to prevent spreading of pathogens? What could be done to minimize disease risk?
Risk Communication	Whom should be informed – management, staff, suppliers, customers? How to inform?

Good housekeeping and general husbandry for enhanced biosecurity in quarantine facilities

Biosecurity obviously should be achieved through developing a proper "hygienic and safety" culture which include the following basic steps.

- Good technical staff and facility
  Ensure that appropriate staff has knowledge on the biology of the fish species and the biology and characteristics of fish diseases, especially those caused by the pathogens of greatest concern. The staff needs to recognize, treat or call for expert

advice and assistance as appropriate. Protocols should be developed to identify and separate sick fish and safe removal and disposal of dead animals.

- Appropriate husbandry
  Proper facilities and stocking tanks with standard sizes made up of recommended materials, adequate ventilation and light and proper waste water elimination practices are essential components in good husbandry.
  Ensure that routine washing and sterilization of equipment eg. nets, buckets etc. is carried out in a proper manner. For disinfections of utensils and equipments iodine-based preparations (iodophors) are commonly recommended. It is a good practice to isolate new fish stocks and acclimatize them. Stocking densities should be properly decided.

- Quality control
  Controlling quality of water, fish feed, general hygiene of the utensils, workers too is essential. Controlling entry of undesirable animals, both wild and domestic as well as unauthorized personnel should enhance quality.

- Routing checks and monitoring
  Monitoring at regular intervals of the health of fish, any signs of ill health, regular sterilizing should be carried out regularly.

Quarantine of fish and other aquatic organisms

Diseases of aquatic organisms obviously lead to financial losses and many other negative impacts in imports and exports of fish and other aquatic organisms. Quarantine and health

certification programs form part of a first line of defense against possible adverse effects resulting from the introduction or transfer of exotic fish and shellfish (Subasinghe 2000). Thus, efficient and up to date national quarantine programs which are recognized and accepted internationally are essential to reduce the risk of introductions of pathogens. If local programmes are strong enough to prevent, minimize and manage spread of pathogens in the fish stocks it would highly aid in enhancing safety and security in international fish trade.

Tasks of fish quarantine

The main task of quarantine is to prevent the introduction and spread of fish pests and diseases into the dissemination between areas within and the exportation from the territory of a country according to prevailed regulations (Wittington and Chong 2007). Where appropriate, separate life-support systems (LSS) with the ability to quarantine fish should exist to ensure efficiency in quarantine procedures. The LSS should be operated in such a way as to exclude disease transfer from one system to another and/or introduction into natural waters (AZA 2007). Quarantine actions in general include the following.

- Inspection, Isolation, Observation, Treatment
- Detention, Refusal and Destruction

Some good quarantine practices have been recorded from zoos and aquaria in North America (Hadfield and Clayton 2011). Accordingly, all institutions who participated in the study practice 30 days or more on quarantine, regular visual

observations, carry out necropsies on mortalities and sometimes perform histopathology on fresh mortalities.

There are only a few studies reporting pathogens in fish in Sri Lanka that includes bacteria and viruses (Sajeevani et al. 2012). Yet with expansion of current ornamental fish trade more studies are warranted specially focusing on potential zoonotic agents. As per the regulations of Sri Lanka, any person/ organization intending to import live animals should obtain prior approval from the Director General of the Department of Animal Production and Health. Health certification, detailed risk assessment and quarantine procedures will follow (DAHP 2014).

To strengthen biosecurity and quarantine practices in the country, adherence to good facility management principles, rapid investigations, providing training and capacity building for staff and raising awareness will maximize the chances of success.

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Biosecurity and Quarantine of Pets: Dogs, Cats, Birds

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Many types of pets such as dogs, cats, rabbits, birds and ornamental fish are considered in biosecurity and quarantine. Biosecurity protects the pet, other pets and humans from infectious diseases via preventing spread of disease causing agents. Quarantine is a method of biosecurity in which the pet is kept isolated for a particular time period during which it is monitored for disease symptoms that can be physiological or behavioural.

Dogs

Dogs are the most frequently exported or imported pets as it is unthinkable for the owner to leave his furry friend behind. Therefore, the pet owner will take any measure in bearing the high cost in exporting or importing, and laborious task of acquiring the required permits. However, if the dog is under any of the following conditions it will not be eligible for export.

• The dog must not be under quarantine restrictions at the time of export.

• The dog must not be under four months of age.

• The dog must not be more than thirty (30) days pregnant nor be suckling young at the time of export.

• The dog must not be a domestic or non-domestic hybrid or any of the following breeds.

Dogo Argentino
Large, white muscular dogs developed in Argentina.

Japanese Tosa
A rare breed of Japanese origin. Large in size with a red, brindle or fawn coloured smooth coat.

Fila Brasileiro
Fila Brasileiro or the Brazilian Mastiff is a large aggressive dog with excellent tracking abilit

Pit Bull Terrier
Medium-sized, solidly built, short haired dog with English origin.

Perro de Pressa Canario

Strong bodied powerful dogs, originated in Canary Islands. A loving and loyal friend if properly trained from an early stage.

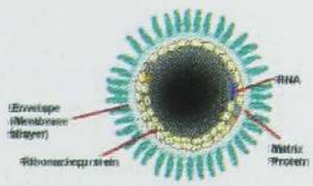
Further, the following biosecurity practices must also be followed.

◆ Dog must be identified by a microchip implant. A microchip implant is an integrated circuit placed under the skin at the back of the neck of the dog. A registration certificate and enrollment form with owner contact information, pet name and description and veterinarian contact information is provided with the implant.

◆ Dog must be tested for the following parasites and diseases, and if positively diagnosed are not eligible for import or export, regardless of treatment.

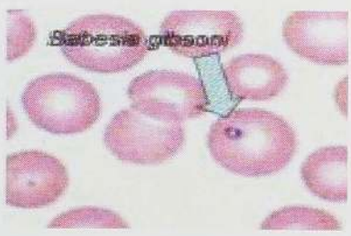
Rabies

Rabies is a fatal disease found worldwide. It is caused by a virus of the genus *Lyssavirus*. Dogs affected by the disease suffer from fearfulness, anxiety, restlessness and agitation which leads to severe aggression, disorientation, paralysis and seizures.



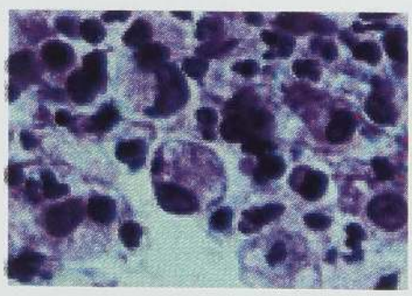
Babesia gibsoni

Babesia gibsoni is a protozoal parasite that is transmitted via ticks. The parasite enters the bloodstream of dogs and causes red blood cell destruction resulting in severe anemia.



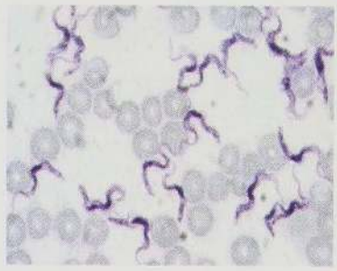
Brucella canis

Brucella canis is a bacterium that causes the disease Canine Brucellosis. The disease causes reproductive failure in dogs and may persist in an animal even after antibiotic treatment.



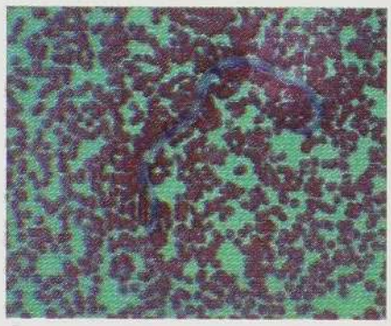
Trypanosoma evansi

This protozoal parasite causes "Trypanosomiasis" in dogs and is seen especially in countries of Asia, Africa and Central and South America. Disease symptoms are fever and parasitaemia, progressive anemia and oedema of the lower parts of the body.



Dirofilaria immitis

Dirofilaria immitis commonly known as the heartworm is a parasitic roundworm spread from host to host through the bites of mosquitoes. Heartworm disease causes cough, difficulty in breathing, abnormal lung sounds, enlargement of the liver and dysfunction of the heart and kidneys leading to death of the dog.



Leishmania

Several *Leishmania* species causes Canine Leishmaniasis in dogs which results in skin lesions, diarrhoea, muscle atrophy, swollen limbs and joints and anemia. Disease is more commonly seen in dogs less than three years of age and older than eight, and certain breeds such as the German Shepherd, Boxer, Cocker Spaniel are more vulnerable.

Cats

Most of the conditions required for biosecurity and quarantine of dogs are also applicable for cats. The following biosecurity and quarantine practices are applied when exporting or importing cats and when housing them in rescue shelters.

• Cats must be identified by a microchip implant as in dogs.

• Cats must not be more than thirty days pregnant nor be suckling young at time of import or export.

• Exporting and importing is not allowed for cats of domestic breed or a non-domestic breed such as the following.

Savannah cat

A hybrid cat resulting from the cross between a serval and domestic cat. A tall, slim cat that is loyal to owners but revert to hissing and growling when confronted by a stranger.

Chausie

A hybrid cat which is known to have originated in Egypt. They have broad, tall ears set high on the head and a coat that maybe solid black, brown or tabby.

Safari cat

A hybrid cat that is very rare.

Bengal cat

Bengal cats result from crossing domestic cats with Asian leopard cats. They are medium to large in size with large spots or distinctive marbling.

Safari cat

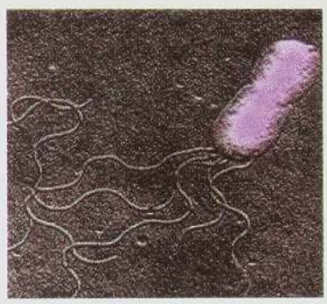
Bengal cat

• The cat must be tested and vaccinated for the following parasites and diseases before being allowed for travel.

Rabies

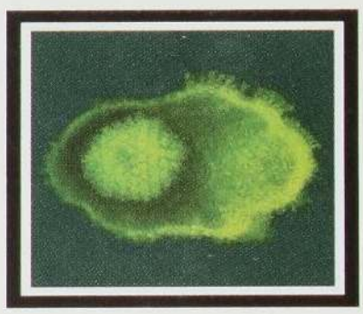
Cat Scratch Disease

A zoonotic disease caused by the bacterium *Bartonella henselae*. The bacterium is transmitted to humans via a cat scratch, bite or lick and symptoms become apparent within 7-14 days. The disease is not fatal but causes symptoms such as swelling of the lymph nodes nearest to the bitten or scratched site, fever, headache and malaise.



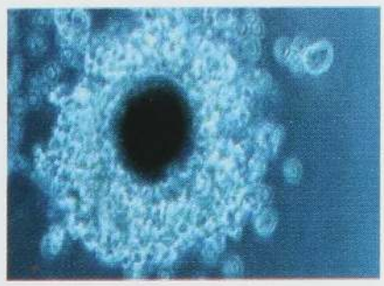
Feline Rhinotracheitis

This disease is caused by feline herpesvirus 1. Cats of all ages are susceptible and Siamese and Burmese breeds are severely affected. Infection causes fever, conjunctivitis, sneezing, nasal and



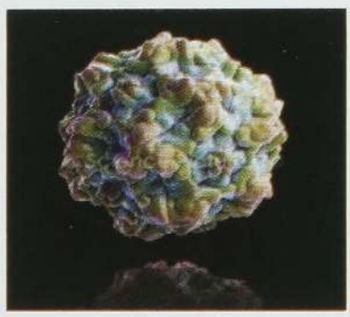
ocular discharges.

Feline Calcivirus



Feline calcivirus infection is a respiratory disease in cats caused by a virus. The virus attacks the respiratory tract, the mouth, tongue, intestines and musculoskeletal system. It is spread in unvaccinated cats in multicat facilities, shelters and breeding catteries.

Feline Panleucopenia



Feline panleucopenia is an infection caused by the feline parvovirus. The virus destroys white blood cells, lymphoid tissue and intestinal epithelium of affected cats and in most situations is fatal. Disease symptoms include depression, lethargy, fever, vomiting and self-biting of the tail, lower back and back legs.

Birds

Birds are kept captive as poultry (duck, geese, fowl, turkeys, quails, etc.) for the production of meat and eggs, and as pets for breeding and selling. Parakeets, parrots, pigeons, doves and raptors are kept as pets and taken with the family when moving to a new home or country. In biosecurity, bird-keepers intend to protect the birds from disease and in conditions of disease outbreak quarantine is carried out. The following biosecurity and quarantine practices are a best way of preventing bird diseases from spreading and conditions of outbreak.

• Aviaries must be kept clean and isolated from other animals, other bird flocks, carcasses, vehicles and humans.

• When bringing a new bird to the property, isolation from resident birds for a period of 14 days is recommended.

• Sick birds must be isolated at the first signs of illness and if notifiable diseases such as the following should exist, veterinary officers or government quarantine officials must be informed.

Avian Influenza

This disease is also known as bird flu and is caused by a virus. Most avian influenza do not infect humans, however some have caused serious infections in people. Birds suffering from this disease lacks energy and appetite; shows nasal discharge; coughing and sneezing; diarrhea and sudden death.

Exotic New Castle Disease (END)

This is a contagious and fatal viral disease that affects all bird species. Birds affected suffer from sneezing, gasping for air, nasal discharge, muscular tremors, drooping wings, greenish diarrhoea and sudden death.

Pullorum Disease

A disease primarily affecting chickens and turkeys that is fatal to young birds. Caused by the bacterium *Salmonella pullorum*. Characterized by weakness, loss of appetite and diarrhoea.

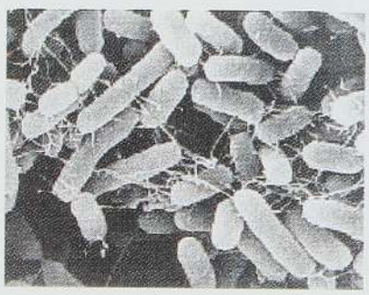
Fowl Typhoid

This disease is caused by the bacteria *Salmonella gallinarum*. Causes weakness, anorexia, poor growth, death and poor feathering of survivors.

Egg Drop Syndrome

A viral disease affecting a wide range of birds such as turkeys, chickens, duck, geese and swans. Causes a loss of egg production due to laying of thin shelled eggs.

Bird Flu Virus



Salmonella pullorum

• When birds are imported an import permit is required and certain parrot species such as the following that are listed as highly endangered under the CITES permit are not allowed for import or export.

Amazona species

Ara species

Cyanoramphus species

Primolius species

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Biosecurity and Human Health

Emerging Infectious Diseases in Sri Lanka

Biosecurity and Living Modified Organisms

Emerging infectious diseases in Sri Lanka

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Introduction

The emergence of infectious diseases that threaten human health has increased dramatically in the last few decades. Pandemics caused by these infections often take a heavy toll of life and are responsible for much concern and panic due to their rapid spread across borders. Besides health, emerging infections also present a grave economic, developmental and security challenge. Developing strategies to effectively manage such acute public health threats is therefore a top biosecurity priority.

Emerging infectious diseases (EIDs) are defined as diseases of infectious origin whose incidence in humans has increased within the recent past or threatens to increase in the near future. These include new, previously undefined diseases as well as known diseases with new features viz, clinical symptoms, vector range, host specificity etc. The AIDS pandemic is a prototypical example of a truly new and emerging infectious disease whose public health impact had not been previously experienced. More rarely, emergence may also be due to the recognition of a new infectious agent of an established condition where infectious origin was not recognized previously. On the other hand, reappearance of a disease which was once endemic but had since been eradicated or controlled would be classified as a re-emerging infectious

disease and is grouped under the EIDs. The influenza A pandemics of 1918, 1957, and 1968 are prototypical examples of re-emerging infections.

Humans are affected by an impressive diversity of pathogens. To date, more than 1400 pathogenic species of viruses, bacteria, fungi, protozoa, and helminths have been recognized out of which, nearly 180 (13%) pathogen species are considered emerging or re-emerging. During the past three decades alone, more than 30 new pathogens have been detected worldwide, many of which have caused serious outbreaks. Although this increase could be attributed to better identification of disease causing pathogens and better reporting, it has been shown that a significant rise in EIDs has actually occurred. A large portion of these EIDs are of zoonotic origin, mostly spilling from wildlife reservoirs, either directly to humans or *via* domestic animals.

Morbidity and mortality caused by these EIDs are enormous. For instance, infectious diseases are responsible for 15 million (26%) of 57 million annual deaths worldwide. Nearly 30 % of 1.49 billion disability-adjusted life years (DALYs) are lost every year to diseases of infectious origin. The figures continues to rise in a surprising manner over the years due to the re-classification of some of the fatal chronic diseases as infectious- eg. cervical cancer (human papillomavirus), Kaposi's sarcoma (human herpesvirus), and *Helicobacter pylori* ulcers, among others. The burden of morbidity and mortality associated with infectious diseases falls most heavily on people in developing countries, and particularly on infants and children, with estimated three million child deaths each year from malaria and diarrhoeal diseases alone. Although precise figures are

lacking, a substantial fraction of the infectious disease burden is due to emerging infectious diseases.

SARS, a novel corona virus, is the first severe infectious disease to emerge in the twenty-first century. The economic losses incurred to countries in Asia alone by the pandemic of SARS were estimated at UD$ 10-30 billion. More recently, in March 2009, cases of H1N1 influenza were first reported in Mexico and within six months, nearly all countries had reported H1N1 virus to the World Health Organization (WHO). Given its far reaching impact, the President of the United States in October had declared 2009 H1N1 influenza pandemic a national emergency. These examples illustrate the magnitude of the threat posed by the emerging infectious diseases to global health security, where health system capacities to cope with unexpected outbreaks of severe contagious diseases are substantially limited.

In the South-East Asia Region (SEAR) infectious diseases are estimated to be responsible for about 40% of the 14 million deaths annually in the region and account for 28% of the global burden of infectious diseases. The Region has witnessed several outbreaks of new and emerging infections. Japanese encephalitis, Chandipora virus, Nipah virus and leptospirosis are examples of emerging infectious diseases that appeared a few years back and have now established endemicity in the region. These infections are gradually and steadily progressing to conquer newer areas and populations.

Many of the infections defined as EIDs are pathogens from newly emerged strains, drug resistant bacterial strains (multi drug resistance tubercle bacillus), those that have entered the

human population recently (Human Immunodeficiency Virus or HIV, Severe Acute Respiratory Syndrome or SARS virus), or are due to RNA viruses (dengue, chickungunya), which have become more capable in overcoming host defenses or adapting to a new host due to the higher mutation rates in their genomes. Dissemination of these EIDs are closely interwoven with human and environmental factors such as rapid and unplanned urbanization, congested working and living environments, changes in population density, antibiotic usage, new agricultural practices, increased contact with wild animals and greater international travel. In addition, in the developing countries, spread of many infections are associated with poor sanitation, contaminated food, inadequate personal hygiene or access to safe water and lack of basic health services.

It is likely that epidemics will continue to occur in the future as they have in the past. Consequently, the successful detection and treatment of emerging infectious diseases is becoming a formidable challenge. Left unchecked, emerging diseases can assume pandemic proportions causing social and economic disruption ultimately becoming endemic. HIV/AIDS, which spread from a remote part of Africa to all other continents and entrenched all over the world, is a good example. In less than 25 years from its first isolation, it has become the fourth leading cause of death worldwide. To effectively respond to these diseases a well-developed strategy and a programme must be implemented through a coordinated and pragmatic plan of action. This paper provides an overview of emerging infections (including re-emerging ones) which are having significant impact on health system in Sri Lanka due to the already experienced high incident rates or due to the possible

threat of disease outbreaks, their determinants, and the way forward.

Dengue viral infection

Dengue fever is one of the most important emerging arbovirus infections in South-East Asia with 1.3 billion people at risk. The disease is caused by a flavivirus with 4 serotypes and is transmitted by mosquito vectors. *Aedes aegypti* is known to be the principal vector although *Ae. albopictus* and species belonging to genus *Ochlerotatus* serve as vectors for more rural infections. The geographical spread of both the mosquito vector and the causative virus has led to the global resurgence of epidemic dengue fever (DF) and emergence of dengue hemorrhagic fever (DHF) in the past 25 years. With the rising levels of endemicity in both urban and peri-urban centers of many tropical and subtropical countries in recent decades, epidemic dengue fever and dengue haemorrhagic fever have emerged as a global public health problem.

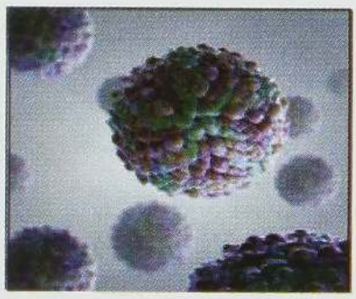
Although dengue infections have been endemic in South Asia for over a century, it rarely caused significant disease outbreaks until the 1980s. However, its epidemiology has dramatically changed over the past two decades, and it is now one of the leading causes of hospitalization and death among children in the region. Further, it is spreading to areas where it has not been reported earlier as evident by its first-time occurrence in Bhutan in 2004. Currently, nine of the 11 Member States (leaving out Nepal and Afghanistan) report dengue incidences. This rise of dengue fever in tropical and subtropical areas of the world is explained by factors such as rapid population

growth, expanding urbanization, inadequate municipal water supplies and inadequate refuse disposal facilities. Nepal and Afghanistan are free of cases of DHF possibly due to geographic and climatic factors, such as high mountain areas in Nepal and little rainfall in Afghanistan, leading to poor vector densities.

The first documented dengue fever epidemic in Sri Lanka occurred in 1965-1966 during which a few sporadic cases of haemorrhagic disease were reported. DEN-1 and DEN-2 serotypes were isolated from these outbreaks. In 1989-1990 Sri Lanka experienced its first epidemic of dengue haemorrhagic fever with 203 clinically diagnosed cases and 20 deaths accounting to a case fatality rate of 9.8%. Although some believe that the emergence of DHF outbreaks in Sri Lanka coincided with the appearance of a new DEN-3, subtype III variant, others have disagreed and shown that the virus strains identified prior to the DHF epidemics and thereafter were similar. The occurrence of the massive DHF epidemic in year 2004 is also thought to be due to yet another change in the predominant circulating virus serotype (from DEN-2 to DEN-3). DEN-3 was also the cause of the epidemics that occurred in India and other countries of the region during this period pointing at its significant impact on disease epidemiology.

Since 1989 major outbreaks have occurred every 3-4 years, while cyclical epidemics are observed in urban centers with a sharp increase in case fatality rates. In 2002, DF/DHF ranked as the third commonest notifiable disease in Sri Lanka (first and second were malaria and tuberculosis). In recent years deaths due to dengue infections have been greater than those due to malaria, with dengue becoming the number one killer mosquito borne infection in Sri Lanka. Initially dengue was

considered an 'urban' disease, where epidemics mainly occurred in densely populated urban settings. However, this pattern appears to have changed with the disease now spreading to rural areas as well. Shifting of circulating dengue serotypes from DEN-2 and DEN-3 (which predominated up to 2010) towards Den-1 may have also contributed to this changing epidemiology. Recently the incidence rates of both DF and DHF increased at a massive scale, approaching a hyperendemic situation within the country.



Structure of the Dengue virus

Leishmaniasis infection

Leishmaniasis is a vector borne disease caused by an obligate intracellular protozoa of genus *Leishmania*. There are around 21 Leishmanial species, which are transmitted by about 30 species of *Phlebotomine* sandflies. The organism develops and multiplies in the gut of the fly and is introduced into the bloodstream of humans after a bite. It can cause a skin infection or a more serious systemic infection. The skin infection, which consists of sores, develops weeks or months after a sand fly bite. The more serious infection, which consists of fever, enlargement of the liver and spleen, and anemia, can take months or even years to develop. Due to the wide spectrum of disease manifestations, leishmaniasis is considered

as a group of diseases rather than a single disease entity with three main clinical forms viz. visceral, mucocutaneous, and cutaneous. Visceral leishmaniasis (VL), the most severe form of the disease, has a mortality rate of almost 100%, if left untreated. Mucocutaneous leishmaniasis develops in a small percentage of persons infected with *Leishmania braziliensis* in Latin America. The cutaneous form of the disease (CL) is the most common and accounts for nearly 50—75% of all new cases that appear worldwide. At its simplest condition, it produces a self- healing ulcer, which appears at the site of the sandfly bite.

The disease is found in 90 tropical and subtropical countries around the world with 20,000 to 30,000 deaths occurring each year. Annually, an estimated 2 million new cases are reported around the world accounting for the 2.4 million disability-adjusted life years. More than 90% of the systemic cases occur in Bangladesh, Brazil, India, Nepal, and Sudan. Cutaneous cases are mainly reported from Americas, the Mediterranean basin, and the Middle East and Central Asia.

In South-East Asia, visceral leishmaniasis is the main form of the disease. The disease is most common in agricultural villages where houses are frequently constructed with mud walls and earthen floors, and cattle and other livestock live close to humans. Until over a decade ago, except for the rare imported cases, leishmaniasis was not prevalent in or reported from Sri Lanka, although in some parts of neighbouring countries like India, Bangladesh and Nepal it represents a major public health problem, with case burden as high as 21 cases per every 10,000 individuals.

In Sri Lanka, the first locally acquired case of CL was reported in 1992 from Ambalanthota. Most of the early cases were soldiers who appeared to have acquired it while on combat duty in the north and east of the country. It is now, however, an established disease in the country with a steady increase in numbers and spread of CL cases, affecting almost all provinces. In 2011 alone 940 cases of CL were reported in Sri Lanka. Most of the patients were from the dry and intermediate zones of the low-altitude areas. This could be due to the abundance of sandflies and their breeding sites in the low-altitude areas. A few cases were also reported with mucosal involvement and even more alarmingly with fatal visceral disease.

In most endemic countries, CL is considered to be a zoonosis with canids and rodents acting as reservoirs. However, a study in the search for animal reservoirs in Sri Lanka has observed rarity of infection in animals. Only two dogs were found to carry *Leishmania* amastigotes indicating dogs being the possible zoonotic reservoirs in Sri Lanka. Further, zoophilic *Phlebotomus argentipes* (that might be acting as the sandfly vector for animals) has also been observed in the lowland areas where human infections were detected. Therefore, the notion that CL has a zoonotic origin in Sri Lanka cannot be ruled out without further investigations.

The causative species of CL in Sri Lanka has been identified as *L. donovani zymodeme MON-37*. *L. donovani* is commonly considered to be responsible for VL. There are reports, however, of *L. donovani* causing CL in several Asian and East African countries at rare occasions. This atypical behavior of *L. donovani* in Sri Lanka, might be related to the vector bionomics and reservoir hosts for this parasite. Further, there is a very

close similarity (genotypic and phenotypic) between the local parasite *Leishmania donovani* MON-37 and the parasite causing visceral leishmaniasis in India (*L. donovani* MON-2), calling for urgent action to avert a potentially major catastrophe of more virulent form of leishmaniasis, particularly the visceral type becoming endemic in Sri Lanka.

Chikungunya viral infection

Chikungunya is an infection caused by *Alphavirus* of family Togaviridae and is transmitted by *Aedes, Culex* and *Mansonia* mosquitoes. It is characterized by fever and musculoskeletal pain, and hence mimics dengue fever and other acute febrile illnesses. Since it was first recognized in Tanzania in 1953, Chikungunya has been identified in many countries in Africa and Asia and is responsible for numerous localized epidemics in these areas. However no major Chikungunya outbreak was observed between 1975 and 2004. The disease reemerged in 2004, first appearing in Kenya, from where it spread to Madagascar, parts of Europe and also to the Indian subcontinent. In 2006, a large outbreak emerged in India infecting more than 1.39 million people within a year. By the end of 2006, Chikungunya had established endemicity in several parts of South-East Asia Region. Since then, millions of cases have occurred throughout countries in and around the Indian Ocean and in Southeast Asia. Transmission has also been documented periodically in temperate areas, such as in Italy in 2007 and France in 2010. In late 2013, the first locally acquired cases of chikungunya were reported in the Americas on islands in the Caribbean. It is postulated that given the high level of viremia in humans and the worldwide distribution of

Ae. aegypti and *Ae. albopictus*, the principal vectors of the disease, the risk of importation of Chikungunya virus into new areas by infected travelers is tremendous.

The first recorded outbreak of chikungunya occurred in Sri Lanka in 1965. However, the first major epidemic occurred after a 40-year interval in November 2006. During 2006 and 2007, more than 100,000 chikungunya cases were diagnosed in Sri Lanka. The most affected districts were Puttalam, Kalmunai, Colombo, Jaffna, Mannar, Batticoloa and Trincomalee. Following these epidemics however, Chikungunya incidences again subsided with a few isolated cases reported occasionally. However, globally, chikungunya fever outbreaks were observed to burn-out after a period of intense transmission, only to recur after years of quiescence. During the inter-epidemic periods, other vertebrates such as monkeys, rodents and birds are known to serve as reservoir hosts. Generally viraemia in animals has no pronounced physical manifestations, although outbreaks could occur in monkeys when herd immunity is low. Recent evidence suggests the presence of such a sylvatic cycle in Malaysia in addition to the urban cycle involving humans. Similarly in Africa the virus is enzootic and is thought to be maintained in a sylvatic cycle involving primates and forest *Aedes* species.

Although it may be too early to conclude whether in Sri Lanka chikungunya fever will soon be eradicated or recur later at a massive scale, it is important to identify and address the systemic and demographic vulnerabilities in preparation for the next outbreak. With the high vector densities prevalence over the country at present, the interplay of host, vector and viral factors will continue to evolve dynamically, requesting a

high-level of vigilance and a robust system of surveillance to allow early detection and swift response to a possible resurgence of the disease.

Avian influenza A (H5N1) infections

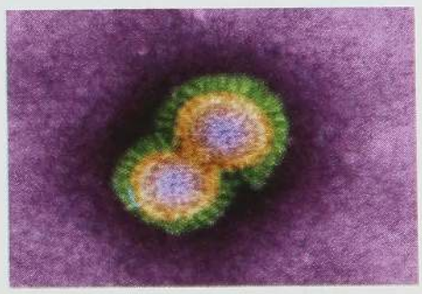
Avian influenza (AI) is an infectious viral disease of birds, especially among wild water fowl such as ducks and geese, often causing no apparent signs of illness. AI viruses can sometimes spread to domestic poultry and cause large-scale outbreaks of serious disease. Occasionally they can cross the species barrier and cause infections in mammals including humans. The A (H5N1) virus subtype, a highly pathogenic AI virus first infected humans in 1997 during a poultry outbreak in Hong Kong, China. Since its widespread re-emergence in 2003 and 2004, this avian virus has spread from Asia to Europe and Africa and has become entrenched in poultry in some countries. Since 2003, H5N1 has killed or forced the culling of more than 400 million domestic poultry and caused an estimated $20 billion of economic damage across the globe before it was eliminated from most of the 63 countries infected at its peak in 2006. However, the virus remained endemic in six nations and outbreaks in poultry have seriously impacted livelihoods, the economy and international trade in affected countries.

The primary risk factor for human infection appears to be direct or indirect exposure to infected live or dead poultry or contaminated environments, such as live bird markets. Although human-to-human spread does occur, it is believed that the virus is relatively inefficient in such form of

transmission. According to WHO figures, since 2003 re-emergence, 650 people had been infected with 386 deaths. Further, approximately 20% of adults who contracted the infection developed respiratory failure and the mortality rate in children who develop AI is reported to be 50%. However, in Sri Lanka, neither the zoonotic disease among poultry nor the cases of Avian Influenza among human caused by H5N1 strain has been reported to date.

As there is a possibility that the H5N1 virus may mutate on its own or re-assort with a human influenza strain to acquire the capacity to transmit efficiently between humans, there is an imminent threat of a severe influenza pandemic. Furthermore, one of the deadliest influenza epidemics that occurred in 1918, killing more than 20 million people worldwide is now thought to be an avian influenza virus strain that had adapted to cause infection in humans. With the growth of global trade and travel, a localized epidemic can transform into a pandemic rapidly, with little time to prepare a public health response. As such, like the rest of the world, Sri Lanka must be prepared to deal with the enormous health, economic and social disruption that would inevitably accompany such a global health emergency.

Promastigote *of Leishmania donovani*



Transmission electron micrograph of H5N1 avian influenza virus particles

Severe acute respiratory syndrome (SARS)

Severe acute respiratory syndrome (SARS) is a serious form of pneumonia caused by the SARS coronavirus (SARS-CoV). It is a rapidly progressive, acute, community-acquired respiratory illness, which spreads to all persons who are in close contact with a patient. The first reported case of SARS originated in Guangdong, China in late 2002 and was identified few months later in early 2003. Within weeks, SARS spread from Hong Kong to infect individuals in 37 countries including countries in America and Europe, and caused an eventual 8,273 cases and 775 deaths within a period of nine months. This was a dramatic example of how quickly world travel can spread a disease.

The disease is thought to be of zoonotic origin as viruses similar to the SARS-CoV virus was subsequently isolated from animals such as civets, raccoon dogs and bats. The unique form of airborne transmission by this virus is thought to be responsible for the rapid spread and also the high incidence among health care workers. Since 2004, there have not been any known cases of SARS reported anywhere in the world. Although the global SARS pandemic has been successfully contained, there is still a potential risk of the same virus or similar viruses re-emerging and causing outbreaks, and therefore preparing for such situations is of utmost importance.

Pandemic influenza A (H1N1) [formally, swine flu]

A novel Influenza A H1N1 virus was first identified on 15th April 2009 in Mexico. Shortly afterwards on 11th June 2009, WHO declared the onset of a pandemic due to this virus which spread from person-to-person in much the same way that regular seasonal influenza viruses spread. The clinical presentation ranged broadly from asymptomatic infection to severe pneumonia, encephalitis and myocarditis. By August 2010, more than 214 countries worldwide have reported laboratory confirmed cases of pandemic influenza A H1N1 with an estimated death toll of 284,500. In Sri Lanka there were 642 confirmed cases and 48 laboratory confirmed deaths during this period.

This new virus carried a unique combination of influenza virus genes that closely resembled North American swine-lineage H1N1 and Eurasian lineage swine-origin H1N1 influenza viruses. Because of this, initial reports referred to the virus as a swine origin influenza virus ('swine flu'). However, further investigations confirmed that the infection had no involvement with exposures to pigs and quickly it became apparent that this new virus was circulating among humans and not among U.S. pig herds despite the observed genetic similarities.

As for today the pandemic H1N1 virus has become a regular human flu virus and continues to circulate seasonally worldwide. Its transmission remains most active in parts of South Asia and in limited areas of tropical South and Central America. In the temperate zone of the southern hemisphere, overall seasonal and pandemic influenza activity remains low, except in South Africa. As the world continues to live under the

constant threat of influenza pandemics, the WHO recognized the need to strengthen influenza laboratories and to establish efficient surveillance systems in member countries. Provided such facilities, the world could be optimistic in controlling future outbreaks of H1N1 pandemic influenza, particularly with a protective vaccine now being available.

Ebola virus disease

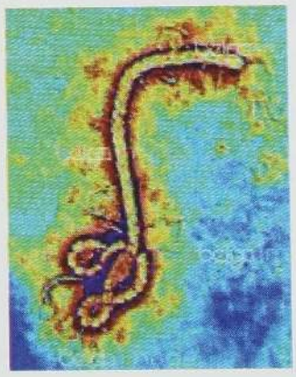
Ebola virus disease (EVD-formerly known as Ebola haemorrhagic fever) is a severe, often fatal illness, with a death rate of up to 90%. It is often characterized by the sudden onset of fever, intense weakness, muscle pain, headache and sore throat followed by vomiting, diarrhoea, rash, impaired kidney and liver function, and in some cases, both internal and external bleeding. The illness affects both humans and nonhuman primates (monkeys, gorillas, and chimpanzees). The disease first appeared in 1976 in two simultaneous outbreaks, one in a village near the Ebola River in the Democratic Republic of Congo, from which the infection was named after, and the other in a remote area of Sudan. Since then EVD outbreaks are known to occur primarily in remote villages in Central and West Africa, near tropical rainforests. The current outbreak has affected four countries in the West African region -Guinea, Liberia, Nigeria, and Sierra Leone. According to the latest World Health Organisation statistics, current ebola virus epidemic has so far killed 1,013 people and infected another 1,848 in West Africa.

Although the origin of the virus is unknown, based on available evidence, fruit bats (Pteropodidae) are considered the likely natural host of the Ebola virus. Ebola is introduced into the

human population through close contact with blood, secretions, organs or other bodily fluids of infected animals. In Africa, infection has been documented through the handling of infected chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead in the villages or in the rainforest. Once acquired, human-to-human transmission is possible through broken skin or mucous membranes, with the blood, secretions, organs or other bodily fluids of infected people. Men who have recovered from the disease can still transmit the virus through their semen for up to 7 weeks after recovery from illness.

In the absence of an effective treatment or a vaccine, it is an urgent necessity to have appropriate biosecurity procedures in place to limit transmission of the virus to prevent further spread of the disease. Reports concerning EVD transmission to health-care workers at hospitals further increase the importance of proper implementation of such measures. Although Sri Lanka at present is faced only with a minimal threat of contacting the deadly virus, the health sector nevertheless should be prepared to deal with any probable outbreak of EVD, especially due to the fact that no immigration screening is performed so far, as WHO is yet to issue such directive.

Transmission electron micrograph of two matured SARS-CoV particles



False-colour transmission electron micrograph of the Ebola virus

Combating emerging infections

Though technological and scientific advances have improved management of infectious diseases in recent decades, a significant number of challenges still remain to be addressed regarding EIDs. These include a lack of basic public health surveillance and response capabilities in many regions, scientific and technological limitations as well as political, trade and intellectual property barriers. These can delay and compromise the effectiveness of EID detection and response efforts and might hinder information-sharing and timely development and distribution of diagnostic tools, vaccines, drugs etc. for newly emerging diseases.

A guiding framework for global efforts for combating EID is given at the revised *International Health Regulations* (IHR 2005), a legally-binding international agreement among member-states of the World Health Organization (WHO). It requires countries to develop a minimum level of capacity to "detect, assess, notify and report" potential outbreaks and other public health emergencies and also outlines the processes for reporting, investigating, and responding to these threats at the international level. The *Asia Pacific Strategy for Emerging Diseases* (APSED) was developed in 2005 by WHO and revised in 2010 to meet the challenges of emerging diseases that pose serious threats to regional and global health security. It provides a common framework to strengthen national and regional capacities within the Asia Pacific Region to manage emerging diseases, improve pandemic preparedness and comply with the core capacity requirements of the International Health Regulations (2005). Thus, APSED serves as a road map to guide all countries in the region ensuring

regional and global health security. Its vision is meant to be achieved via five objectives;

1: Reduce the risk of emerging diseases.

2: Strengthen early detection of outbreaks of emerging diseases and public health emergencies.

3: Strengthen rapid response to emerging diseases and public health emergencies.

4: Strengthen effective preparedness for emerging diseases and public health emergencies.

5: Build sustainable technical collaboration and partnership in the Asia Pacific region.

To provide a focus for operational programme work and to realize these objectives of the APSED, eight focus areas have been identified: (1) surveillance, risk assessment and response; (2) laboratories; (3) zoonoses; (4) infection prevention and control; (5) risk communications; (6) public health emergency preparedness; (7) regional preparedness, alert and response; and (8) monitoring and evaluation. The key components and proposed strategic actions that should be implemented for systematic capacity-strengthening under each focus area are outlined in Table 1.

Although Sri Lanka has one of the best health care systems in Asia, as evident by the very low infant and maternal mortality rates, high vaccine coverage rates and life expectancy, preparedness and the ability of Sri Lankan health care system to handle a sudden epidemic of EID is not convincing.

Formulating a comprehensive national plan to develop and apply established standards for public health infrastructure (laboratory, epidemiological, communications and research) is crucial in order to prevent and contain any possible EID outbreaks in Sri Lanka. This requires a multisectoral approach with enhanced coordination and collaboration among different government departments, agencies and partners. Realization of such agenda would inevitably depend on the availability of sustainable financial investment and political support. Further, without strong mechanisms for international cooperation, no country can ensure its biosecurity at present.

The vulnerability of the human race against emerging infections is enormous. History has shown that it is far less costly, in both human suffering and economic terms, to anticipate and prevent infectious diseases than to react with expensive treatment or containment measures to public health crises. Therefore, our challenge is to stay a step ahead of any new EIDs that may emerge. It can be met only through a national commitment that paves way to strengthened public health infrastructure, human capacity building, inter-sectoral collaboration and international cooperation.

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Table 1. APSED (2010) focus area and key components

Focus area	Key components
1. **Surveillance, risk assessment and response**	▪ Event-based surveillance ▪ Indicator-based surveillance ▪ Risk assessment capacity ▪ Rapid response capacity ▪ Field epidemiology training
2. **Laboratories**	▪ Accurate laboratory diagnosis ▪ Laboratory support for surveillance and response ▪ Coordination and laboratory networking ▪ Biosafety
3. **Zoonoses**	▪ Coordination mechanism for: ○ sharing of surveillance information ○ coordinated response ○ risk reduction ○ research
4. **Infection prevention and control**	▪ National infection prevention and control (IPC) structure ▪ IPC policy and technical guidelines ▪ Enabling environment (e.g. facilities, equipment and supplies) ▪ Supporting compliance with IPC practices
5. **Risk communications**	▪ Health emergency communications ▪ Operation communications ▪ Behaviour change communications
6. **Public health emergency preparedness**	▪ Public health emergency planning ▪ National IHR Focal Point functions ▪ Points-of-entry preparedness ▪ Response logistics ▪ Clinical case management ▪ Health care facility preparedness and response
7. **Regional preparedness, alert and response**	▪ Regional surveillance and risk assessment ▪ Regional information-sharing system ▪ Regional preparedness and response
8. **Monitoring and evaluation**	▪ Country-level monitoring (including workplan and APSED/IHR indicators) ▪ Regional-level monitoring: Technical Advisory Group ▪ Evaluation

Biosecurity and Living Modified Organisms

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Plant and animal breeders have made use of natural recombination and reproductive techniques to improve product yield for years in human history. Two individuals with desired characteristics are selected and facilitated mating between them gives rise to offspring with preferred characteristics over generations. Selective breeding has given rise to almost all the crops and livestock in consumption and pets we adore at some level.

Although rice cultivation was there before 1000 BC in Sri Lanka, population explosion since 1950s has given a new dimension of challenges to farmers as well as the researchers. Since then, Rice Research and Development Institute of Sri Lanka has produced a large number of hybrid rice varieties with increased crop yield and better pest and disease resistance.

Though hybridization techniques have developed over the years and given rise to many significant improvements, recent advances in biotechnology has opened up a new dimension. Living Modified Organisms (LMOs) are a result of modern biotechnology. Defining an LMO or a regularly used synonym, Genetically Modified Organisms (GMOs), have different contexts of usage and thus would have different interpretations in scientific and legal forums. Following excerpt from article

three of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity, states the accepted definition of LMOs. "***Living modified organism*** *means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology.* ***Living organism*** *means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids.* ***Modern biotechnology*** *means the application of in vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection.*" EU directive 2001/18/EC clearly states a definition for GMOs where, "*Genetically modified organism (GMO) means an organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination.*" Further it defines a list of techniques that creates GMOs and techniques that does not qualify to create GMOs. Essentially the two definitions on LMOs and GMOs carries the same root.

Organisms are manipulated at genetic level to have higher production efficiency where high yield with low input are achieved with low land usage. Most modified products carry higher nutritional value which is aimed at decreasing nutrient deficiencies in the developing countries. Better taste and longer shelf life are added advantages for the consumer. Insecticide and disease, drought and winter tolerance are also achieved through genetic modifications. The seasonal availability of certain food items has also been removed for year-round

production. Overall efficiency makes them greener in production compared to the non-GM counterparts.

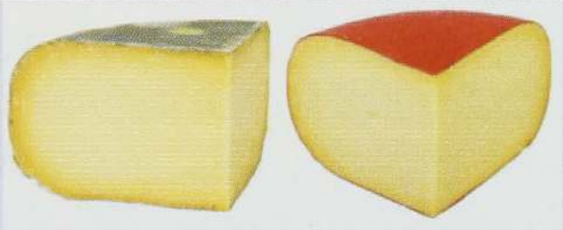
Corn is consumed in millions of metric tons each year and the demand is increasing steadily. Many genetically modified corn varieties are in production and corn based products are found in most food variants consumed all over the world. Insect resistance, drought resistance, herbicide tolerance and improved nutrient production are some of the traits incorporated in to corn and the tolerance genes come from a number of different species. For an example, BT-Corn expresses one or more proteins from the soil bacterium *Bacillus thuringiensis* which makes them poisonous to some insects. Further the drought tolerance is created by inserting cspB gene from the soil microbe *Bacillus subtilis* in corn.

GM crops have created a public uproar against modified organisms at genetic level. Consumer public fear for long term health problems that range from cancers to allergies. It has been shown that transgenic soy contains Brazil nut allergens and the rise of food allergies is widely attributed to GM food. It is difficult to sieve a single dimension in this debate where the sociopolitical motives, media exaggerations and scientific evidence have parts to play in concerto while latter seems to have the least priority. Recent report on the ill effects of GM corn-pollen on caterpillars of monarch butterflies and the controversial French study on cancer onset in GM corn-fed mice over their life time, which was published and then retracted by the publisher, has provided scientific evidence for the case against LMOs. Although most of LMO producers claim that their organisms are sterile and would not breed naturally or will be contained from natural habitats they

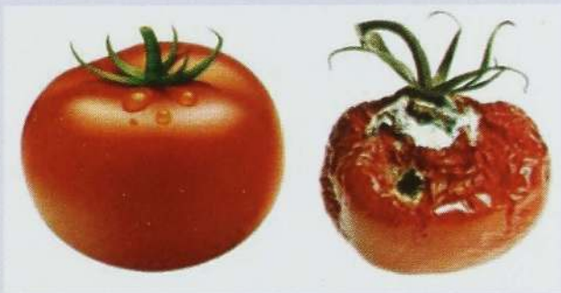
constantly pose a threat to the biological diversity of a country. Public reports on glow fish (Zebra fish inserted with fluorescent protein) naturally breeding where in production they are made sterile and transgenic, Atlantic salmon experimentally hybridizing under natural conditions with wild brown trout and the detection of the modified growth genes in offspring where they outcompete both wild and GM fish expounds the threat posed on native flora and fauna of a country. GM crops are widely blamed for being a threat to the seed sovereignty of farmers. Small farmers are prohibited from exchanging seeds and laws are enforced to buy seeds from the companies and produce seed registration documents of their crops. This movement decreases the genetic variation among plants and high use of GM crops can contaminate the wild germ plasm.

The debate over living modified organisms stems from awarding the FDA approval to the first LMO. To establish a legal framework on LMOs the Cartagena Protocol on Biosafety to the Convention on Biological Diversity was formulated. This international agreement ensure the safe handling, transport and use of LMOs that may have adverse effects on biological diversity and human health. It was adopted on 29 January 2000 and entered into force on 11 September 2003. One hundred and sixty seven countries have enforced this protocol where Sri Lanka is one of the earliest to become a signatory in year 2000 and enforced in 2004. Accordingly the Ministry of Environment and Natural Resources has produced a National Biosafety Framework in 2005 with the objective of assessing the current status of biosafety in Sri Lanka with a gap analysis and formulate policies, legislations and administrative systems to enforce biosafety and biosecurity regulations in the country.

It is noteworthy that there are many products coming in to market from the field of biotechnology that are not covered by the Cartagena Protocol. These need to be evaluated as individual cases and taken under a national biosecurity regulation.



Traditional rennet for the production of firm cheese is extracted from frozen stomachs of slaughtered unweaned calves. Rennin, the major component of rennet, is now largely produced through bioengineered fungi and bacteria since the current demand for cheese cannot be met with traditional rennet.



Flavr-Savr™ tomato is the first genetically modified, FDA approved crop for commercial sale since 1993. Polygalacturonase production was inhibited in these tomatoes thus they retain natural color and taste. Though the traditional tomatoes need to be harvested unripe and need to be artificially ripened, Flavr-Savr™ tomatoes could be vine ripened without compromising their shelf-life.

AquAdvantage Salmon are genetically modified Atlantic Salmon with a growth hormone gene from Chinook Salmon made active by a promoter from an Ocean Pout. They grow to the market size in 16 to 18 months compared to three years taken by conventional salmon and grow year-round.

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Biosecurity and Quarantine Strategies in Sri Lanka

Biosecurity and Quarantine Strategies for Plants

Biosecurity and Quarantine Strategies for Animals

Plant and Animal Biosecurity and Quarantine Acts and Ordinances in Sri Lanka

Biosecurity and Quarantine Strategies for Plants in Sri Lanka

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Sri Lanka has an outstanding biodiversity because of its tropical climate, soil, topographical variations, geographical location and its striking biogeographic history. Floristic wealth of Sri Lanka is also extraordinary despite of small land area having 4,143 flowering plant species in 214 plant families and 1,522 genera and of which 930 species are endemic.

If a new pest is introduced to the country that pest could be well established and spread due to absence of natural enemies, with the favorable environment for its lifecycle and availability of wide range of host plants. According to the Plant Protection Act No. 35 of 1999, a pest is an "any biotic agent capable of causing injury or damage or loss to plant or plant product and shall include weed" and in the same act weeds are defined as "a plant, competitive, persistent, pernicious and interfering with man and his activities". Recently we lost thousands of coconut palms due to the newly introduced Weligama coconut wilt disease in Southern part of the country. Papaya Mealybug (*Paracoccus marginatus*) is another newly introduced serious pest which destroyed almost all the papaya cultivation of the country. Not only the papaya plantations but also papaya mealybug infested to several flower plants, weeds, forest plants and vegetable crops due to availability of wide host range.

Pest introduction may occur due to natural or manmade pathways. The natural pathways include wind, storms and flood and cannot be prevented by enforcing laws. However, manmade pathways such as aircraft and ships, passengers, baggage, imported plant and plant products, planting material and seeds, cargo and containerize cargo, packing material, mail and garbage could be prevented by enforcing laws and regulations. To protect our natural resources, it is essential to have an official preventive mechanism to prevent introduction, spread and establishment of alien plant pest in to country. The National Plant Quarantine Service (NPQS) belonging to the Department of Agriculture is the authorized and legally based government institute which implements the plant quarantine activities of Sri Lanka. The NPQS is headed by Additional Director and plant quarantine units are established in each entry points at sea port Colombo, Bandaranayake International Airport Katunayaka, Mahinda Rajapakshe Airport Mattala, and another unit will be opened soon in sea port at Hambantota. Another plant quarantine unit is located at Gannoruwa, Peradeniya. NPQS has facilities to certify plant quarantine treatment and has a well established testing facility for insect pests, mites, plant nematodes, plant pathogens and weeds. The plant quarantine activates are conducted according to the national and international rules and agreements. The Plant Protection Act No. 35 of 1999 the regulation under therein and the International Plant Protection Convention (IPPC) are governing the plant quarantine activities of Sri Lanka.

International Plant Protection Convention (IPPC)

International Plant Protection Convention (IPPC) is an international plant health agreement which was established in 1952 governing the plant quarantine activities of the contracting parties. The purpose of IPPC is to secure common and effective action to prevent, spread and introduction of pests of cultivated and wild plants and to promote appropriate measures for their control. Currently it has 181 members including Sri Lanka. The IPPC provides a framework and a forum for international cooperation, harmonization and technical exchange between contracting parties dedicated to these goals and it involves the collaboration of National Plant Protection Organizations (NPPOs) and Regional Plant Protection Organizations (RPPOs). The NPPO is defined as an official service established by a government to discharge the functions specified by the IPPC. NPQS is the responsible official organization of Sri Lanka to discharge the functions specified by the IPPC. In 1990s the newly formed IPPC Secretariat and the NPPOs started the work of formulating International Standards for Phytosanitary Measures (ISPM) to harmonizing and equalization of the plant quarantine activities of the member countries. At the moment IPPC has developed 36 ISPMs and examples for some important ISPMs are ISPM1 "Principles of plant quarantine as related to international trade", ISPM5 "Glossary of phytosanitary terms", ISPM7 "Export certification system" ISPM15 "Guidelines for regulating wood packaging material in international trade" and ISPM12 "Guidelines for phytosanitary certificates" etc.

Plant Protection Act No. 35 of 1999

The Director General of Agriculture (DGA) is the in- charge of general administration of this Plant Protection Act and the DGA nominates plant Quarantine (PQ) officers as "Authorized Officers" to perform this act. The authorized officers have reasonability to enter to any land, water reservoir, vehicle, vessel, air craft, building, container and conveyance used for keeping, storing and transporting plant or plant products. The Authorized Officer has the responsibility to give the order to take the necessary steps in taking to avoid the spreading of pests there in inspection, detention and treatment recommendation or if clearance cannot be granted, it should be destroyed, re-ship or re-export. If the importer does not agree to that decision, they can appeal to the secretary of the Ministry of Agriculture within 72 hours. Therefore, the plant quarantine officers have responsibility and authority to protect biodiversity of the country by applying the plant quarantine strategies.

According to IPPC and the Plant Protection Act No. 35 of 1999 the regulation under therein National Plant Quarantine Service is adopting the following strategies for the Biosecurity of Sri Lanka.

- **Embargo**

According to the Plant Protection Act No. 35 of 1999, importation of some plants and plant products are either prohibited or restricted. The planting materials of Coconut, Rubber, Tea, Rice and Cacao are some examples for prohibited plants. These prohibited plants could only be imported in

restricted amount for research by the respective research institutes with the special approval of Director General Agriculture.

Restricted plant materials could be imported by fulfilling the prescribed plant quarantine requirements. Therefore, before importing the restricted plant material it is compulsory to get a plant import permit issued by NPQS except for plant products for consumption. The plant import permit document contains conditions that must be observed for the importation of plant or plant products allowed with the plant species and also it contains the variety requested, amount or quantity and the address of importer and exporter. These import conditions depend on the risks involved with the item, the purpose of the importation and country of origin etc. The importer must obtain an import permit before importation of each and every consignment and it should be sent to the exporter to fulfill the import conditions before shipping the consignment. When importing either prohibited or restricted plant or plant product, the consignment must be accompanied with a phytosanitary certificate issued by the plant quarantine authority (NPPO) of the exporting country, according to the import conditions of importing country. The phytosanitary certificate is the document which certifies that the consignment is free from injurious pests after thorough examination of the materials and it should be issued conforming to the model appended to IPPC. Phytosanitary certificate must be issued 14 days prior to the shipping of the plant material.

Direct imports of any plant, plant material, plant product or seeds from Tropical America are prohibited to Sri Lanka for

fear of introduction of the extremely dangerous South American Leaf Blight (SALB) pathogen of rubber. Importation of soil is strictly prohibited. Fresh fruits are not allowed to be imported as air cargo and Banana, Guava and Mango are strictly prohibited to be imported because of the risk of fruit fly introduction.

- **Post-entry Quarantine**

The main purpose of post-entry quarantine is to detect and observe latent development of symptoms of pests, specially for diseases, for a period of time in a pest proof plant house with double doors and closed drainage. Imported oil palm seeds from Ivory Cost should be kept 6 months in a pest free plant house under PQ supervision.

- **Inspection at the port of entry**

When importing any plant or plant product it needs to fulfill the entry condition. The basic plant quarantine requirement is that the consignment must be free from pests. Therefore PQ officers at the entry point conduct registration and inspection procedures to ensure the pest status of the consignment.

When a consignment arrives to the port of entry, all the entry documents should be submitted to the PQ officers and they will check the documents (import permit, phytosanitary certificate, bill of leading, ISTA (International Seed Testing Association) certificate, non-GMO certificate, relevant health certificate and fumigation certificates) and if the documents are in order they register the import consignment and appoint a PQ officer to inspect the registered consignment. If the inspected consignment is free of pests the plant quarantine

clearance would be granted but if the inspected consignment is contaminated it would be detained for detailed examination, subjected to treatment, post-entry quarantine, destruction or re-export. If the consignments are not fulfilled to the international phytosanitary standards, the importing country has authority to send noncompliance to the exporting country. Special consignments like seed potatoes, beetle nuts would be inspected at the seaport, random sampled for laboratory testing and the consignment will be detained till the test report is received.

- **Field inspection during growing season**

According to the special import permit conditions the exporting country should conduct inspection of the field during the growing season. If the requested pests have a chance to contaminate within the growing period, the PQ authority of the exporting country should have to inspect the field before phytosanitary certification.

The PQ authority of the importing country also can visit to inspect the fields at the growing season to confirm the application of appropriate plant quarantine mashers before the shipment. PQ authority of Sri Lanka has conducted time to time visits to inspect seed potato fields of importing country to fulfill this inspection.

- **Treatment as a condition of entry**

Any practice applied to a commodity to eliminate the pest is defined as a treatment and the phytosanitary treatment is an official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalization.

According to the IPPC, NPPO is responsible for the disinfestations or disinfection of consignments of plants, plant products and other regulated articles moving in international traffic, to meet phytosanitary requirements. Phytosanitary requirements may be physical treatments (irradiation, hot-water, hot air, vapour heat and cold treatments etc.) and chemical treatments (fumigation and pesticide application).

As the wood packaging materials pose threat to forest coverage all the wood packing materials must be treated according to the guidelines given by the ISPM 15. Therefore debarked wood with specified tolerance for remaining bark must be treated with methyl bromide fumigation or forced hot air treatment and application of the mark must always be under the authority of the NPPO.

Cold treatment is reducing the temperature of the host commodity below the thermal tolerance limits of the target pest for certain period of days, depending upon the life cycle of the pest. This treatment is used to kill insects, especially fruit flies in regulated articles as a prerequisite for movement of those articles out of fruit fly infested areas. The import pre - cooling condition for importation of fresh fruits to Sri Lanka is cold storage of fruits at temperatures of 2°C to 3°C for a period of 14 to 16 days.

Shipments like herbal tea, Palmira fiber, sworn timber etc should be fumigated at the exporting country before shipping according to the permit condition of Sri Lanka. Seed imported to the country may be treated with recommended fungicides.

The PQ officers play an important role to protect biodiversity of Sri Lanka, not only PQ officers but also all the citizens have a responsibility to protect biodiversity by following the plant quarantine regulations of the country.

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Plant Protection Act NO.35 of 1999

Biosecurity and Quarantine Strategies for Animals

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In Sri Lanka biosecurity of animals is maintained by preventing disease causing agents from entering to where farm and pet animals are present.

Mainly biosecurity measures are concerned with minimizing movement of people, vehicles and equipment where animals are kept and implementing best practices in hygiene in situations where there is direct contact with animals.

In quarantine new animals are isolated from others to check or minimize the entry of exotic diseases in to the country. During isolation proper biosecurity measures should be adopted.

In Sri Lanka quarantine strategies are carried out in two stages,

1. Post-import Quarantine Surveillance
2. Pre-export Quarantine Surveillance

Post-import quarantine surveillance is done in the quarantine stations at Colombo and Katunayake for large animals such as horses, cattle and pet birds which are monitored for a minimum of thirty days. Post-import quarantine surveillance for day-old chicks and ornamental fish are conducted on farms, while for pets such as dogs and cats health monitoring is done at the owner's premises.

During the quarantine period animals are monitored for disease symptoms and conditions and if recorded positive are destroyed according to the Animal Disease Act No. 59 of 1992. However, if the animal does not show any disease conditions they are released to the owners after completing the quarantine period.

Pre-export quarantine surveillance is done for large animals, pet birds and ornamental fish at selected farms with proper biosecurity conditions. Quarantine surveillance is carried out for a minimum of thirty days. If they do not show any disease condition permission is granted for exporting.

Plant and Animal Biosecurity and Quarantine Acts and Ordinances in Sri Lanka

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Plant and animal biosecurity and quarantine acts and ordinances have been established in order to reduce risk of transmission of animal and plant pests and diseases that can harm human health and the agricultural economy of the country. These acts and ordinances intend to improve biosecurity issues while increasing international trade of high quality plants and plant materials as well as animals and animal materials. The Sri Lankan government is primarily responsible for the development of legislations on biosecurity and quarantine and they cover a range of activities relating to biosecurity incidents involving domestic and international movement of animals and plants. Primarily, written legislations were introduced to Sri Lanka in the British period. These legislations have been changed from time to time to strengthen the current biosecurity system in the country and hence strong biosecurity and quarantine legislations currently protect Sri Lanka's unique and highly valued natural ecosystems.

The Animal Diseases Act

Short title: The Animal Diseases Act: No. 59 of 1992

Long title: "An act to provide the control and prevention of contagious diseases of animals; for the control of the import

and export of animals, animal products and veterinary drugs and veterinary biological products and for matters connected there with or incidental thereto"

Date of commencement: 13th November, 1992

Administration of the Act: The director of animal protection and health, a veterinarian who has registered under the veterinary surgeons and practitioners Act, No. 46 of 1956. In addition there may be a number of deputy directors and assistants.

Abstract: The act introduces measures that should be taken by public bodies and holders of animal for the control and prevention of animal diseases in Sri Lanka. The act is divided into 4 parts and each part consists of several sections; (i) Administration of the act (section 2): appointment of the director general and other authorized officers, (ii) Control and prevention (section 3-20): matters concerned with control and prevention of animal diseases - sealing of infected area and premises, immunization of animals in infected areas, destruction and disposal of animal infected or come into contact with diseased animals, seizure of harmful animal products, testing of animals for detection of specified disease, registration of premises as an animal clinic, animal house and hatchery, issuance and validation of licenses for veterinary drugs and veterinary biological products and keeping and maintaining stud bull and donor cow, (iii) Import and export of animals, animal products, veterinary drugs and veterinary biological products (section 21-34): regulations related on exportation and importation on animals, animal parts and animal products; issuance of permits for the import of an

animal product and prohibition on import without a permit, power of minister to declare any port or other place as being infected with disease and power of ports authority to refuse entry to vessels carrying any infected or diseased animal, issuance of health certificates and a minimum 30 day quarantine period for the imported animals, declaration of protective zones at areas adjoining to quarantine stations, establishment of veterinary drug control authority, issuance of permits to import animal semen and embryos and export of any animal, animal product, veterinary drug, veterinary biological product, semen or embryos; (iv)General (section 34-40): offence and penalties, regulations, interpretations

The above 4 sections are completed by 3 schedules, i.e. Contagious diseases, Certificate for the import/export of animal products or veterinary biological products intended for international trade and Zoo sanitary certificate for the import/export of animal and semen or embryo of animals.

The Plant Protection Act

Short title: The Plant Protection Act: No. 35 of 1999

Long title: "An act to make provision against the introduction into Sri Lanka and the spreading therein, of any organism harmful to, or injurious to, or destructive to, plants, and for the sanitation of plants in Sri Lanka"

Comments: Repeal of the Plant Protection Ordinance (Chapter 447)

Date of commencement: 7th October, 1999

Administration of the Act: The Director General of Agriculture shall be in charge of general administration of the act. In addition there may be a number of authorized officers to give effect to the provisions of the act.

Abstract: An act implemented to protect plants and plant products from any harmful organisms, to control introduction and spreading of harmful organisms in the country. The act is divided into 7 parts and each part consists of multiple sections - (i) Administration of the act (section 2-3): appointment of the Director General and other authorized officers; (ii) Procedure (section 4-6): the Director General or any other authorized officers have jurisdiction to check any premises that suspects the existence of a pest or pests. Any authorized officers not to be deemed trespasser by reason of entry. Director General and authorized officers have power to carry out measures or execute work and recover the expenses incurred; (iii) Quarantine pests (section 7): plant or plant product infested with any quarantine pest cannot be kept, planted, released, delivered or otherwise the Director General has jurisdiction to take necessary action to control such pest or pests; (iv)Appeals (section 8-9): appeal panel consists of scientists in the field of entomology, plant pathology, microbiology, virology or nematology. Any persons who resent the decision of the Director General can appeal in writing within seventy-two hours of the communication, however, the decision of the appeal panel will be the final verdict; (v) Offences and Penalties (section 10-11): matters regarding offences and penalties; (vi) General (section 12-14): matters required for making regulations of the act, repeal of chapter 447; (vii)Interpretation (section 15): explaining the meaning of some terms in the act; "genetically modified", "importer", "living

modified", "minister", "occupier", "organism", "owner", "pest", "plant", "plant product", "premises", "quarantine pest", "secretary" and "weed".

Coconut Leaf Rot Disease (CLRD)

Weligama Coconut Leaf Wilt Disease (WCLWD)

The Coconut Leaf Rot Disease and the Weligama Coconut Leaf Wilt Disease were identified as critical diseases in Galle, Matara and Hambantota districts in the Southern Province of Sri Lanka, since it impactedsignificantly on the coconut industry. Hence the Coconut Leaf Rot Disease and Weligama Coconut Leaf Wilt Disease have been declared as diseases affecting the coconut industry in Sri Lanka by the gazette notification no. 1542/7 of 24th March 2008 under the Plant Protection Act 35 of 1999.

Quarantine and Prevention of Diseases Ordinance

Short title: Quarantine and Prevention of Diseases Ordinance: Chapter 553

Long title: "An ordinance to make provision for preventing the introduction into Sri Lanka of the plague and all contagious or infectious diseases and for preventing the spread of such disease in and outside Sri Lanka"

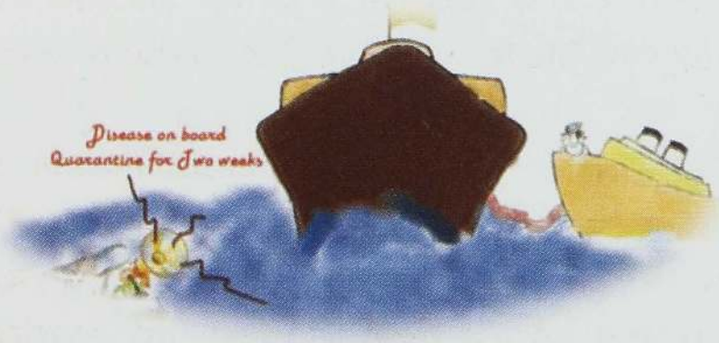
Comments: Minister makes or repeals regulations of original ordinance of the Quarantine and Prevention of Diseases Ordinance, Chapter 553, from time to time in order to prevent introduction and spreading of disease within the country or outside the country.

Date of commencement: 9th February, 1897

Administration of the Act: The Minister and other authorized officers are responsible for giving effect to the provisions of the Act.

Abstract: The ordinance makes legislations relating to prevent introduction and spread of all infectious diseases in and outside Sri Lanka. The act consists of 13 sections - (i) Short title; (ii) Regulations: The Minister makes and revokes regulations from time to time for the purpose of preventing of disease in and out of the country; (iii) Matters in respect of which regulations may be made: legislation and regulations on placing and inspecting aircraft, vessels and boats arriving at any port and placing persons or goods coming or brought in aircrafts, vessels and boats; isolation and removal of all cases of diseased and disease persons; cleansing, disinfection and

closing of places where insanitary; (iv) Offences: any person omit regulations made under this ordinance or hamper other officers to carry out regulations shall be guilty; (v) Punishments: the person being *guilty* of an offence and *liable* on summary conviction *before* a *Magistrate* to a fine or imprisonment; (vi) Duties of inspectors and police officers: any persons seen or found committing regulations comes under this ordinance can be arrested without warrant; (vii) Presumption: any person in charge of a diseased person in a house presume to have existed in such diseased, until he shows no potential for diseases;(viii) Officers are public servants within the meaning of the Panel Code; (ix) Security for expenses of certain persons landed from aircrafts or vessels; (x) Any person refusing to leave Sri Lanka can be removed by a police officer specially authorized in writing by the Inspector-General of police (xi) Execution of regulations may be delegated to local authority (xii) Regulations to be published in the Gazette; (xiii) Interpretation: explaining the meaning of "aircrafts", "disease", "diseased" and "goods".



Fauna and Flora Protection Ordinance (FFPO)

Short title: Fauna and Flora Protection Ordinance: Chapter 469

Long title: The long title of original Fauna and Flora Protection Ordinance (Chapter 469) was repealed and the following long title has been adopted.

"An ordinance to provide for the protection and conservation of the fauna and flora of Sri Lanka and their habitats; for the prevention of commercial and other misuse of such fauna and flora and their habitats, for the conservation of the biodiversity of Sri Lanka; and to provide for matters connected therewith or incidental thereto"

Comments: The principle ordinance (Act No 2 of 1937), Chapter 469 has been amended from time to time.

Date of commencement: 1st March, 1938

Administration of the Act: The Minister and the other officers are responsible for giving effect to the provisions of the Act.

Abstract: The act has 6 parts and each part consist of several sections - (i) National reserves and sanctuaries (section 2-11): regulations related with establishing and management of national reserves, natural reserves, national parks, intermediate zones and sanctuaries; substitute of sections 2- 3A, 5-10 of the principle enactment and insertion of new section 5B of the principle enactment; (ii)Tuskers, elephant, buffalos ,deer and fowl (section 12-29): matters related with protection of tuskers,

elephant, buffalos, deer and fowl in areas outside national reserves and sanctuaries; replacement of sections 12 and 17 of the principle enactment; repeal of section 14 and 22 of the principle enactment; substitution of sections 19,22,22A 23,24 and 28 of the principle enactment; (iii) Birds, beasts and reptiles (section 30-41): offences relating to birds, beasts and reptiles; substitution of sections 30, 31A, 31B, 34, 35, 39 and 41 of the principle enactment; (iv) Flora (section 42- 48): regulations related to protection of plants; substitution of sections of sections 42, 45,46 and 48 of the principle enactment; insertion of new section 46A on certificate of proof by competence authority; (v) Miscellaneous provisions (section 49-55): legislations on issuance of licenses to carry out business involving animals and matters regarding protection, management, conservation of flora and fauna in the country; substitution of sections of sections 49, 50, 53C, 54,55 and 55A of the principle enactment; insertion of new sections 52B, 55B, 55C and 55D on matters concerning timber felling in national reserves and sanctuaries; (vi) General (section 56-70) : matters related on issuance of licenses and permits, offences and penalties, making general regulations, appointment of officers and committees and interpretations and savings; substitution of sections of sections 57, 58A, 60, 64, 66, 66A, 66B, 66C, 66D, 67, 67B 67D , 67F, 68, 71 and 72 of the principle enactment; insertion of new sections 57A, 60A, 60B, 60C, 60D, 60E, 68A and 68 B of the principle enactment; repeal and replacement of sections 65 on wild life preservation funds; Substitute of schedules i, ii, iii, ivA and v with new list of protected and non-protected flora and fauna.

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