LEARNING MODULE

SOCIO-SCIENTIFIC ISSUE

CVPD Disease in Citrus Plantation

Focal Points of the Sections:

1. Encounter Focal Issue: How dangerous is CVPD disease in *Citrus* plantation at Kintamani, Bangli-Indonesia
2. Engage in Three Dimensional Learning: Cause and Effect CVPD disease in Citrus Plantation
3. Synthesis Key ideas and Practice: Choosing the possible way as the best solution to control CVPD disease in *Citrus* plantation
4. Sustainable development through *Integrated Management of Healthy Citrus*

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CVPD DISEASE IN CITRUS PLANTATIONS AT KINTAMANI, BANGLI-INDONESIA

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PREFACE

Socio-scientific issues are complex and contentious societal issues with substantive connections to scientific ideas and principles. The context of SSI in learning begins in the nearby neighborhood and has reality and meaning in everyday life. SSI is chosen as a context for learning because it may be utilized to make students' science education more relevant while also enhancing their capacity to analyze scientific data.

One of the socio-scientific issues that is used in this proposed research is the CVPD disease issue that has been attacking citrus crops in several plantations at Kintamani, Bangli, Indonesia. This issue has become one of the local environmental issues that is not only happening in Bali but also in other areas of Indonesia.

In order to help the farmers control the CVPD disease, it is crucial to provide them with enough information on how to comprehend all control techniques. It entails providing information on how to prevent and manage the insect vectors that transmit this CVPD disease. Incorporating knowledge and data regarding the identification of CVPD disease vectors into a learning module is one of the effective methods. The designed SSI-based learning module can inform students about current local issues occurring in their surroundings. In addition to presenting knowledge about the CVPD and the CPVD-carrying insect vectors, students will be encouraged to utilize their critical thinking abilities to analyze the module's content in order to comprehend the CVPD disease's control strategies. Lastly, the students can also share any useful information from the module to educate the local farmers about the vector insect control that can be used as one strategy to cope with the CPVD disease, which has been harming the plantation yields of local farmers.

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Introduction
CVPD Disease in Citrus Plantation

Did you know that CPVD disease is a major cause of yield loss in citrus plantations in almost all countries, especially in Asia and Africa? Citrus is one of the commodities that plays an important role in the economy and the welfare of farmers. On the other hand, CVPD disease is still a problem in citrus plantations, which affects the environment. With the help of this module, we will discover these issues in CVPD disease in citrus plantations in four sections.

This module is divided into four sections, the majority of which concern the CVPD disease in citrus plantations in Kintamani, Bali. The first section will begin with an encounter with a focal issue using socio-scientific issue teaching and learning. This section will define CVPD and explain how dangerous it is in citrus plantations. In this section, you will also discover the other problematic issue in the citrus plantations of Bali. In the second section, this module will help you engage in three-dimensional learning related to CVPD disease in citrus plantations. You will discover disciplinary core ideas, cross-cutting concepts, and science practice in these socio-scientific issues. Following that, you will discover a possible solution for preventing CVPD disease attacks on citrus (including evaluation and reflection) through Integrated Management of Healthy Citrus. In the last section, the concept of sustainable development is introduced, and the relationship between Integrated Management of Healthy Citrus and sustainable development is examined.

SECTION 1
ENCOUNTER FOCAL ISSUE:
How Dangerous CVPD Disease in Citrus Plantation

This section will explain what CVPD is and its threat to citrus plantations. You will also learn about the additional problematic aspect of citrus plantations in Bali.

Learning Objectives

After discussing this chapter, you will be able to:

1. Explain CVPD that attack Citrus production
2. Explain the effects of CVPD in Citrus Plantation
3. Explain SWOT analysis regarding problematic issue in Citrus Plantation

CVPD THAT ATTACK CITRUS PRODUCTION

Citrus as an Important Commodity

Citrus is one of the most important fruit commodities in Indonesia. Citrus came in second place behind bananas in terms of fruit production in 2017. People's consumption reached 0.06 kg per week in 2015 and increased up to 0.09 kg per week in 2016. Citrus also ranked first for the average fruit expenditure of Indonesians (in rupiah), both in the village and in the city (Ministry of Agriculture in Indonesia, 2019). Citrus consumption tends to increase, which is caused by the many good nutrients and non-nutrients found in this fruit. Citrus contains a number of secondary metabolites, such as flavonoids, alkaloids, coumarins, limonoids, carotenoids, phenolic acids, and essential oils, amongst several others (Figure 1). These active secondary metabolites show several biological activities of importance to human health, including anti-oxidative, anti-inflammatory, and anti-cancer effects, as well as cardiovascular protective effects and neuroprotective effects (Adenaike & Abakpa, 2021).

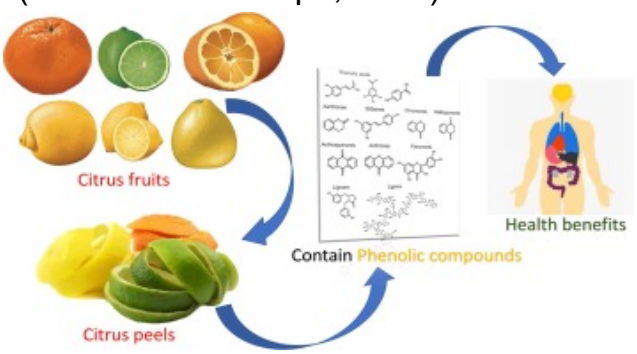


Figure 1: Nutrients in Citrus

With high demand for citrus consumption, this fruit plantation will be very profitable, increasing people's income, job opportunities, and national export foreign exchange. In terms of international trade, Indonesia has higher import than export values. Among South East Asian countries, Indonesia was considered the second largest citrus importer after Malaysia, with an increasing trend of up to 11% per year (Taufiq, et al., 2019).

Citrus is also an important horticultural commodity that is growing rapidly in Bali. According to Alitawan (2017), Kintamani, Bangli is the center of the highest citrus production in Bali, with citrus land areas increasing in 2015. Many local farmers in Kintamani are converting land they have traditionally used to harvest corn into citrus-producing plots. They divert corn crop land into land where they plant citrus to sell in the local market, to meet the demands of tourists, the local society, and ritual purposes (Figure 2).

CVPD THAT ATTACK CITRUS PRODUCTION

Citrus Vein Phloem Degeneration that Attack Citrus Production

The high demand and consumption of citrus is due to the fact that this fruit is easy to find in the community and because the price is quite affordable. On the other hand, the quality of citrus can be influenced by various factors, including the attack of Citrus Vein Phloem Degeneration (CVPD). CVPD disease is caused by a gram-negative bacteria, Liberibacter asiaticus. It is transmitted by an insect vector, Diaphorina citric, through the osculation of seedlings from CVPD disease-infected citrus plants. Several types of citrus plants, especially those with less economic value, were known to be resistant to CVPD. Types of citrus that are resistant to CVPD are hereafter referred to as "citrus with the CVPDr gene." Citrus plants resistant to CVPD (CVPDr) are thought to contain genes that produce a trait that is able to break the pathogenic infection of CVPD (L. asiaticum) or is able to resist transmission of pathogens carried by vector insects (Wirawan et al., 2014).

The CVPD disease issue has been attacking citrus crops in several plantations at Kintamani, Bangli, Indonesia. This issue has become one of the local environmental issues that is not only happening in Bali but also in other areas of Indonesia. The CPVD disease is a major cause of yield loss in citrus plantations in almost all countries, especially Asia and Africa. Africa reduced citrus crop losses from CVPD diseases by 30-100% in 1965. Previous attacks occurred in 1932–1936 and in 1939–1946. In Vietnam, especially in the Mekong Delta, 70–79% of the crop has been infected, and Vinh Long Province and Can Tho reduced crop yields by 42%. Damage to crops in the Philippines is estimated at seven million trees between 1962 and 1971, wiping out more than one million trees in one area. Plant damage in Thailand exceeded 95%, while approximately three million crops in Indonesia were damaged between 1960 and 1970 (Julyasih, 2009).

CVPD THAT ATTACK CITRUS PRODUCTION

The effects of CVPD in Citrus Plantation

Citrus production in Indonesia has fluctuated since the last decade. After reaching nearly 2.4 million tons in 2008, production fell to a low of 1.5 million tons in 2015.Positive production trends then resumed, reaching 2.2 million tons in 2017 (Indonesian Statistic Bureau 2017).Citrus production has fluctuated due to a variety of issues, particularly pest and disease attacks, particularly CVPD or Huanglongbing (HLB), in several major production centers (Widyaningsih et al., 2017).

Typical disease symptoms include yellowing leaves, dark green leaf bones, leaves that are more rigid and thicker than healthy leaves, and leaves that are smaller and harder. The spread of the disease occurs primarily through insect vectors such as Diaphorina citri Kuwayama (Homoptera: Psyllidae). The spread of the disease can also be caused by the spread of citrus plant seeds that have been infected by pathogens that cause CVPD (tissue graft) (Capoor et al., 1974; Mead, 1998). Wijaya (2007) says that the number of D. citri as a vector insect and the presence of a source of inoculum affect how CVPD spreads in the wild.

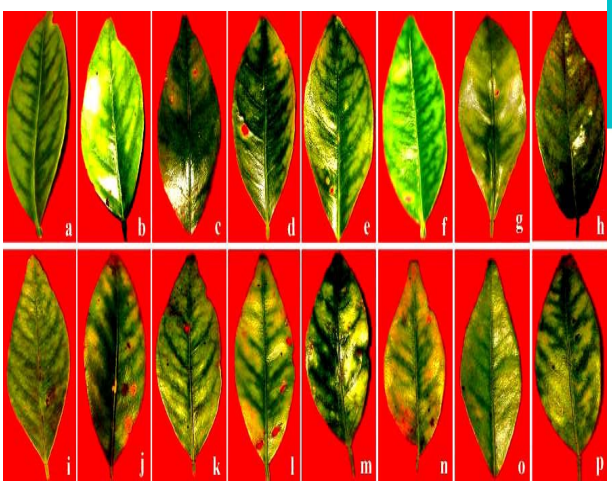


Figure 3: The symptoms of CVPD disease in Citrus leaf

Based on a 2015 study, it was found that 98% of citrus plants in Buleleng Regency and 60% in Karangasem Regency were infected with CVPD. Due to the CVPD outbreak, a large-scale eradication was carried out until it reached almost 100% in 1990. It's done specifically to siem oranges and tangerines caused by an infectious CVPD (Citrus Vein Phloem Degeneration) disease caused by the bacteria Liberobacter asiaticum, which is common in citrus crops in the field, so that the citrus fruit breaks into small pieces and changes color, which is not good (Wirawan et al., 2014). In addition, it is reported that this disease continues to damage citrus crops in various plantation regions in Kintamani, Bangli, Indonesia.

Find out the symptom of CVPD in Citrus!

Task 1: Read the text and find out the symptoms of CVPD in citrus. You can complete your explanation by drawing every part of the citrus that is attacked by this disease. A separate sheet of paper can be used for a better and more complete answer.

Citrus Leaf

Citrus Fruits

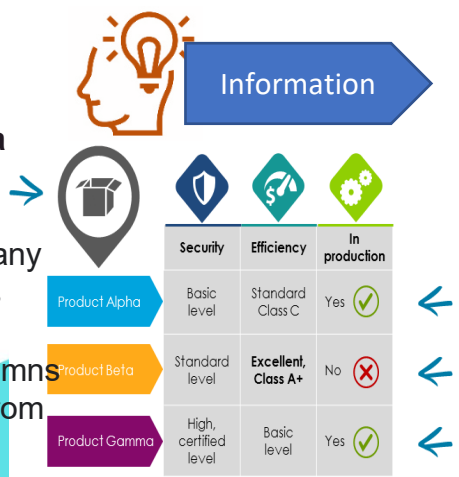
Find out the symptom of CVPD in Citrus!

Make a table of the quality differences between healthy citrus and citrus affected by CVPD to round out your explanation! You can also complete your answer with a picture!

Table

Some tips to make a table:

1. Name your table
2. Figure out how many columns and rows
3. Draw the table.
4. Label all your columns
5. Record the data from your experiment
6. Check your table



PROBLEMATIC ISSUE IN CITRUS PLANTATION

Citrus as Largest Crops in The World

Citrus fruits are one of the largest fruit crops in the world. About 30% of citrus fruits are processed to obtain various products, mainly juice (Figure 4). Similarly, the citrus industry is also the second-largest fruit-processing industry, surpassed again by the grape industry, which mainly produces wine. Neither orange juice nor wine can be considered essential foods, but they do have an important role in our lives. Although citrus fruits have been consumed since ancient times, citrus processing, as it is known today, was not possible until thermal treatment (to inactivate enzymes and microorganisms) and concentration processes were commercially available. Since then, the citrus industry has developed rapidly, becoming prominent among food industries (Izquierdo et al., 2013).

Citrus is also common in every Balinese ceremony. Here in Bali, local farmers love to plant citrus due to the high demand, especially when there are religious ceremonies. Citrus has a very good opportunity as a local fruit for business purposes, being consumed every day as well as for every Balinese ceremony (Figure 5).

PROBLEMATIC ISSUE IN CITRUS PLANTATION

Problems in Citrus Plantation

The development of citrus as horticultural commodities become a top priority in use their own citrus' land as their main income (FiguIndonesia, especially in Bali (Wuryantini, 2018). *Citrus* is one of excellent commodities that plays an important role in the economy and the welfare of farmers. In Bali, many farmers re 6). On the other hand, there are still problems in *Citrus* plantation in Bali which affect the quantity and quality of this fruit.

Figure 6: Citrus' land as a main income for farmers

Citrus vein phloem degeneration (CVPD) is the most important disease and a major cause of yield loss in citrus plantations in almost all countries, especially in Bali. Based on the interview, CVPD disease still exists in Kintamani. There are some citrus farms that are suspected of being infected with CVPD. This issue has become one of the local environmental issues that is affecting citrus production. The typical symptoms when this disease attacks citrus are that the leaves become yellow, the bones of the leaves become dark green, the leaves become more rigid and thicker than the healthy leaves and smaller, while the fruits become small and hard (Figure 7).

PROBLEMATIC ISSUE IN CITRUS PLANTATION

Figure 7: Symptoms of CVPD attack on citrus plant leaves

The typical symptom of CVPD disease is chlorosis of the leaves, which resembles the symptoms of mineral deficiency. The detection of CVPD is quite difficult, so it requires special detection methods. Conventional detection is not satisfactory because the concentration of bacteria in plants is low, the distribution is uneven, the incubation period is long, and many citrus plants are latently infected (Nurhadi, 2015). Conditions such as low temperatures, different plant varieties, nutrient deficiencies, or combinations with other diseases cause indistinct symptoms that make visual observation difficult. According to Ratu et al. (2020), citrus plants that are attacked by CVPD show symptoms of yellowing or chlorotic leaves. The color of the leaf bones remains green, the leaf size becomes small, and the leaves become stiff. Chlorosis occurs because the formation of chlorophyll in the leaves is reduced. According to Rustiani et al. (2015), the symptoms of chlorosis are caused by infection. Liberobacter asiaticus showed physiological disturbances in plants. Physiological disturbances occur because the bacterial mass causes inhibition of nutrient transport to and from the phloem tissue. The same thing was said by Tafik (2010). In mature plants, the symptoms that often appear are branches with yellow leaves, which contrast with other branches whose leaves are still healthy. This phenomenon is known as "sectoral greening." Leaves on infected branches protrude like brushes. Another symptom is that the leaves are narrower and more pointed, with a yellow color between the leaf bones.

SWOT Analysis Regarding Citrus Plantation

Task 2: Read the text and make a SWOT analysis with micro (individual), meso (society) and macro (society as whole) analysis of problematic Issue in Citrus Plantation. You can complete your explanation in diagram below!

SUMMARY SECTION 1
ENCOUNTER FOCAL ISSUE

Task 3: After learning about the first section, please make a summary based on your own understanding!

SECTION 2
ENGAGE WITH THREE-DIMENSIONAL LEARNING

This second section will help you engage in three-dimensional learning related to CVPD disease in citrus plantations. You will discover **disciplinary core ideas, cross-cutting concepts, and science practice** in these socio-scientific issues.

Learning Objectives

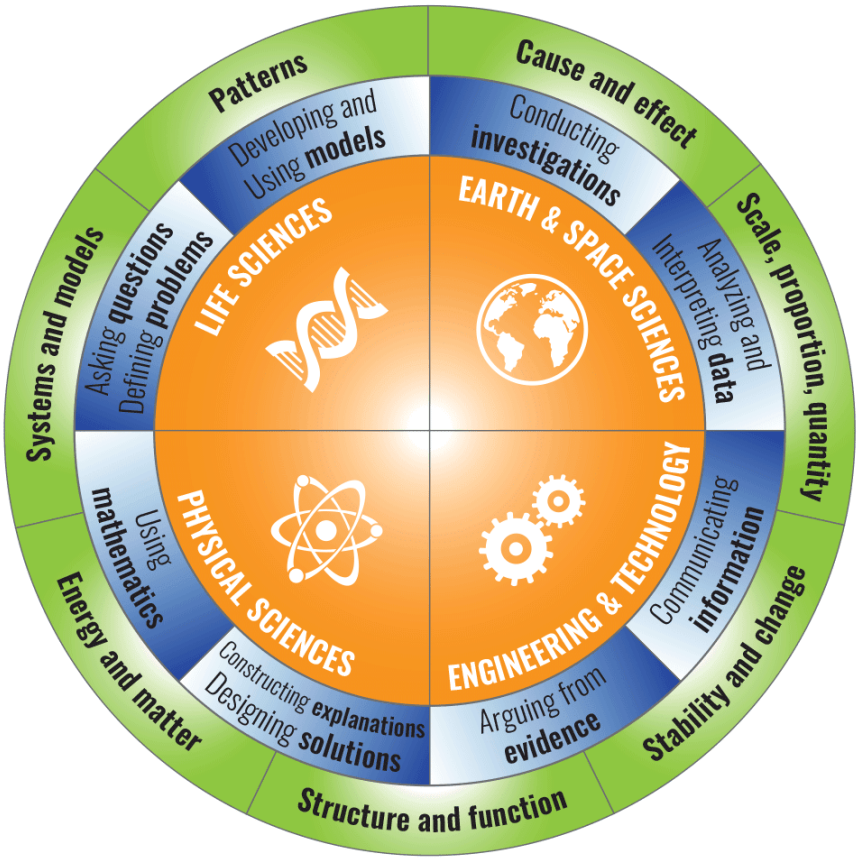
After studying this chapter, you will be able to:

1. Explain the disciplinary core ideas in this socio-scientific issues
2. Explain cross cutting concept: CVPD Disease at different Citrus Plantation in Kintamani, cause and effect CVPD Disease in Citrus Plantation
3. Analyze and interpret data as a science practice dimension related to CVPD Disease in Citrus Plantation

Disciplinary Core Ideas In Socio-Scientific Issues: CVPD Disease in Citrus Plantation

Disciplinary Core Ideas

Based on the instructional model of using SSI-TL (Sadler, et al., 2017), disciplinary core ideas are also known as scientific facts or content knowledge. Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science.



Disciplinary Core Ideas in Socio-Scientific Issues: CVPD Disease in Citrus Plantation

Life Sciences

The content knowledge in life sciences related in SSI: CVPD disease in Citrus plantation is LS 1: From molecules to organism: structures and process. Some specific insect as a vector of CVPD disease. Insect **structure** as the vector and the **process** of this disease attack citrus.

a CVPD disease-causing bacteria named Liberobacter. Liberobacter is an alpha-proteobacterium and has been successfully characterized by analysis of the 16S rDNA sequences and beta operon gene (Hocquellet et al., 1999). CVPD disease-causing pathogenic bacteria are known to be spread by insects such as fleas, also called citrus psyllids, named D. citri Kuwayama (Figure 8). Insect D. citri as a vector, Liberobacter bacteria have the potential to breed highly, especially in the lowlands, and the period of transmission (the infectious period) can take quite a long time, up to 90 days. This insect can lay up to 800 eggs, and the eggs may hatch after 3-5 days; a year later, there were nine generations (Anonymous, 1996).

Psyllid Diapohorina Citri Kuw is a transmitting insect or vector for CVPD that accelerates the spread of this disease in the field. A CVPD vector containing the pathogen L. asiaticus has been shown to transmit this systemic disease to healthy citrus trees. If there are no citrus trees infected by CVPD in the orchard due to disease-free citrus seedlings, the presence of transmitting insects is just an ordinary pest that damages shoot buds or young shoots.

D. citri can be effectively controlled using stem wiping or painting methods with a systemic insecticide containing the active ingredient imidacloprid or other systemic pesticides, the efficacy of which must be determined beforehand. The stem painting can be repeated every 2–4 weeks. It can also be done by sprinkling an insecticide solution containing the active ingredient tiametoksam (5 grams per liter) at a rate of 0.5 liters per tree (4 years old) under the plant canopy or by spraying with insecticide when plants form buds or shoots.

Disciplinary Core Ideas in Socio-Scientific Issues: CVPD Disease in Citrus Plantation

Task 1: After having insight of disciplinary core ideas (DCI), find out another DCI of SSI: CVPD Disease in Citrus Plantation! Explain your answer below!

Physical Sciences

Life Sciences

Earth and Space

Engineering, Technology, Application

Cross-Cutting Concepts in Socio-Scientific Issues: Pros and Cons of using Pesticides in *Citrus nobilis* Cultivation

Cross-Cutting Concepts

Cross-cutting concepts are those that apply across all scientific disciplines. They provide students with an organizational framework based on behavior and function that connects ideas from different scientific disciplines. Specifically, the crosscutting concepts provide a way to make connections between the disciplinary core ideas (CCSSO, 2018).

1. Patterns – Observed patterns of forms and events guide organization and classification. Patterns prompt questions about the factors that influence cause and effect relationships. Patterns are useful as evidence to support explanations and arguments.
2. Cause and Effect – Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted and complex. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
3. Scale, Proportion, and Quantity – In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. Systems and System Models – Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. Energy and Matter – Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the system's possibilities and limitations.
6. Structure and Function – An object's structure and shape determine many of its properties and functions. The structures, shapes, and substructures of living organisms determine how the organism functions to meet its needs within an environment.
7. Stability and Change – For natural and built systems alike, conditions of stability and rates of change provide the focus for understanding how the system operates and the causes of changes in systems.

Cause and Effect of CVPD Disease which Attack Citrus Plantation

Cause of Psyllid Diapohorina Citri Kuw

D. citri is a sucking insect with a pointed stylet. When the insect attempted to sucke sap from a plant, bacteria entered the insect's body and underwent a chemical process in the insect's body. When D. citri, which contained this Liberobacter, sucked the sap of a healthy citrus plant, the bacteria were expelled through its saliva. The disease is spread primarily by the insect vector D. citri Kuwayama. Tipe spread of the disease can also be caused by the spread of citrus plant seeds infected with CVPD pathogens (Capoor et al., 1974; Mead, 1998).

Effects for Citrus

Disease symptoms include yellowing leaves, dark green leaf bones, and leaves that are more rigid and thicker than healthy leaves and smaller (Mead, 1998; Knapp et al., 1999). while the fruit becomes small and hard (Wirawan et al., 1998). CVPD-affected plants' leaves undergo chlorosis; the symptoms resemble nitrogen deficiency, zinc, manganese, and iron deficiency (Tirtawidjaja, 1983).

Cause and Effect of CVPD Disease which Attack Citrus Plantation

Task 2: Read the text and analyzed the cause and effect of CVPD disease which attack Citrus plantation by using your own understanding.

Science Practice In Socio-Scientific Issues: CVPD Disease in Citrus Plantation

Science Practice

The practices describe behaviours that scientists engage in as they investigate and build models and theories about the natural world. The NRC uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice (NRC, 2012).

1. Asking Questions and Defining Problems – A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.
2. Developing and Using Models – A practice of science is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.
3. Planning and Carrying Out Investigation – Scientists plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.
4. Analysing and Interpreting Data — Scientific investigations produce data that must be analysed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data.
5. Using Mathematic and Computational Thinking – In science, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analysing data; and recognizing, expressing, and applying quantitative relationships.
6. Constructing Explanations and Designing Solutions – The products of science are explanations and solutions.
7. Engaging in Argument from Evidence – Argumentation is the process by which explanations and solutions are reached.
8. Obtaining, Evaluating, and Communicating Information – Scientists must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups are critical professional activities.

SUMMARY SECTION 2
ENGAGE WITH THREE-DIMENSIONAL LEARNING

Task 3: After finishing the second section, please make a summary based on your own understanding!

SECTION 3
SYNTHESIS KEY IDEAS & PRACTICE
CVPD Disease in Citrus Plantation

In this third section you will find the possible way as the best solution to prevent CVPD disease in Citrus plantation (including evaluation and reflection) through **Integrated Management of Healthy Citrus.**

Learning Objectives

After studying this chapter, you will be able to:

1. Explain the **Integrated Management of Healthy Citrus**
2. Analyze and evaluate **Integrated Management of Healthy Citrus**

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 8: *Citrus Farm in Kintamani*

The importance of citrus fruits in the world's economy is demonstrated by their wide-scale cultivation under tropical and sub-tropical conditions. Citrus has a huge socioeconomic and cultural impact on society as a whole. The fruit's multifold nutritional and medicinal values make it indispensible in several parts of the world, including Indonesia. Citrus production in Indonesia has fluctuated since the last decade. It cannot be denied that the CVPD (Citrus Vein Phloem Degenaration) disease attack caused damage to citrus plants in Kintamani. The CVPD attack affects nutrient deficiencies and citrus quality. The local government advised farmers to plant citrus in non-endemic areas, or else provide disease prevention strategies. Bassanezi and Gottwald (2008) reveal that it is important to implement the regional control management for the disease immediately after it is detected. Regional disease management highly affects the probability and efficacy of slowing the epidemic.

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 8: *Citrus Farm in Kintamani*

Integrated Management of Healthy Citrus

In Indonesia, one of the ways to prevent CVPD attacks is through integrated management of healthy citrus (IMHC). The technology of IMHC comprises five components, namely: (1) using virus-free citrus seeds; (2) pest and disease control; (3) sanitation; (4) optimal plant maintenance; and (5) consolidation of citrus management. The use of citrus seeds labeled free of disease, especially CVPD, can minimize damage to citrus plants, ultimately saving the farmers from suffering huge losses. Symptoms of CVPD infection are similar to symptoms of nutrient deficiency due to metabolic disorders in plant tissue. However, IMHC should be supported by skilled human resources and solid institutions. If it doesn't have reliable people to back it up, the farmers will continue to lose money.

Using Virus-Fee Citrus Seeds

The Indonesian Citrus Rehabilitation Program has initiated virus-free citrus seed production through Shoot Tip Grafting (STG) technology in vitro and indexing (Supriyanto & Whittle, 1992; Supriyanto et al., 1992; Devy et al., 2015). In 1992, this program was successfully produced. The program distributed CVPD-free citrus seeds and other viruses in several production centers, especially in North Bali. The success of the program was further strengthened by the Indonesian citrus certification program.

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 8: *Citrus Farm in Kintamani*

The disease-free citrus seedling system was then adopted as a recommendation and referred nationally by the Directorate of Horticulture Seedlings with legal support from the Decree of the Minister of Agriculture, number 39/Permentan/OT.140/8/2006, concerning the production, certification, and distribution of seed regulations for disease-free citrus seeds. In citrus plants, the superior seeds are those that are free from systemic pathogens (CVPD = Citrus Vein Phloem Degeneration; CTV = Citrus Tristeza Virus; CVEV = Citrus Vein Enation Virus; CEV = Citrus Exocortis Viroid; CPsV = Citrus Psorosis Virus) and are in accordance with the parent tree with guaranteed purity of variety. This seed can only be obtained if the parent tree is produced in accordance with national seed regulations. As for citrus seed production, it must be in accordance with the disease-free citrus production flow that has been produced by Balitjestro with the classification of basic seed (FB) and main seed (BMB). During the production process from FB, FB, and scattered seeds, there must be periodic supervision and inspection from the Seed Monitoring and Certification Agency (Balai Pengawasan and Sertifikasi Benih, or BPSB). The examined seeds that are still healthy and free of disease will be labeled as "disease-free" according to their status. FB seeds will be labeled in purple, BMB seeds will be labeled in pink, and scattered seeds will be labeled in blue.

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 8: *Citrus Farm in Kintamani*

Pest and Disease Control

CVPD control is generally focused on insect vectors and pathogens. Control of insect vectors is done with the use of insecticides and biological control. It seems effective insecticides for insect vectors are sap feeders, but excessive consumption is not favorable because it is expensive and can affect other organisms. Biological control is done by using parasites, predators, and entomopathogenic fungi (da Graca, 1991). CVPD control is achieved through the eradication of diseased plants, the planting of alternative host plants such as Murraya paniculata (L.) Jack, and the planting of disease-free citrus seedlings CVPD. This effort is simply to reduce the intensity of the attacks and delay the outbreak. On the other hand, the use of insecticides can cause pest resistance, resurgence, blasting secondary pests, and pollution problems because of the residues generated.

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 8: *Citrus Farm in Kintamani*

Sanitation

One of many tactics required for an effective disease management strategy in the greenhouse and field is sanitation. Sanitation includes any practice that aims to prevent the spread of pathogens by removing diseased and asymptomatic infected tissue, as well as decontaminating tools, equipment, and washing hands. Field sanitation to prevent CVPD attacks on citrus is achieved by some methods, such as pruning diseased plant parts, eradication of HLB-infected plants, and replanting with labeled planting materials.

Optimal Plant Maintained

Maintenance to keep plants in optimum operating condition is carried out in all industries in some form or another. The fundamental approach, however, is much the same, involving condition assessment, repair as necessary, scheduling of future assessments and repairs, and condition monitoring. Without a proper maintenance process, an optimal plant's production could be destroyed and difficult to handle. Plant care is essential for producing healthy plants. Some methods can be used, such as pruning of plant architecture, maintenance pruning, land preparation, balanced fertilizer application, irrigation, fruit thinning, weed control, and good harvesting practices.

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 8: *Citrus Farm in Kintamani*

Consolidation of Citrus Management

To produce high yields of good-quality fruit, trees need lots of feeder roots in the surface soil so they can take up plenty of water and nutrients. To enable this, the surface soil should be deep, soft, stable, well-structured, well-drained, fertile, and cool in the summer. The pH level should be between 5.8 and 6.5.

Health management of pathogen-free trees in the orchard

The pathogen-free citrus trees normally grow luxuriantly (vigorously) and begin fruiting as early as two to three years after transplanting by following appropriate health management and cultural practices such as watering, fertilization, and pruning. Health management of pathogen-free citrus seedlings in orchards needs to be properly performed using the following strategies:

INTEGRATED MANAGEMENT OF HEALTHY CITRUS

Figure 9: Placing yellow sat turn trap for monitoring vector

1. Protecting the new citrus orchards with physical barriers like wind breakers, hedgerows (Leucaena glauca), or guava to prevent re-infection from citrus trees or orchards with HLB that are close by;
2. Elimination of CVPD-diseased citrus trees and alternative host plants as sources of inoculum to prevent re-infestation of healthy trees by vector
3. Monitor vector flying activity by diagonally placing 10 sets of "yellow Saturn traps" in a 1-hectare citrus orchard (Figure 11)
4. Protection of pathogen-free trees from vector transmission by effectively spraying insecticides such as imidacloprid (bark painting), azadirachtin (extracted from neem tree seeds, Azadirachta indica), and dimethoate as foliar sprays at the critical sprouting (flushing) period. Biological control of the vector through the use of natural enemies such as the ectoparasite Tamarixia radiata and endoparasite Diaphorencyrtus aligarhensis, predatory coccinellid species, and the entomopathogen Hirsutella sp. during the rest of the fruiting period.

Integrated Management of Healthy Citrus

Task 1: Please share your thoughts on what "**integrated management of healthy citrus**" entails after reading the text. Is there any difference when farmers use this method on citrus plantations?

Integrated Management of Healthy Citrus

Task 2: Now that you know about the *Citrus nobilis* Organic Farm Management, please analyze and evaluate **Integrated Management of Healthy Citrus using SWOT analysis!**

SUMMARY SECTION 3
SYNTHESIS KEY IDEAS & PRACTICE
Integrated Management of Healthy Citrus

Task 3: After learning about the third section, please make a summary based on your own understanding!

SECTION 4
SUSTAINABLE DEVELOPMENT THROUGH Integrated Management of Healthy Citrus

In this fourth section you will learn the concept of **sustainable development** and how far **Integrated Management of Healthy Citrus** relates to the concept.

Learning Objectives

After learning this chapter, you will able to:

1. Explain the ***concept of sustainable development***
2. Analyze and evaluate how far **Integrated Management of Healthy Citrus relates to sustainable development**

THE CONCEPT OF SUSTAINABLE DEVELOPMENT

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A Conceptual Review of the Terms Sustainable Development and Sustainability

Barbosa, G. S. & Drach, P. R. & Corbella, O. D.

Abstract:
The objective of the research aims to develop a theoretical study with different positions on the terms sustainable development and sustainability. Although fairly debated and accepted by common sense, the concept of sustainability does not have precision and ends up acquiring various senses, sometimes contradictory. The distinct ideological perceptions of environmental issues translate into different discourses. Each social sector presents its position on the "environmental crisis", some catastrophic other weighted, some guiding solutions inside the current economic and social system and others suggesting drastic changes. In this context, and especially in the last three decades, the ideas of sustainable development (SD) and urban sustainability began to be discussed more intensively seeking possible solutions to urban and environmental problems.

Full article, visit:
https://www.iises.net/a-conceptual-review-of-the-terms-sustainable-development-and.html

Task 1 : After having read the article about the concept of sustainable development,

a. Explain the key concept of sustainable development with your own understanding.
b. Fill the diagram about the pillars of sustainable development and find out the example of each pillar in your surrounding.
c. Analyse the principle of sustainable development based on the article.

THE CONCEPT OF SUSTAINABLE DEVELOPMENT

The Key Concept of Sustainable Development

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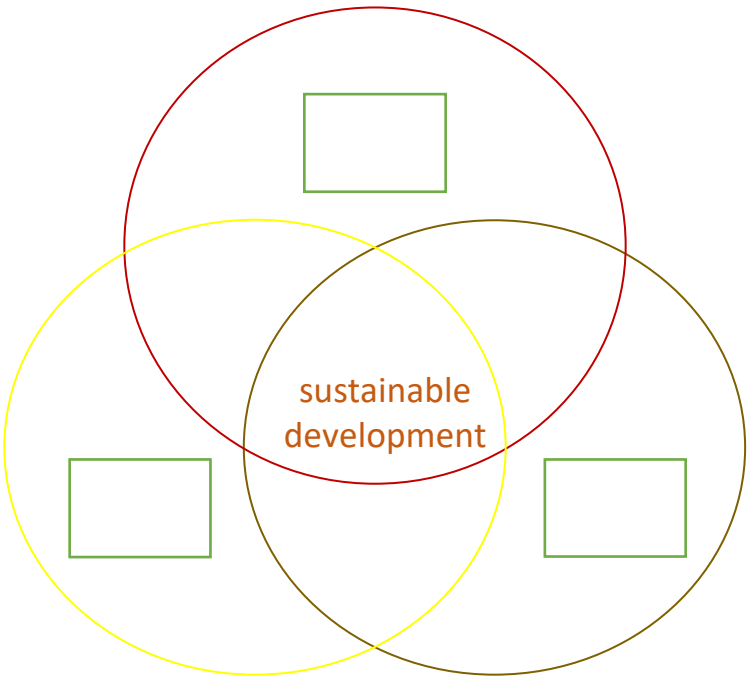
"Sustainable Development for
A Better Future"

THE PILLARS OF SUSTAINABLE DEVELOPMENT

Fill the diagram below

Example:



Example:

Example:

THE PRINCIPLE OF SUSTAINABLE DEVELOPMENT

The Principle of Sustainable Development

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SUSTAINABLE DEVELOPMENT GOALS

Education for Sustainable Development (ESD) is commonly understood as education that encourages changes in knowledge, skills, values and attitudes to enable a more sustainable and just society for all. ESD aims to empower and equip current and future generations to meet their needs using a balanced and integrated approach to the economic, social and environmental dimensions of sustainable development. There are 17 SDGs aiming to create a better world by 2030 by ending poverty, fighting inequality, and addressing the urgency of climate change. **The 17 SDGs are:** (1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reduced Inequality, (11) Sustainable Cities and Communities, (12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life On Land, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals.

Citrus nobilis ORGANIC-FARM MANAGEMENT AND *SUSTAINABLE DEVELOPMENT*

Task 2: Based on your knowledge on sustainable development and *Citrus nobilis* Organic Farm Management, analyze and evaluate how far ***Integrated Management of Healthy Citrus*** **relates to sustainable development!**

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SUMMARY SECTION 4
SUSTAINABLE DEVELOPMENT THROUGH *CITRUS NOBILIS* ORGANIC-FARM MANAGEMENT

Task 3: After studying this fourth section, please make a summary based on your own understanding!

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