

# Society for Underutilized Legumes (SUL)

*SUL*  
*2020*  
*Lecture*  
*Series*



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*.....promoting pulses with pluses*



# CONTRIBUTIONS OF PLANT SCIENCE IN VIRAL DISEASE MANAGEMENT

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9th September, 2020

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# Presentation Outline



- Preamble
- Introduction
- Conditions necessary for pathogenesis
- Symptoms of viral diseases in plants
- Viral diagnosis
- Disease management
- Factors affecting viral disease management
- Fundamental principles of viral disease management
- Exclusion
- Avoidance
- Protection
- Eradication
- Therapy
- Resistance
- Integrated pest/disease management
- Roles of underutilized legumes in viral disease management
- Conclusion

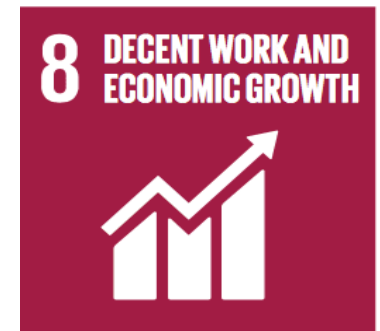


# PREAMBLE



## International Year of Plant Health

- Reducing poverty through plant health
- Ending hunger through plant health
- Protecting the environment
- Boosting economic development





# OUR ROLES IN ACHIEVING PLANT HEALTH

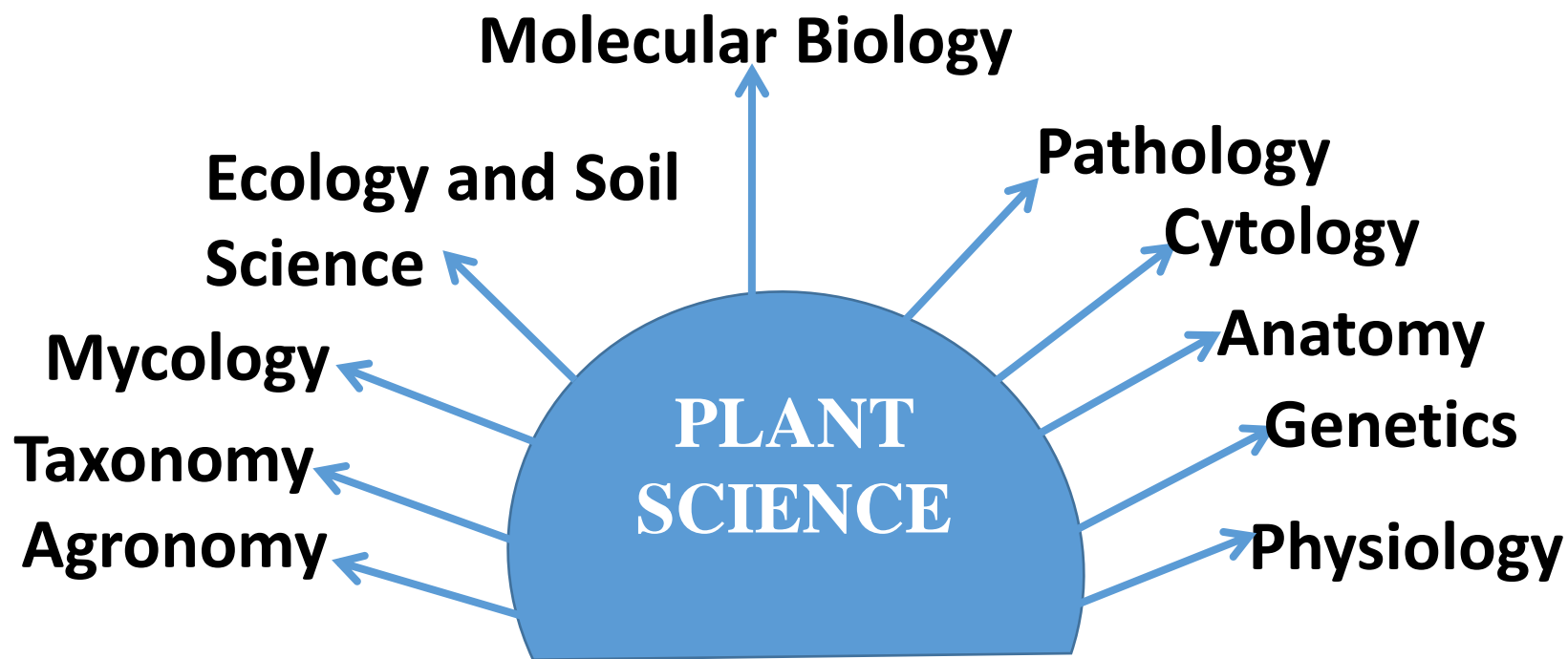
- Avoid taking plants and plant products across borders when travelling
- Transportation industries should ensure that means of transportation (e.g. ships, airplanes, trucks and trains) do not carry plant pests and diseases into new areas
- Government should increase support to national and regional plant protection organizations that are the first line of defence



# Introduction

## What is Plant Science?

- Plant Science is a branch of biology that deals with multidisciplinary study of plants



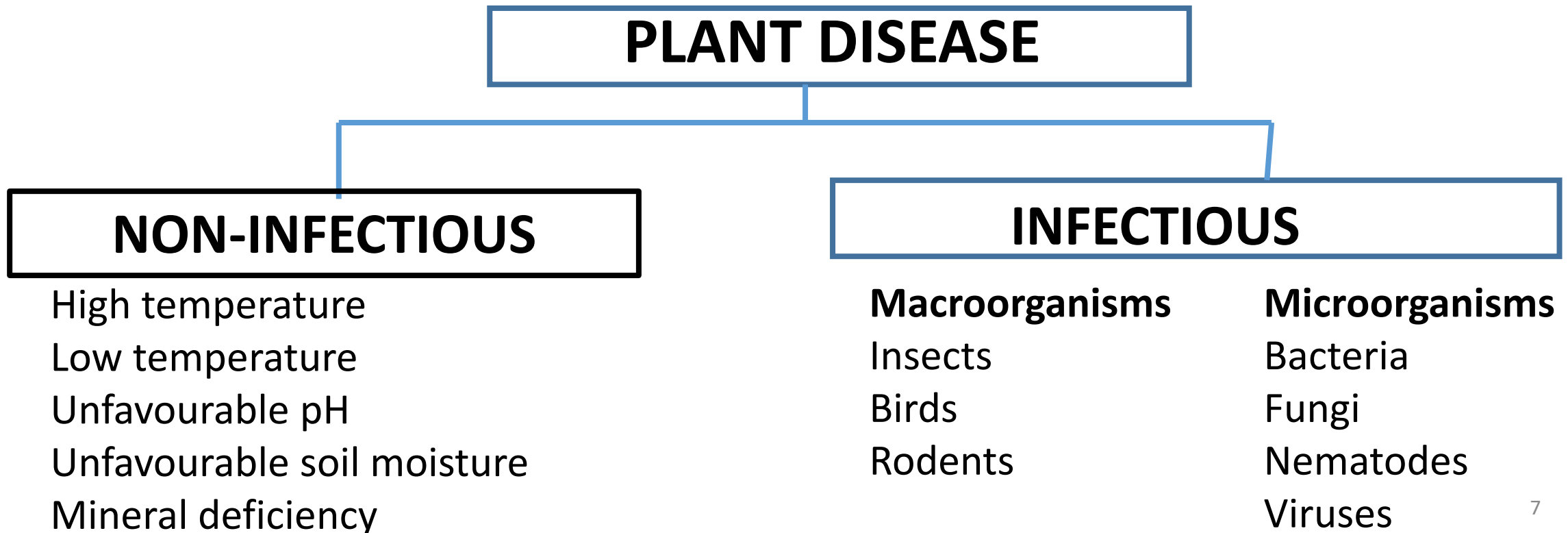
**Disciplines in Plant Science**



# Introduction Contd

## What is a disease?

- A disease is a deviation from the normal physiological functioning of an organism



# Introduction Contd

## What are viruses?

- Viruses are pieces of nucleic acids encased in coat proteins and capable of intracellular parasitism

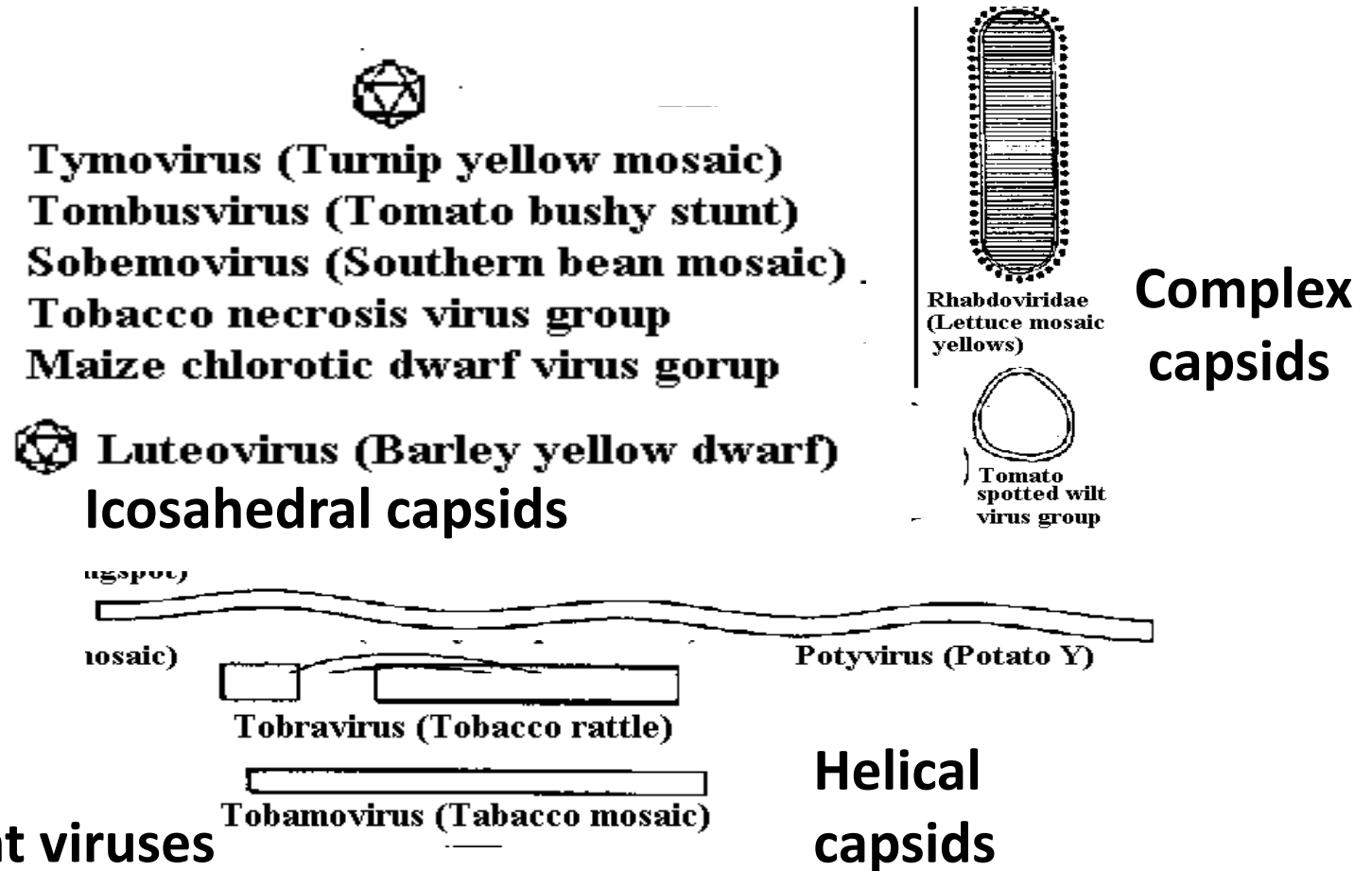


Fig. 1. Capsids of some plant viruses

Source: <https://hosho.ees.hokudai.ac.jp/tsuyu/top/dct/virus.html>



# Conditions Necessary for Pathogenesis

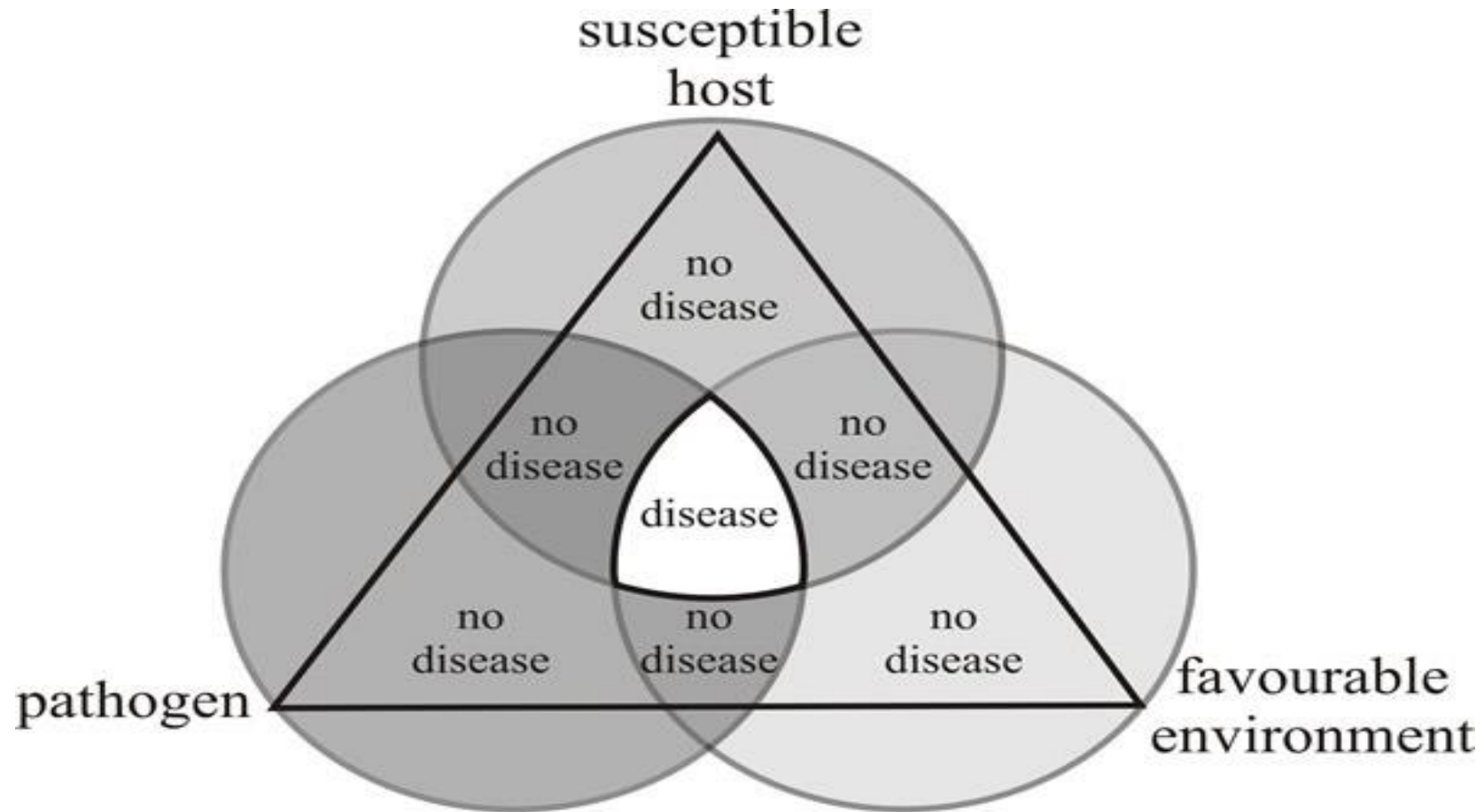


Fig. 2. Disease triangle



# Symptoms of Viral Diseases in Plants

## VIRAL DISEASE SYMPTOMS



### EXTERNAL SYMPTOMS

- Leaf and foliage symptoms
- Stem and root symptoms
- Flower symptoms
- Fruit and seed symptoms

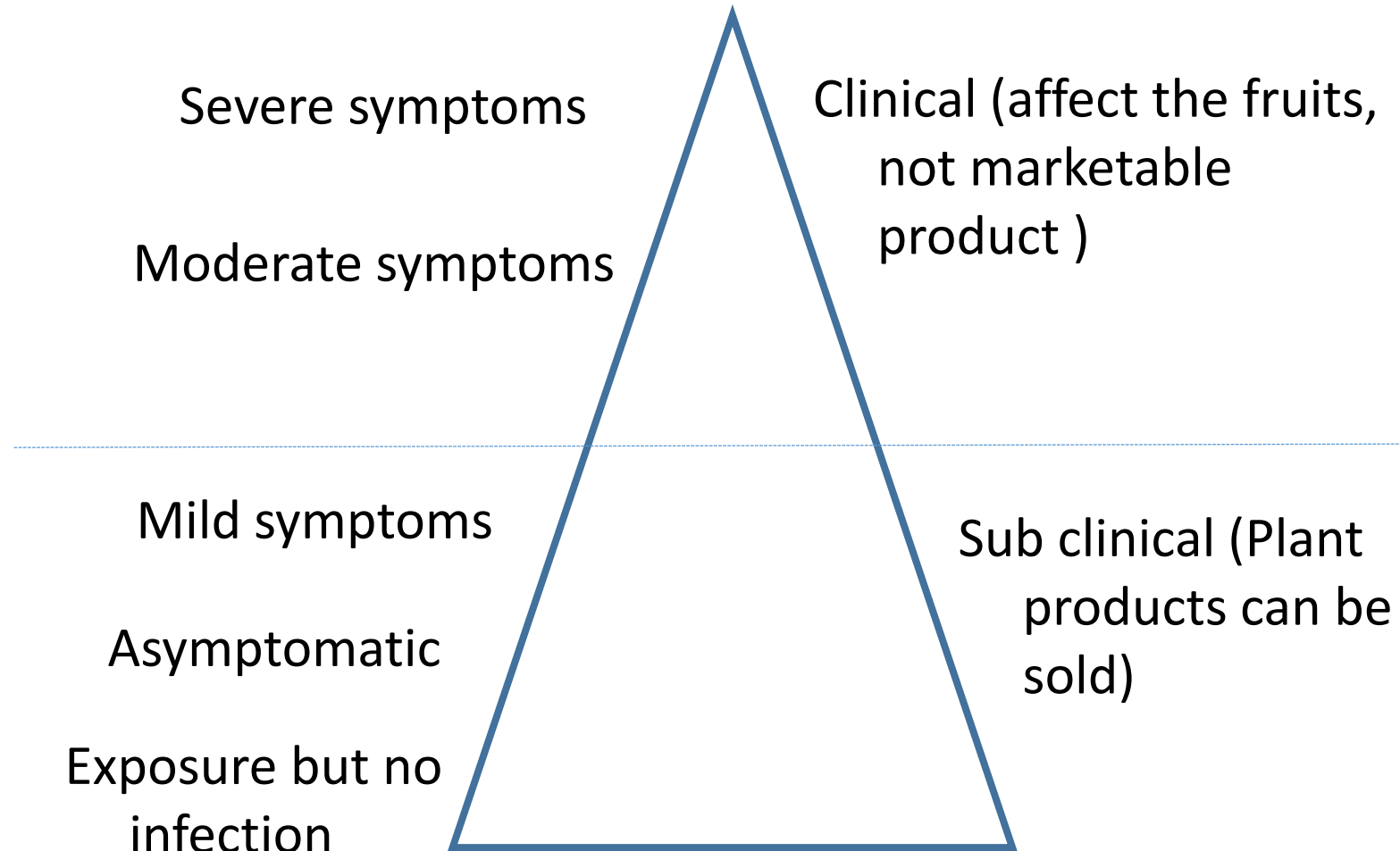
### INTERNAL SYMPTOMS

- |                      |                         |
|----------------------|-------------------------|
| Anatomical changes   | Cytological changes     |
| Histological changes | Ultrastructural changes |

# Symptoms of Viral Diseases in Plants Contd

## Factors controlling the production of symptoms

- Type and strain of virus
- Type and variety of host plant
- Age and stage of development of host
- Physiology of host plant
- Duration of infection
- Presence of other viruses and pathogens
- Environmental and climatic conditions



# Symptoms of Viral Diseases in Plants Contd



Mosaic induced on leaves of African yam bean



Leaf deformation induced on Bambara groundnut



Leaf reduction and chlorosis induced on lima bean



Streaking in maize plant



Vein banding and veinal chlorosis in cowpea



Yellow vein mosaic in kenaf



# Viral Diagnosis



- Viral identification using;
  - Biological indexing (host range test, transmission studies)
  - Serological assay e.g Enzyme-linked Immunosorbent Assay (ELISA)
  - Molecular techniques e. g. PCR, Nucleic acid spot hybridization, LAMP, Southern hybridization e.t.c.



# Disease Management

Disease management is minimizing the occurrence of diseases to avoid spread

- Management focuses on reducing pest invasion, disease emergence and keeping pest population low
- It aims at prevention – long term activity
- It deals with the cause of the problem



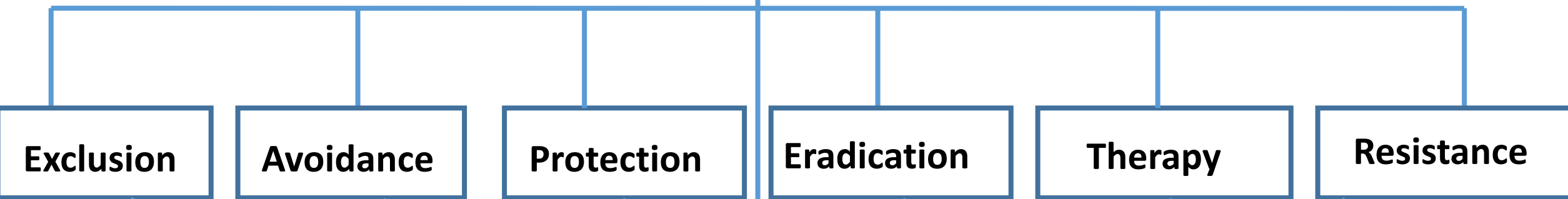
# Factors Affecting Viral Disease Management Contd

- Cost of management measure
- Ease of use of measure
- Measure must not cause other problems and must complement other production practices
- If the management measure opposes other good farming practices, a compromise may be necessary



# Fundamental Principles of Viral Disease Management

**DISEASE MANAGEMENT**



**Integrated disease management (IDM)**





# Exclusion



- Movements of diseased plant materials are prevented or restricted from entering a country, state or geographical area where the disease does not exist
- Certifications are systems of rules, regulations and check inspections used by government plant health authorities to maintain standards for the production of disease-free propagation materials
- Quarantines are regulations forbidding sale or shipment of plants or plant parts



# Avoidance



- The development of a disease can be avoided in a plant if the disease has not occurred in a particular area
- Modification of cropping procedures, crop hygiene, use of virus-free seeds
- Avoid wounding plants when weeding as wounds can serve as entry points for pathogens or reduce the plant resistance to infection
- Use of good horticultural practices such as proper fertilization, weeding and irrigation



# Protection



This involves treating of a healthy plant before it becomes diseased or the use of protective barriers between the host and the pathogen.

- Erection of windbreak or other mechanical barriers
- Biological control: use of beneficial insects to control virus vectors
- Control of vectors: the use of chemicals is an efficient way of controlling vectors



# Eradication

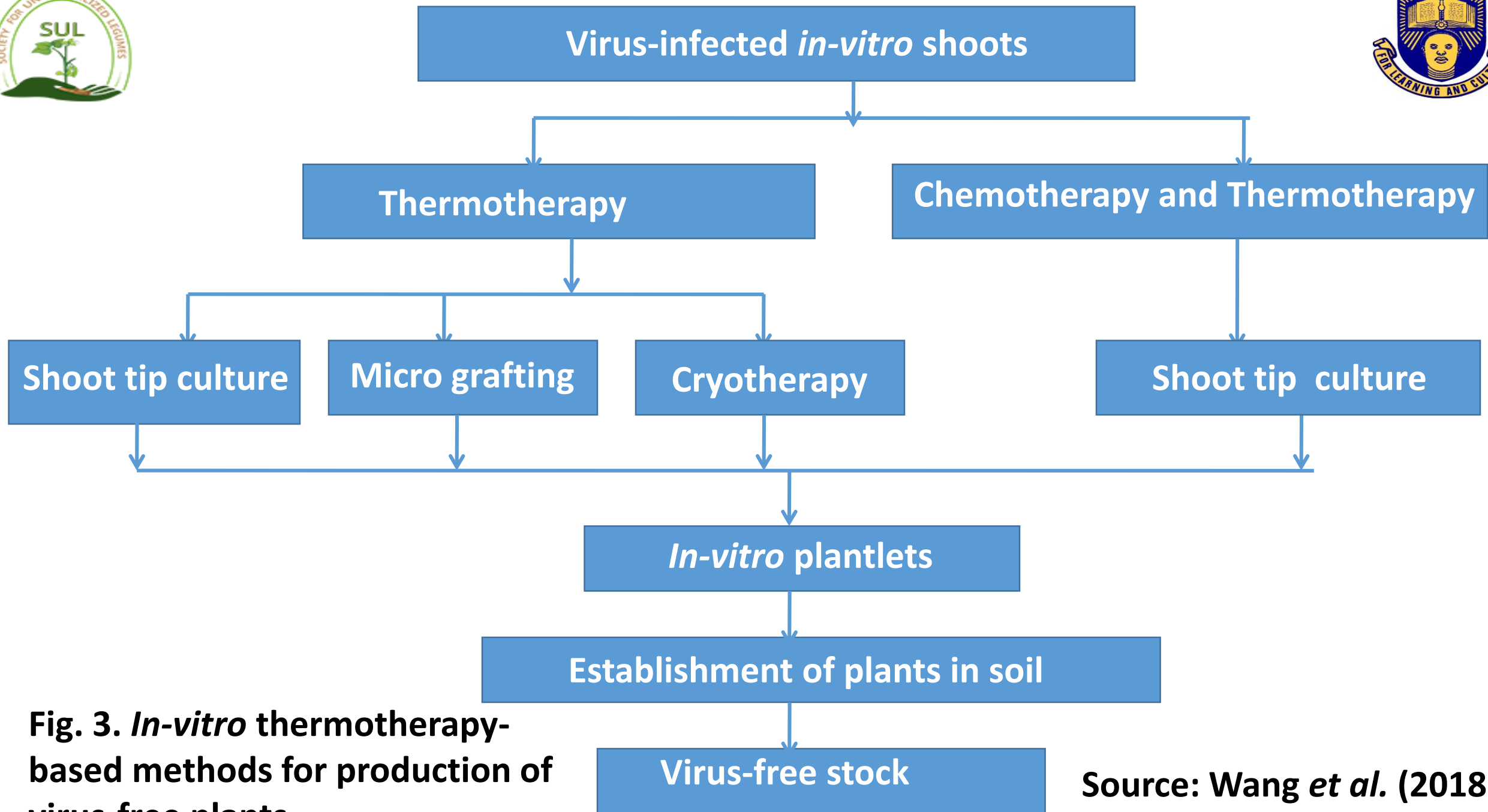
When a plant is infected or an area is already infested with a pathogen, the following methods can be adopted:

- Crop rotation
- Elimination of alternate hosts
- Roguing
- Chemical application
- Heat treatment
- Sanitation



# Therapy

- It involves treating infected plants with agents that will inactivate the virus or pathogen e.g.
- Chemotherapy e.g ribavirin, 2-thiouracil
- Thermotherapy (Tomato mosaic virus; 5 days at 70°C, 1 day at 80°C)



**Fig. 3. *In-vitro* thermotherapy-based methods for production of virus-free plants**

**Source: Wang *et al.* (2018)**



# Resistance

- Resistance is one of the best method of managing plant diseases.
- Resistance can be achieved through conventional breeding, soma clonal variation, somatic hybridization through protoplast fusion, recombinant DNA technology, cross protection
- Tolerant plants can serve as reservoir for the pathogen and vectors can spread the pathogens to a susceptible host



# Integrated Disease Management

IDM is a strategy towards the control of diseases with or without the use of chemicals

## **Strategies towards disease control**

- Prevention such as resistant variety, clean seed, good hygiene
- Non-chemical control e.g biological control, mechanical weeding, soil solarisation, hot water treatment
- Cultural e.g crop isolation (netting), crop rotation
- Chemical control e.g fungicide, pesticide





# Integrated Disease Management Contd



## *Objectives*

- Prevention of crop and post-harvest losses
- Promotion of ecologically sound crop management practices
- Prevention of loss of biodiversity
- Prevention of occupational health risk
- Ensuring food security
- Availability of quality drinking water
- Ensuring food quality and food safety



# Integrated Disease Management Contd



## *Characteristics*

- It requires multi-disciplinary approach
- Integration of multiple strategies
- Aims at prevention rather than curative
- Knowledge and information intensive
- Links agriculture to environment, biodiversity and human health
- Location specific
- Local adaptation
- Integral part of integrated crop management



# Roles of Underutilized Legumes in Viral Disease Management

## ***Alley cropping***

- Used in pest management (Atachi *et al.*, 2006)

## ***Crop rotation***

- Faba bean in crop rotation disrupted pests and disease cycles (Stoddard *et al.*, 2010).
- Used as break crops to help in weed control (Seymour *et al.*, 2012).

## ***Intercropping***

- Rice-blackgram intercrop system used in weed smothering (Midya *et al.*, 2005)
- Wheat-chickpea intercrop used in pest control (Lopes *et al.*, 2016)
- Intercropping groundnut with pigeonpea reduced the incidence of Peanut bud necrosis disease by 60.6% (Sunkad *et al.*, 2005)



# Contributions of Plant Science in Disease Management



- Increase food security by preventing crop losses
- Improve crop yield
- Improves food quality
- Natural resources conservation
- Protects biodiversity
- Economic development
- Enhances farmers' livelihood



# Conclusion

- Plant viral diseases hinder sustainable and profitable production
- It is one of the major causes of hunger, malnutrition and food insecurity.
- Plant Science has assisted in proper identification of viruses which is a prerequisite for their management
- Proper management translates to healthy plants and healthy plants are high yielding
- All these translate to increased income, healthy and wealthy nation

# ACKNOWLEDGEMENTS





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**THANK YOU  
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