

## **BIOLOGICAL DISASTER**

- Biological disaster is caused by biological agents
- Biological agents are living organisms (bacteria, virus, fungus) and their toxic products that can kill people, livestock, and plants or cause epidemics, health impacts, property damage, social and economic disruption, or environmental damage.
- It is important to recognise that biological disasters may be naturally occurring events (e.g. an influenza pandemic) or a deliberate event (biological terrorism).
- Biological Disaster leads to mass mortality due to the entry of virulent microbes into a congregation of susceptible people living in a manner suited to the spread of infection.

## What is a Biological Disaster?

A biological disaster is the disaster, which causes sickness and fatalities in human beings and animals at mass scale, when they come in contact with biological hazards in the form of living organisms, such as, bacteria, virus, fungi, etc. Destruction of crops and plantation also falls within the ambit of biological disasters.

All communicable diseases, either of human beings or livestock are potential biological disasters. They spread widely, affect huge number of people in communities, sometimes across the geographical limits of provinces and nations.

Biological Disasters have caused havoc in human settlements in the form of communicable disease since times immemorial. Plague savaged Europe for 300 years from 1300s to 1600s. About 20-25 million or about one-third of the population was eliminated by the deadly epidemic across the continent. Plague broke out in Surat in Gujarat in 1994.

**For your information**

## Causes of Biological Disasters:

The microorganisms like bacteria, virus, and toxins act as agents in transmitting diseases leading to disasters, below are few major causes

- **Vulnerable Animal Farms:** The productivity, health, and welfare of livestock and animals in farms are not addressed by the insurance and financial sectors as they are not seen as sentient beings. These unsustainable farming to spread of diseases affecting both people and animals, loss of wildlife habitat due to encroachments and illegal wildlife trades.
- **Zoonotic Diseases:** Zoonosis diseases are transmissible from animals to humans and vice versa. Majority of emerging infectious diseases of humans (including Ebola, HIV, influenza) have an animal origin.
- **Trans Boundary Animal Diseases:** The majority of Trans Boundary Animal Diseases are viral in origin, which can spread diseases and cause subsequent problems between countries on trade, production, and economy.

**For your understanding, no  
need to memorize line by line**

**Table.1 Prominent Pandemics in History and Implications**

Sl. No.	Prominent Pandemics	Death (lakh s)	Years Lasted	Outbreak Period	Major Regions Affected
<b>A</b>	Plague of Athens	1	3	430-427 BCE	Greece
<b>B</b>	Antonine Plague	50	15	165-180 CE	Roman Empire
<b>C</b>	Plague of Justinian	3	1	541-542 CE	Europe, West Asia
<b>D</b>	Black Death	250	3	1343-1346	Worldwide
<b>E</b>	Great Plague of London	1	1	1665-1666	Great Britain
<b>F</b>	Great Plague of Marseille	1	3	1720-1723	France
<b>G</b>	Russian Plague	1	2	1770-1772	Russian Empire
<b>H</b>	3 <sup>rd</sup> Cholera Pandemic	10	21	1839-1860	Worldwide
<b>I</b>	Russian Flu	10	1	1889 - 1890	Worldwide
<b>J</b>	6 <sup>th</sup> Cholera Pandemic	8	24	1899-1923	Worldwide
<b>K</b>	Spanish Flu	500	2	1918-1920	Worldwide
<b>L</b>	Asian Flu	20	1	1957-1958	Worldwide
<b>M</b>	Hong Kong Flu	10	1	1968-1969	Worldwide
<b>N</b>	Covid-19	38	1.5	2019-Present	Worldwide

**Source:**
<https://www.livescience.com/worst-epidemics-and-pandemics-in-history.html> ;
**For your understanding**

Three categories of biological agents are as follows:

### CATEGORY- A

- Easily disseminated or transmitted person-to-person
- High mortality
- Require special action for public health preparedness
- Viruses: *Variola major* (SmallPox), *Filo viruses* (Ebola, Marburg).
- Bacteria: *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague).
- Toxins: *Clostridium botulinum toxin* (botulism)

### Category – B

- Moderately easy to disseminate
- Moderate morbidity and low mortality
- Require improved diagnostic capacity & enhanced surveillance
- Viruses: Alphaviruses
- Bacteria: *Coxiella burnetii* (Q fever)
- Toxins: Staphylococcus enterotoxin B

## CATEGORY C

These third highest priority agents include emerging pathogens that could be engineered for mass spread in the future -

- Easily available
- Easily produced and spread
- Morbidity and mortality rates and major health impact.
- Viruses: *Nipah, hantaviruses, tick borne hemorrhagic fever viruses, tick borne encephalitis viruses, yellow fever*
- Bacteria: *Multi-drug resistant Mycobacterium tuberculosis*

Methods of biological agent transmission and delivery in humans are as follows:

- Through air – as aerosols, the most veritable route of disseminating biological agents.
- Food and water contamination - Contamination of food and water with biological agents is another method of dissemination of biological agents.
- From person to person - Person-to-person transmission of biological agents is yet another route via which infectious agents can cause disease and death in a target human population.
- Through vector: Zoonotic delivery of biological agents using rodents and insect vectors could be another method of bioterrorism. However, there are a limited number of biological agents that can be disseminated by this means.

## Methods of bio-logical agent dissemination and delivery:

- ☐ Aerosols -
- ☐ Animals -
- ☐ Food and water contamination-
- ☐ Person to person-

- Aerosols - biological agents are dispersed into the air, forming a fine mist that may drift for miles. Inhaling the agent may cause epidemic diseases in human beings or animals.

- Animals – some diseases are spread by insects and animals, such as mice, flies, mosquitoes, and livestock.

- Food and water contamination – some pathogenic organisms and toxins may persist in food and water supplies. Most microbes can be killed, and toxins deactivated, by cooking food and boiling water. Most microbes are killed by boiling water for one minute, but some require longer.

- Person-to-person - spread of a few infectious agents is also possible.

- Humans have been the source of infection for smallpox, plague, etc.

- ☐ The widespread of infection is caused by spore dispersal in the air. Small Pox spreads by aerosols, Typhus and Plague spread through vectors such as lice, fleas, rodents and mosquitoes.

Various categories of biological agents potential enough to cause mass casualties:

1. Anthrax
2. Smallpox
3. Plague
4. Botulinism Toxin
5. Dengue
6. Cholera

## Cholera

- Cholera is an infectious disease caused by a bacterium called *Vibrio cholerae*. The bacteria typically live in waters that are somewhat salty and warm, such as estuaries and waters along coastal areas.
- People contract *V. cholerae* after drinking liquids or eating foods contaminated with the bacteria, such as raw or undercooked shellfish.
- There are hundreds of strains or “serogroups” of the cholera bacteria: *V. cholerae* serogroups O1 and O139 are the only two strains of the bacteria known to cause outbreaks and epidemics.
- These strains produce the cholera toxin that cause cells lining the intestines to release increased amounts of water, leading to diarrhea and rapid loss of fluids and electrolytes.
- A single diarrhea episode can cause a one-million-fold increase of bacterial numbers in the environment, according to the National Institute of Allergy and Infectious Diseases.



## Treatment :

Cholera is an easily treatable disease. Cholera requires immediate treatment because the disease can cause death within hours.

Rehydration - The main treatment for cholera is fluid and electrolyte replacement using a simple rehydration solution, oral rehydration salts (ORS). Intravenous fluids. Antibiotics. Zinc supplements.

## Anthrax

- ☐ Anthrax became widely known in 2001 when it was used as a biological weapon.
- ☐ Anthrax is a serious infectious disease caused by gram-positive, rod-shaped bacteria known as *Bacillus anthracis*.
- ☐ It has been a scourge of cattle and other herbivores for centuries. Anthrax illness is more common in farm animals than people.
- ☐ Anthrax is not contagious through indirect or direct contact by touching, inhaling, or ingesting anthrax spores. Once anthrax spores get inside your body and activate, the bacteria multiply, spread, and produce toxins.
- ☐ The inhalation form of disease is highly lethal.
- ☐ The spores can maintain for decades they can be milled into ideal particle size for optimum infection of human respiratory tract.

### Humans can get anthrax through:

- ☐ exposure to infected domestic or wild grazing animals
- ☐ exposure to infected animal products, such as wool or hides
- ☐ inhalation of spores
- ☐ consumption of undercooked meat from infected animals (gastrointestinal anthrax)

The symptoms of anthrax exposure depend on the mode of contact.

### Cutaneous (skin) contact :

- Sore is developed that's itchy. It usually looks like an insect bite. The sore quickly develops into a blister. It then becomes a skin ulcer with a black center. This doesn't usually cause pain.

### Inhalation :

- The symptoms of inhalation anthrax include: cold symptoms, sore throat, fever, achy muscles, cough, shortness of breath

How is anthrax treated?

- treatment consists of antibiotics and the anthrax vaccine.

## SMALLPOX

- ❑ Smallpox is caused by variola virus.
- ❑ Smallpox is contagious.
- ❑ Transmission of this virus can occur by aerosol, by direct contact with the infected patient.
- ❑ The first smallpox vaccine was created in 1758. However, the disease continued to infect and kill people on a widespread basis for another 200 years.
- ❑ The World Health Organization (WHO) implemented a strict vaccination standard in order to slow the infection rate.

### Symptoms :

- flu-like symptoms occurred - high fever, chills, headache, severe back pain, abdominal pain, vomiting, rashes on the face, hands, forearms, and the main part of the body.
- The person would be highly contagious until the rash disappeared. Later, the rashes would develop into abscesses that filled with fluid and pus. The abscesses would break open and scab over. The scabs would eventually fall off, leaving pit mark scars. Until the scabs fell off, the person remained contagious.

### Treatment :

By repeated vaccination programs, the variola virus (smallpox) could be completely eradicated.

## Plague

- Plague causes by a bacterium coccobacillus *Yersinia pestis*. This bacterium is found in animals throughout the world and is transmitted to humans by the bite of infected fleas.
- The risk of plague is highest in areas that have poor sanitation, overcrowding, and a large population of rodents.
- There are three basic forms of plague:
  - i) Bubonic plague - following the bite of an infected flea, plague bacilli are carried via the lymphatic to the regional lymph nodes where they multiply exponentially.  
Bubonic plague is the most common type. It causes buboes, which are very swollen and painful lymph nodes under the arms, in the neck, or in the groin.
  - ii) Septicemic plague - bacteria enter the bloodstream directly and multiply there
  - iii) Pneumonic plague - the bacteria spread to or first infect the lungs. It is the most lethal form of the disease. When someone with pneumonic plague coughs, the bacteria from their lungs are expelled into the air. Other people who breathe that air can also develop this highly contagious form of plague, which can lead to an epidemic.
- Plague is devastating. It is transmissible person to person when in its pneumonic form.

### BIOLOGICAL DISASTER: A STUDY OF PLAGUE AT SURAT

- ☐ Surat in Gujarat was hit by plague epidemic in 1994.
- ☐ Approximately six hundred people died.

## BOTULINUM

- Botulism is a serious muscle-paralyzing disease caused by a nerve toxin made by the bacterium *Clostridium botulinum*.
- These bacteria are in soil throughout the world and produce spores that can survive in a dormant state until favorable conditions allow them to grow.
- The toxins produce serious disease in human beings. The toxin can't be passed between people.
- Symptoms from an attack would start within 12-72 hours.
- Toxins are natural and non-volatile. If you eat foods containing the toxin, it is likely that you will become ill. Generally do not penetrate intact skin, which happens in case of chemical weapons.

### The three main types of botulism are:

- Foodborne – caused by eating botulism toxin in food if the tainted food items were not heated or were not completely heated. A food attack could start problems within 2 hours or as long as 8 days after eating the toxin.
- Intestinal – most commonly seen in infants who have the bacteria in their intestinal tract.
- Wound – caused when wounds are infected with spores that produce the toxin.

### ☐ Common problems:

Double vision, blurry vision, swallowing problems, speaking problems, muscle weakness etc.

Prevention : Bulging containers of canned and preserved foods should not be opened and foods with off-odors should not be eaten or even tasted.

## EBOLA

- ❑ Ebola virus / *Zaire ebola* virus is one of the four *ebola viruses* known to cause disease in humans.
- ❑ It has the highest case-fatality rate of these ebolaviruses
- ❑ The first outbreak occurred on 26 August 1976 in Yambuku.
- ❑ The symptoms resembled malaria, and subsequent patients received quinine.
- ❑ Transmission has been attributed to reuse of unsterilized needles and close personal contact, body fluids and places where the person has touched.

### SYMPTOMS OF EBOLA

- Bleeding from mouth ,nose, ears.
- Increased sensitivity to pain on the skin.
- Genital swelling. memorize only first few
- Conjunctivitis. (symptoms), not all
- Rashes all over the body.
- Reddening of roof of the mouth.

## Dengue

- Dengue: It is an acute, infectious, mosquito- borne tropical disease, causes hemorrhagic fever.
- It is caused by the female aedes aegypti mosquito bite, which transmit the dengue virus to human.
- Dengue fever is also known as “breakbone fever” caused by the mosquito bite.
- "breakbone fever", comes from the associated muscle and joint pains.
- Dengue outbreaks are occurring in many countries of the world. Dengue is common in more than 100 countries around the world. Forty percent of the world’s population, about 3 billion people, live in areas with a risk of dengue.

Tropical regions are :-

- ☐ Indian sub continent
- ☐ Mexico
- ☐ Africa
- ☐ Southern China

### SIGN & SYMPTOMS

- Fever ( more than 105 )
- Headache
- Muscle, joint pain
- skin rash ( appear 4-5 days after fever )
- Pain behind eyes
- Nausea memorize only first few
- Vomiting (symptoms), not all
- Mild bleeding

### PREVENTION

- No vaccine
- Insecticide sprays & foggers (indoor & outdoor)

## Major Events across the Globe

### Plague pandemics :

- There have been three great world pandemics of plague recorded, in 541, 1347, and 1894, each time causing devastating mortality of people and animals across nations and continents.
- The three great plague pandemics had different geographic origins and paths of spread.
- In 541, the Justinian Plague started in central Africa and spread to Egypt and the Mediterranean.
- The Black Death of 1347 originated in Asia and spread to the Crimea then Europe and Russia.
- In 1894 - the third pandemic originated in Yunnan, China, and spread to Hong Kong and India, then to the rest of the world. The plague eventually reached India via naval trade routes and was spreading through Bombay by the summer of 1896.

### Cholera — 1817–1824 :

- ❑ It is also known as first Asiatic cholera pandemic or Asiatic cholera. Though cholera has been around for many centuries, the disease came to prominence in the 19th century, when a lethal outbreak occurred in India.
- ❑ It is known to have begun in the city of Calcutta and spread throughout Southeast Asia to the Middle East, eastern Africa and the Mediterranean coast over the time. Hundreds of people died during this pandemic. This pandemic affected almost every country in Asia.
- ❑ There have since been numerous outbreaks and seven global pandemics of cholera. Each year, cholera infects 1.3 to 4 million people around the world, killing 21,000 to 143,000 people, according to the World Health Organization (WHO).



## Spanish Flu (1918-1920):

- It is one of the deadliest influenza pandemic humanity has ever witnessed. It spread worldwide during 1918-1920.
- It is estimated that about 500 million people or one-third of the world's population became infected with this virus. Many indigenous communities were pushed to the brink of extinction.
- This influenza pandemic is more accurately called "The Great Influenza" by modern historians.
- The pandemic was caused by an H1N1 virus with genes of avian origin. Although there is not universal consensus regarding where the virus originated.
- In the United States, it was first identified in military personnel in spring 1918.
- It was called the Spanish flu not because it originated in Spain but because it was World War I, and Spain was the only country being honest about the toll the pandemic took on the country unlike others in the Allied and Central Powers nations.
- Spain was one of only a few major European countries to remain neutral during World War I.

## Coronavirus — 2019-2020

- ❑ COVID-19 can be traced back at least to Dec. 31, 2019, when the government in Wuhan, China, confirmed that health authorities were treating dozens of cases of pneumonia from an unknown cause.
- ❑ Eight days later, China identified a new type of coronavirus. The first coronavirus case in the United States was confirmed on Jan. 21, 2020.
- ❑ The World Health Organization declared COVID-19 a pandemic on March 11, 2020, saying it is the first pandemic caused by a coronavirus.

### Coronavirus disease (COVID-19) advice for the public:

COVID-19 is spreading in your community, stay safe by taking some simple precautions, such as physical distancing, wearing a mask, keeping rooms well ventilated, avoiding crowds, cleaning your hands

### Others –

- ❑ Slow , evolving epidemics such as HIV/ AIDS – socio-economic disruption.
- ❑ Emerging and re-emerging diseases , notably SARS, avian influenza, Nipah virus, leptospirosis, dengue, Chikungunya, and Rickettsial are also posing serious threats.

## PREVENTION OF BIOLOGICAL DISASTERS

### ☐ Vulnerability Analysis and Risk Assessment:

Vulnerability analysis and risk assessment needs to be carried out at the macro and micro levels for existing diseases with epidemic potential, emerging and re-emerging diseases, and zoonotic diseases with potential to cause human diseases, etc., so that appropriate preventive strategies and preparedness measures explained in the foregoing paragraphs are instituted appropriately.

- Low Public Awareness

Lack of basic health and hygiene education and in some cases superstitions add to vulnerability of certain sections of population.

- Poor Health and Malnutrition

Poor health and malnutrition lead to depleted body resistance to diseases. Thus, certain groups in urban areas, and women and children in backward rural areas become more vulnerable .

- Congestion in Urban Areas

Congestion in urban areas leads to problem of waste disposal, which provides fertile ground for various diseases to spread.

### ☐ Environmental Management -

Should ensure safe water supply (to prevent waterborne diseases), awareness on personal hygiene, Should have proper vector control method etc.

## Prevention and preparedness

- Prevention and preparedness shall focus on the assessment of bio-threats, medical and public health consequences, medical countermeasures and long-term strategies for mitigation.
- The important components of prevention and preparedness would a robust surveillance system that can detect early warning signs, capacity building for surveillance, laboratories, and hospital systems that can support outbreak detection, investigation and management.
- Contingency plan for dealing with the epidemics that are likely to occur in the region.
- Early warning system and regular surveillance are primary requirements so as to mount an effective control response in early stages to prevent any outbreaks

## Medical Preparedness

- ❑ Response, quick evacuation of casualties, well-rehearsed hospital DM plans,
- ❑ training of doctors and paramedics and upgradation of medical infrastructure at various levels which will reduce morbidity and mortality.
- ❑ Medical preparedness will also entail specialised facilities including chains of laboratories supported by skilled human resource, Hospital preparedness for mass casualties , Trauma counselling .
- ❑ Stockpile of Antibiotics and Vaccines - vaccines to be administered rapidly in the event of an outbreak to contain the spread of the disease.

### Some early warning signals :

- Sudden high mortality or morbidity following acute infection with short incubation period.
- Occurrence of cases which are difficult to diagnose with available clinical and laboratory support and their nonresponsive to conventional therapies.
- Clustering of cases/deaths in time and space with high case fatality rate etc.

### Detection :

- Those exposed to biological agents may not come to know of it till symptoms manifest because of the varied incubation period of these agents.
- A high index of suspicion and awareness among the community and health professionals will help in the early detection of diseases.
- When exposure is suspected, the affected persons shall be quarantined and put under observation for any atypical or typical signs and symptoms appearing during the period of observation.
- However, awareness ensures early detection.

### If you are exposed to a biological agent:

- Ultra efficient filter masks can be used.
- Follow official instructions for disposal of contaminated items such as bag and cloths.
- Seek medical assistance.
- If required and advised, stay away from others or even quarantined.

## National Disaster Management Authority

- ❑ The DM Act, 2005 was enacted on 26 December 2005.
- ❑ The Act mandates: (a) the formation of a national apex body, the NDMA, with the Prime Minister of India as the Chairperson, (b) creation of SDMAs, and (c) coordination and monitoring of DM activities at district and local levels through the creation of district and local level DM authorities.
- ❑ MoH&FW, as the nodal ministry, will foresee the implementation of the guidelines at the national level. The other stakeholders in biological emergency management are MoD, MoR (Ministry of Railways), MoL&E (Ministry of Labour & Employment), MoA, DADF (Department of Animal Husbandry, Dairying and Fisheries) at the central level; ministries/departments of health of the states/UTs; scientific and technical institutions, academic institutions in agriculture, life sciences, zoological sciences, animal husbandry, medical, biomedical and paramedical field; and professional bodies, corporate sector, NGOs and the general community.

## Institutions supporting Management of Biological Disasters

- ❑ Indian Council of Medical Research (ICMR), New Delhi.
- ❑ National Institute of Cholera and Enteric Diseases (NICED), Kolkata.
- ❑ National Institute of Epidemiology, Chennai.
- ❑ Defence Research and Development Organisation (DRDO).
- ❑ Department of Biotechnology (DBT).

## Management

i) The risk of epidemics are higher after any type of disaster, whether natural or manmade. These include waterborne diseases such as diarrhoea/dysentery, typhoid and viral hepatitis, or vector-borne diseases such as scabies and other skin diseases, louse-borne typhus and relapsing fever.

ii) In certain natural disasters like floods, earthquakes, etc., disturbance of the environment increases the risk of rabies, snake bites and other zoonotic diseases.

Preventive measures will be taken to deal with such eventualities by keeping reserves of adequate stocks of anti-rabies vaccine and anti-venom serum.

■ Biological disasters are natural scenarios involving disease, disability or death on a large scale among humans, animals and plants due to micro-organisms like bacteria, or virus or toxins. Biological disasters may be in the form of:-

Endemic - describes a disease that is present permanently in a region or population

Epidemic affecting a disproportionately large number of individuals within a population, community, or region at the same time, examples being Cholera, Plague; or,

Pandemic is an epidemic that spreads across a large region, that is, a continent, or even worldwide of existing, emerging or reemerging diseases and pestilences, example being Influenza H1N1, COVID-19.

## Zoonosis is a great public health concern :

### Classification of Zoonoses

- ❑ Zoonotic diseases are caused by a wide range of pathogens.
- ❑ Based on etiology, zoonoses are classified into bacterial zoonoses (such as anthrax, salmonellosis, tuberculosis, Lyme disease, brucellosis, and plague), viral zoonoses (such as rabies, acquired immune deficiency syndrome- AIDS, Ebola, and avian influenza), parasitic zoonoses (such as trichinosis, toxoplasmosis, trematodosis, giardiasis, malaria, and echinococcosis),

### Deforestation and disease: How natural habitat destruction can fuel zoonotic diseases

Growing proximity between human settlements and wildlife is increasing the rate of disease transmission between domestic animals and wildlife. Irrespective of whether humans are going into forest areas or animals are coming to human settlements due to deforestation, viruses are being exchanged. Increasing human-animal interactions are perceived as driving factors in pathogen transfer, emphasising the close relationships between human, animal and environmental health. Contemporary livelihood and market patterns tend to degrade ecosystems and their services, driving a cycle of degradation in increasingly tightly linked socio-ecological systems

Outbreaks of Nipah virus : Destruction of forests that have adversely affected the roosting site for fruit bat species which is the reservoir for these pathogens. As a result, fruit bats have shifted to the fruit trees in human settlements, increasing contact between human and bats.

An outbreak of anthrax in Chhattisgarh state is another example that happened due to loss of biodiversity.



- Destruction of forests for growing crops, urban expansion and building road networks and a parallel intensification of wildlife trade has resulted in ecological conditions and movement of wild animals, which are reservoirs (or hosts) of some viruses or bacteria, towards human settlements. This, in turn, results in the emergence of new pathogens.
- Overexploitation of ecosystem services beyond natural carrying capacities, especially where these have been converted by human activities into disservices, potentially heightens risks of zoonotic diseases.
- The COVID-19 pandemic “is likely a global effect of natural habitat destruction combined with the effects of globalization. The novel coronavirus disease (COVID-2019) pandemic, believed to have been triggered by the transmission of the virus from animals to humans, has brought into sharp focus zoonotic diseases that are spread by animals as they forced to move out of their natural habitats that are increasingly being destroyed. Some other examples are described in the next page.
- The pandemic shows how vulnerable humanity is to major environmental and human health emergencies and how a local event may soon turn into a global crisis”.
- This is something scientists have been predicting could have happened.
- So, we have learnt that there are strong links between destruction of natural habitats of animals, and a rise in man-vector contact, leading to an upsurge in zoonotic diseases.

**For your understanding**

## India is among the top geographical hotspots for zoonotic diseases

a. Local deforestation has been linked to the emergence of Kyasanur Forest Disease (KFD) in and around Shimoga in Karnataka state. Hard tick is a reservoir and vector of Kyasanur Forest Disease (*Hard ticks have a “plate” on their back that is called a scutum*). Once these ticks get infected, they remain so for life and are able to pass to offspring via the egg. Transfer of Kyasanur Forest Disease Virus (KFDV) to humans may occur after a tick bite or contact with an infected animal (monkeys, cattle can get infected). No person-to-person transmission reported.

b. There are many examples of pathogen spillover related to deforestation for agricultural monocultures

- including palm oil, for example Nipah viruses;
- sugar cane and soybean in the case of hantavirus.

Native forest-living rodents were forced to seek out food when forests were cleared to establish palm oil plantations. Nipah Virus is being linked to changes in ecological conditions that have led to fruit bats coming out of their natural habitat and feeding on agricultural produce. Destruction of forests that have adversely affected the roosting site for fruit bat species which is the reservoir for these pathogens. Consumption of fruits or fruit products (such as raw date palm juice) contaminated with urine or saliva from infected fruit bats was the most likely source of infection. Nipah virus infection was transmitted to people from animals, and can also be transmitted through contaminated food or directly from person-to-person.

- The expansion of sugarcane production in the state of São Paulo in Brazil causes an increase in the local abundance of rodents and result in the emergence of infectious diseases such as hantaviruses and leptospirosis in humans.
- The virus is carried by the deer mouse. Hantaviruses are zoonotic viruses present in multiple rodent hosts resident in Neotropical ecosystems and are involved in hantavirus transmission.
- Hantaviruses causing infectious diseases such as haemorrhagic fever with renal syndrome (HFRS) etc.
- Dengue virus, Chikungunya virus, Mayaro virus, Zika virus and *Leptospira* infections are all endemic to both Latin America and the Caribbean. These regions consist of rich biodiversity hotspots (especially Neotropical rodents) and Neotropical climates.

## Locusts Infestation

- Locust is an insect that belongs to the family of grasshoppers. These insects are essentially harmless unless they meet certain circumstances under which they become more abundant and change their behaviour.
- Locusts look like ordinary grasshoppers—most notably, they both have big hind legs that help them hop or jump. They sometimes share the solitary lifestyle of a grasshopper, too. However, locust behavior can be something else entirely.
- LOCUSTS has both solitary and gregarious phases.
- The solitary phase is the normal state of the species, the gregarious phase being a physiological response to violent fluctuations in the environment.
- When these locusts meet suitable environmental conditions, they transform themselves from solitary animals into gregarious phase and start breeding abundantly which results in millions of swarms, becoming gregarious (LOCUST SWARM). This majorly happens after a series of strong rain or amid damp environment conditions.
- In their gregarious phase, they move faster and are attracted to other locusts. IT IS IN THIS PHASE THAT LOCUSTS FORM THE OPPRESSIVE SWARMS THAT CAN BLACKEN THE SKIES AND DECIMATE CROPS. These swarms attacking crops and thereby devastating the entire agricultural economy is what is commonly referred to as locust plague.

- There are four types of locusts that create a plague – desert locust, migratory locust, Bombay locust, and tree locust. The swarms that have built up June-July 2020 in India are of the desert locust.
- Some species may travel 81 miles or more a day. They can stay in the air for long periods, regularly taking nonstop trips across the Red Sea.

### India's approach to controlling locust plague

- ❑ India is equipped with a proper structure .
- ❑ Six annual border meetings are held with Pakistan between June and November
- ❑ Wireless conversation between Jodhpur (India) and Karachi is also maintained during June and Nov
- ❑ Locust upsurges in India in recent time – July 2020

The normal locust season in India spans June-November and coincides with the kharif season. After Iran and Pakistan, the locust swarm has entered India and the forecasting officers have already warned the country against experiencing the worst locust situations in decades. This means that the country that is already dealing with a drastic economic and health crisis due to COVID-19 is faced the worst agricultural crisis as well.

### Effect of locust plague on food

As mentioned in a report published in *The Hindu*, a swarm of desert locust containing around 40 million locusts can consume (or destroy) food that would suffice the hunger need of 35,000 people, assuming that one person consumes around 2.3 kg of food every day.

## HOW ARE LOCUST INVASIONS DEALT WITH?

### New bio-control agents :

Recent advances in biological control research, coupled with improved surveillance and intelligence have been proved to be very effective for locust control.

#### Use of Phenylacetonitrile (PAN) :

- Phenylacetonitrile inhibits pheromonal communication among gregarious hoppers ( ie., disrupts gregarization), reduces feeding and marching, and increases mortality due to predation.
- This pheromone could be an alternative control agent to conventional pesticides.
- It costs very little per hectare treated and could cut control costs enormously.

#### Use of Green Muscle :

- A different, but also highly effective biological approach is Green Muscle<sup>®</sup>, a bio-pesticide (only attacks locusts and grasshoppers, effectively stopping them in their tracks).
- could be applied by ground-based and aerial spray equipment at ultra-low volume (ULV) rates.
- Green Muscle consists of spores of the fungus *Metarhizium anisopliae* suspended in mineral oils. The fungi grow in the locust, producing a toxin and weakening them, making them easy prey for birds and lizards.
- If used in combination with a small amount of PAN, only a quarter of the normal dose of Green Muscle<sup>®</sup> is needed.

## Bio-Terrorism

- Bio-terrorism : use of biological agents to cause death, disability or damage mainly to human beings.
- To create mass panic and slow mass casualties.
- The three basic groups of biological agents : bacteria, viruses, and toxins.

### Trends Favoring Biological Weapons

- ☐ Low cost and widespread availability
- ☐ More efficient in terms of coverage
- ☐ Advances in biotechnology have made production easy
- ☐ Agents are largely natural pathogens
- ☐ Have an unmatched destructive potential

### HISTORY : MAJOR EVENTS ACROSS THE GLOBE

- Limited biological warfare is reported to have been carried out by Japan during World War-II
- Japan used plague bacilli in China during 1932-1945 causing 260,000 deaths.
- Mixed mycotoxins-based weapon have been reported to be used between the early 1970s and '80s in in South-East Asia, Cambodia and Afghanistan
- The Red Indians in North America were given the smallpox infected blankets
- 2001, the USA experienced biological attacks involving the intentional distribution of bacillus anthracis spores through the postal system. It created the threat for bioterrorism.