FACTSHEET

Naturland ACADEMY

COFFEE LEAF RUST IN EAST AFRICA

The Coffee leaf rust (CLR), known as orange rust as well, is caused by the biotrophic fungus Hemileia vastatrix Berk. & Br. CLR is a disease specific to genus Coffea and can infect all species in this genus. Coffee leaf rust (CLR) inflicts significant harm on coffee plants by inducing extensive leaf defoliation resulting in substantial reductions in yield of up to 75%, and in some cases can result even in total plant health.

Figure 1: *Coffee leaves covered in coffee leaf rust.*
© Purdue University

Damage of Coffee leaf rust

Infected coffee plants will drop infected leaves prematurely (figure 8), and severe infections can cause significant defoliation. This will result in long, bare branches and decrease the ability of the plants for photosynthesis. This reduces coffee plant ability to produce coffee beans. Due to defoliation and the plant's weakened state, the overall yield of coffee beans will be reduced, impacting both quality and quantity.

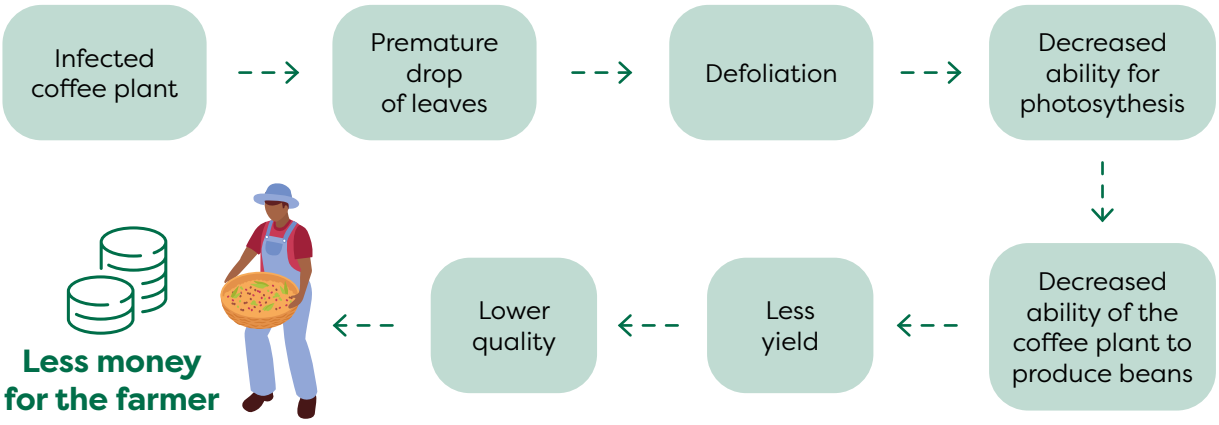

Figure 2: *Coffee leaf rust progression and its consequences. © Naturland e.V.*

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Symptoms of Coffee leaf rust

The Hemileia vastatrix fungus life starts when its spores are released into coffee leaves. Once they land, these spores germinate, and the infection phase begins.

The early signs or symptoms observable are small pale-yellow spots on the upper surfaces of the leaves (figure 3). Eventually with time these spots are formed together increasing in size and forming yellow-orange larger masses with yellow dust on the underside of the leaves (figure 4). Powdery lesions on the underside of the leaves can occur either in yellow-orange or sometimes in red-orange, depending on the region. Leaf spots will grow and join together to form bigger irregular spots (figure 5). In figure 6 you can observe leaves of coffee infected with fungi before drying out and turning brown. Over time, the center spots will dry out and turn brown as seen while the edges will continue to expand and produce uredospores.

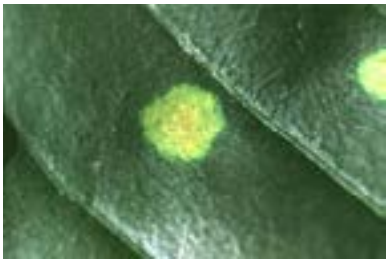

Figure 3: *First symptoms, lesions observed on the coffee tree.*
© Phil A. Arneson

Figure 4 *Stage of the development of urediniospores in size underside of the leaves in yellow-orange color 10-14 days after infection.*
© Phil A. Arneson

Figure 5: *Advanced stage of Yellow-Orange masses lesions of the fungus which continue to enlarge over a period of 3-4 weeks underside of coffee leaf.*
© Nigel Cattlin/Alamy

Figure 6: *Coffee species leaf infected with coffee rust.*
© Ezequiel Becerra – AFP/Getty Images

Figure 7: *Leaf defoliation caused by coffee leaf rust. © Dr. Melanie Bordeaux*

Conditions of the development of *Hemileia vastatrix*

In Rwanda, the environmental conditions are optimal for the development of the fungus: the average temperature ranges from 21 to 22 °C, and the long rainy season, especially from March to May and short rainy season from September to November, bring high levels of humidity (70–80%) that are critical for the development of *H.vastatrix*. Rainfall provides the moisture needed for fungal spores' germination and disease spread. During the rainy season disease will develop and spread.

A fungal germ tube of *H.vastatrix* enters coffee leaves through tiny pores called stomata on the underside of leaves. When it enters inside, the fungus spreads its nutrient-absorbing structure, called mycelium, within the leaf cells. It uses specialized structures called haustoria to draw nutrients from the cells. Eventually, there are orange clusters of spores out from the stomata. Fungal attack comes from spores that enter the leaf from the underside, where the tiny pores (stomata) are more numerous.

Coffee leaf rust life cycle

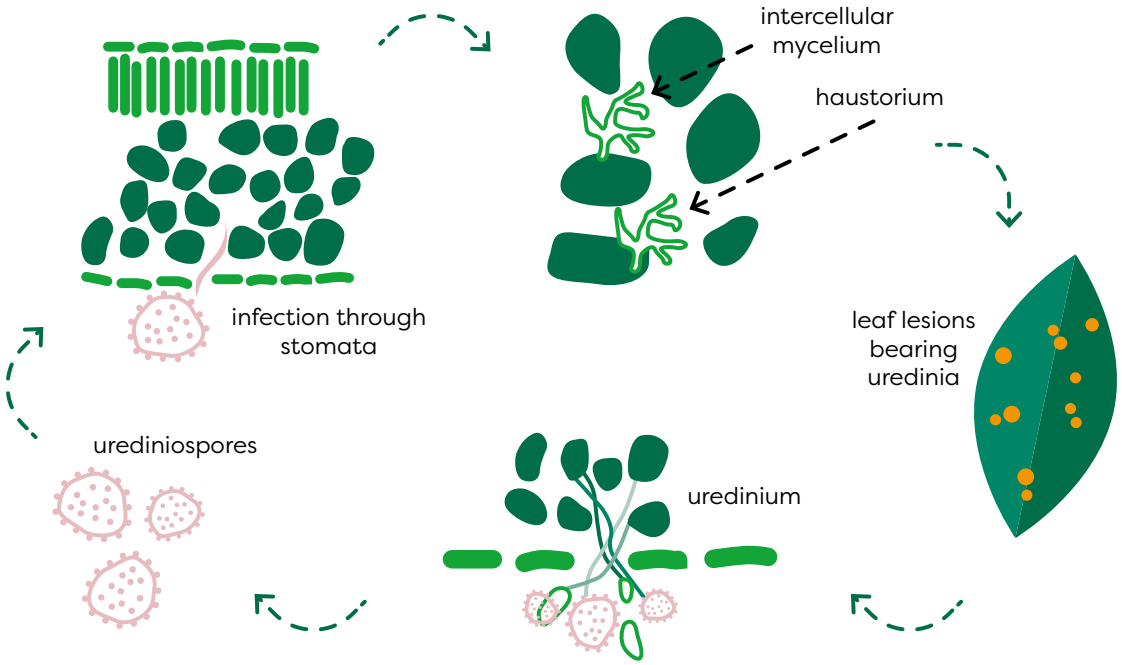

Figure 8: *Coffee leaf rust disease cycle. Illustration adapted from Phil A. Arneson, Cornell University, 2011*

Spore germination in the presence of constant rain that falls for at least six hours, so it should be uninterrupted wetness on the leaf surface due to rainfall or heavy dew. When the first yellow spots appear and are visible on the field, this means that the spores have germinated and are feeding on the coffee leaves and this process started approximately 24 days before.

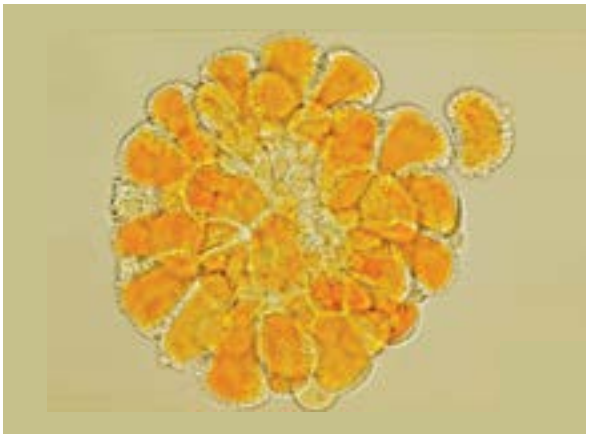

Figure 9: *Uredinium structure producing uredinio-spores with orange* ***rust color.*** *© Carvalho et. (2011)*

Management Practices for fungus *Hemileia vastatrix*

Protecting coffee leaves from Coffee leaf rust (CLR) becomes vital, especially during fruit development, as healthy foliage is necessary for carbohydrate provision. To prevent Coffee leaf rust (CLR) in organic farming, the following measurements should be taking including cultural practices and preventive measures:

1. Shade management

A good shade quality prevents coffee leaf rust which can be reached with diversified species, ages, middle and upper tree layer to provide quantity and quality of the shadow in the agro-forestry system. The shade should not completely block sunlight but rather allow filtered light to penetrate. Having trees of different ages ensures that there is a continuous provision of shade as older trees might be pruned or die off. Trees help to regulate the microclimate of the coffee plantations, and this is very important because coffee plants are very sensitive to temperature variations.

After the coffee harvesting season, shade pruning can take place at the beginning of summer, and another pruning management can take place at the beginning of the rainy season. During the time of dry season, the coffee trees would require more shade, so it is not advised to prune heavily during that time of year. While, at the beginning of the rainy season, there is a need for more light input for the coffee trees to prevent coffee leaf rust, so higher pruning is required. Furthermore, shade trees have the ability to increase soil fertility and improve organic matter, and that would result in the coffee plant becoming more resistant to fungal disease. Shade conditions provide favorable conditions for natural enemies as well and this would prevent development of the disease (See fact sheet “Shade trees for agroforestry systems: Rwanda” on the Naturland Academy).

According to the Naturland standards, at least 70 shade trees per hectare are required with a coverage of 40% of shade throughout the year. It is also required that 12 different species of shade trees per hectare and coffee trees and shade trees should form three tree layers or at least 2 tree layers and this will contribute to better plant health and prevention of coffee leaf rust.

2. Coffee pruning and sucker removal

Another important management is pruning of coffee trees which would rejuvenate old coffee trees. That would mean removal of unproductive branches and stems and that would encourage growing of new stems. Pruning would help to eliminate infection with fungal disease and eliminate any broken branches so that the coffee tree can be renewed. Pruning is preferred to occur if there are signs of exhaustion, that would be in the third year of production, or it can be after five to six years after planting the crop. It is crucial that the pruning is done at the end of the coffee harvest season, so it should be done before the trees start to flower again.

Sings of exhaustion of coffee trees can be:

- unproductive branches
- damaged or dead branches (from the middle to the top upper part of the plant).
- very little foliage
- infested with pest and diseases

3. Application of Organic fertilizers

Organic fertilizers can help and prevent coffee leaf rust by promoting overall health and resilience of coffee plants. By adding organic matter and beneficial microorganisms' better structure of the soil would be created allowing plants to absorb nutrients and water more efficiently. This would increase resilience and plant health against coffee leaf rust.

- Efficient microorganism: (effective microorganisms are mixed cultures organisms which occur naturally, and they can be applied as inoculants to improve soil and plant growth)
- Decomposed cowshed manure

You can find further learning materials on the online platform of the Naturland Academy:

- **Compost Guide**, Naturland Academy
- **Composting of Coffee pulp**, Naturland Academy
- **Manual on Vermicompost**, Naturland Academy

4. Use of resistant cultivars and selection of good planting material

It is important to select good quality planting material that is pest and disease-free and choose suitable rust-resistant coffee cultivars that are adapted for the local climate.

If the farmer chooses their own seeds to establish it is important to select:

- Pest and disease-free seeds (this can be done by observing on the tree with naked eye)
- Good-sized and very ripe berries
- Uniform bean size and a healthy bean

Farmer can use the float test to choose viable seeds. Put the berries in a bucket of water and select the berries that are sinking. Coffee berries that sink are the good ones because they are filled with healthy, mature seeds.

If the farmer chooses to do vegetative propagation, for example, by clonal cuttings it is important to choose mother plant which is the tree selected with desired characteristics, for example:

- Resistance to common diseases or has higher yield capacity within the coffee plantation and pest and disease free.
- Tree age between 7–12 years
- Plant bearing a high fruit load

Figure 10: *Float test with infected and overripe berries floating & healthy and ripe berries at the bottom. © Amanda Bensel*

Farmers can ensure the quality of planting material by sourcing it from certified and registered nurseries or suppliers. Observation can also occur on the spot where farmers can check if they notice any symptoms of disease or pests in the planting material.

Some of the varieties that can be grown with higher resistance to Coffee leaf rust are:

Cultivar	Species
Ruiri II	Arabica
SL 28	Arabica
Batian	Arabica
Tuzza	Arabica
Sarchimor	Arabica x Robusta
Pop 2/91	Arabica
Catimor T8663	Arabica x Robusta
Timor hybrids	Arabica x Robusta

Table 1: *Suitable coffee varieties for Rwanda, East Africa*

5. Biological control agents

Control of different pests or pathogens such as *H.vastatrix* can be also managed through with the introduction of different microorganisms or insects which can act as a biological control agents. However, the price of such biological control agents is an important component to take into account, as their high price may affect the economic viability of the plantation. Biological control agents have mechanisms such as competition, hyperparasitism, or induced resistance which can suppress pests and pathogens. These organisms include: fungi, bacteria and insects, having the ability to inhibit the growth of *H.vastatrix*. By farming coffee trees in agroforestry systems, this natural enemies can occur in the coffee plantations.

Figure 12: *The antagonist Lecanicillium lecanii (white spores) attacking H.vastatri (orange spores) on a coffee leaf tree. © Dr. Melanie Bordeaux.*

List of biological control agents against coffee leaf rust:

- Fungus: *Calonectria hemileiae, Lecanicillium lecanii* (figure 12), and *Trichoderma harzianum.*
- Insects: *Ricoseius laxocheles.*
- Bacteria isolates: *Bacillus lentimorbus* and *Bacillus cereus*).

6. Copper-based Fungicides

- Copper oxychloride
- Bordeaux mixture
- Copper sulphate + lime
- Sulphur + lime (Sulphuric lime).

Same as for the biological control agents, copper-based fungicide are very expensive, and may not be accessible for smallholder farmers. Application of fungicide according to Naturland standards include copper preparations used as prophylactic measure and the quantity is limited to 3 kg per hectare and year.

To manage diseases in coffee plantations would require regular monitoring and scouting on the coffee field to identify infections as early as possible. That would allow farmers to have enough time to make the intervention before the damage occurs!

The biological control methods might not be appropriate for all the farms. The introduction of biological control agents and copper-based fungicides into the farms will be expensive, requires labour and proper equipment for their application. The level of effectiveness might not be the same every time as it will depend on the severity of infection, climate, optimal conditions for the biological agents to multiply etc. Greater effort should be placed on preventing the infection by following the mesures 1, 2, 3 and 4. This will increase the quantity and quality of the berries which will increase the income for the farmer.

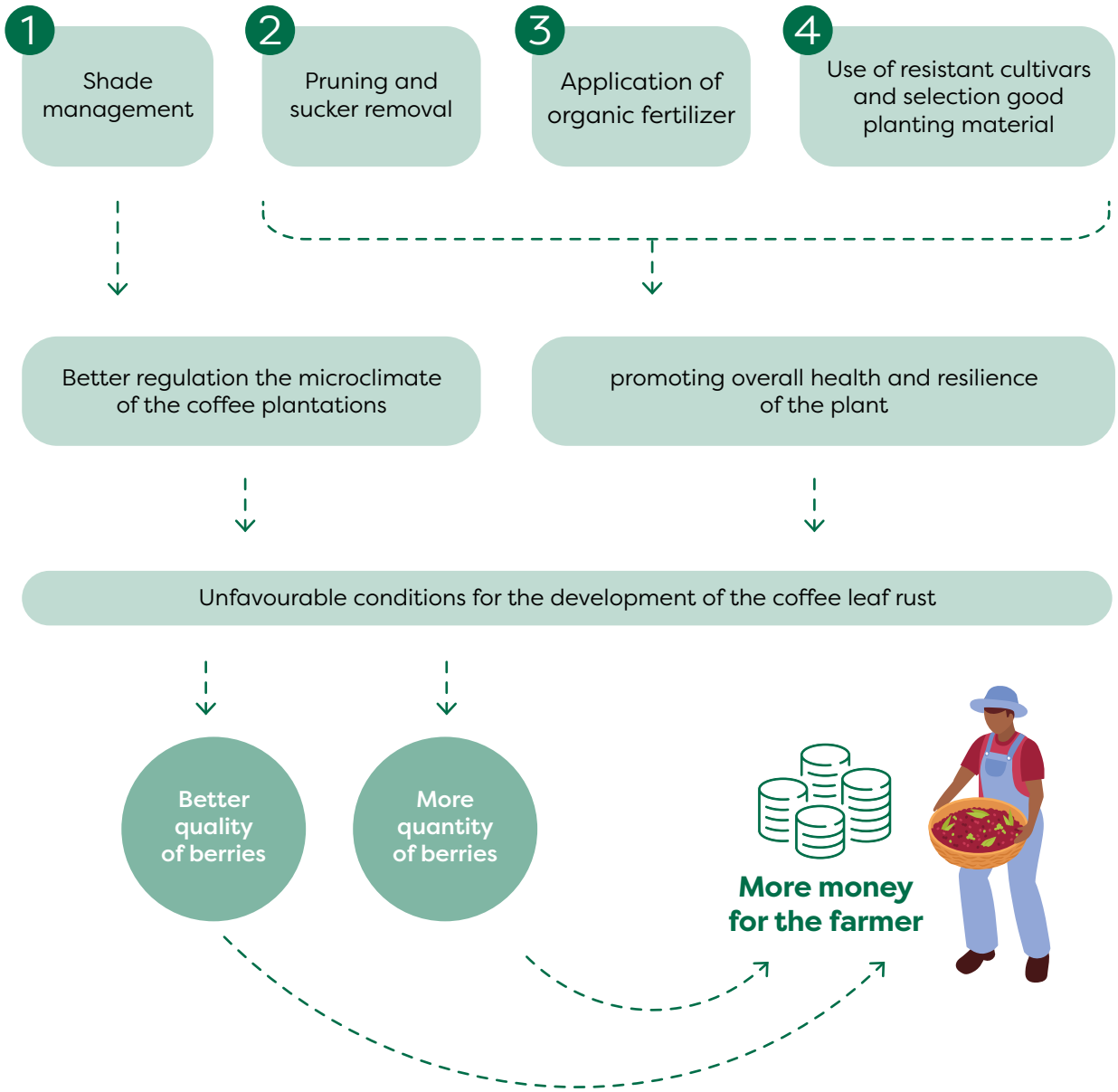

Figure 13: *Summary of the effects of cultural practices to control coffee leaf rust. © Naturland e.V.*

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Picture sources

Figure 1: Purdue University (photo/courtesy of Catherine Aime)

Figure 3 and 4: Arneson, P.A. 2000. Coffee rust. The Plant Health Instructor. DOI: 10.1094/PHI-I-2000-0718-02, updated 2011. https://www.apsnet.org/edcenter/disandpath/fungalbasidio/pdlessons/Pages/CoffeeRust.aspx

Figure 5: Nigel Cattlin/Alamy, https://www.britannica.com/science/coffee-rust/images-videos

Figure 6: Ezequiel Becerra – AFP/Getty Images, https://www.britannica.com/science/coffee-rust/images-videos

Figure 7 and 12: Courtesy of Dr. Melanie Bordeaux, director of NICAFRANCE Foundation's research center, Nicaragua

Figure 8: Figure adjusted from Vickie Brewster (Arneson, 2011)

Figure 9: Courtesy of Carvalho et al. (2011), Creative Commons Attribution 2.5 via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Hemileia_vastatrix_Uredinium_02.png

Figure 10: Amanda Bensel, https://sites.middlebury.edu/amandabensel/2012/08/07/the-coffee-process-from-field-to-roastery/

Figure 11: Figure adjusted African Organic Agriculture Training Manual: FiBL, Research Institute of Organic Agriculture. Suitable coffee varieties for East Africa, Rwanda.

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