Coffee Climate Care Vietnam

CLIMATE CHANGE AND VIETNAMESE COFFEE PRODUCTION

MANUAL ON CLIMATE CHANGE ADAPTATION AND MITIGATION IN THE COFFEE SECTOR FOR LOCAL TRAINERS AND COFFEE FARMERS

UTZ Better farming Better future

DE FOUNDATION

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Imprint

Produced for coffee farmers and trainers in Vietnam

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FOREWORD

The agricultural sector is increasingly faced with major challenges. They arise from complex market interactions and crystalize in, among others, increasing prices of labor as well as of input materials, and daily changing supply and demand of products. Climate change aggravates the already difficult business of agricultural production with severe weather events such as prolonged droughts, heavy rains, tornadoes, hurricanes and floods.

To limit the risks from climate change for coffee farmers, UTZ Certified implemented the Coffee Climate Care project under the support of the Douwe Egbert Foundation (DEF) and the Deutsche Investitions- und Entwicklungsgesellschaft (DEG) together with the two trading companies ACOM Vietnam Lt. (member of the ECOM coffee group) in Lam Dong and DAKMAN in Daklak. The project aimed at helping coffee growers get the information and good farming practices to minimize production losses caused by climate change.

Running for 3 years, the scope and time line of the project were inherently limited. However, good results were achieved through great coordination on the local level and smooth collaboration of different partners. A thorough documentation made it possible to develop an extensive body of (training) materials. National and international scientists together with local extension staff and farmers representatives identified the impacts of climate change on coffee production in the two areas in Vietnam, and analyzed the risks occurring for farmers during coffee cultivation and the greenhouse gas emissions per ton coffee. This data collection formed the basis of the content of this manual as well as other training material for coffee growers and local trainers in the situation of current climate change.

This manual aims to assist producers in adapting to and mitigating climate change by providing information on climate change, the concepts of adaptation and mitigation and, in particular, by presenting farming practices that coffee growers have made good experiences under the new challenges related to climate change. Although these practices are not entirely new, coffee growers were hesitant in the past to implement them for various reasons. However, without these practices coffee cultivation will not be feasible for farmers in the near future and, especially, for those of future generations.

Climate change is complex and uncertain and only a flexible management can deal with such a problem. We therefore explicitly welcome any feedback - suggestions and experiences – which will be taken into account when next versions are developed.

We sincerely thank all the farmers in the two pilot areas, the donors, scientists, managers and local extension staff. Their enthusiastic participation formed the basis for the implementation of the project and for developing this manual.

1. INTRODUCTION: COFFEE, CLIMATE CHANGE AND UTZ

In many tropical and subtropical regions climate change threatens to become an environmental disaster for farmers due to decreased water availability, new or different pest and disease attacks and more frequent extreme weather events. Crop yields are at risk, in terms of quality and quantity and hence farmer income. Robusta as well as Arabica coffee are especially vulnerable to such climatic hazards as they depend on a very narrow climatic range. Scientific projections warn that climate change can reduce the area climatically suitable for coffee production by up to 50% especially in lower altitudes if no action is taken[1].

While climate change affects agricultural production, the latter in turn contributes to the global climate change phenomenon by emitting greenhouse gases (GHG) through e.g. deforestation, decomposition of organic residues and fertilizer use. Consequently agriculture, forestry and land use changes account for around 25% of global emissions[2]. There is, therefore, an increasing need for approaches in agriculture that not only help farmers adapt to a changing climate but also minimize the contribution of farming to global warming.

Because of these two sides of the same coin – climate change impacting agriculture as well as agriculture contributing to climate change – UTZ‘ mission to support sustainable farming worldwide is compromised by climate change. UTZ therefore addresses climate change through requirements in the Code of Conduct as well as through specific pilot projects. The Coffee Climate Care project in Vietnam (C3) is one such pilot project. C3 ran from 2013 to 2015 and worked on adaptation strategies that make coffee producers more resilient against climate change impacts. Additionally, greenhouse gas emissions in coffee production were analyzed. The partnership is sponsored by the Douwe Egberts Foundation and the Deutsche Investitions- und Entwicklungsgesellschaft (DEG) with public funds of the German Ministry for Economic Cooperation and Development (BMZ).

Among the first steps in regards to producer level interventions the project carried out kick-off workshops with two producer units in Vietnam and sensitization sessions with coffee farmers. These sessions aimed at generating basic knowledge around climate change impacts on coffee production and response options at farmer level. The most severe climate change hazards for the Vietnamese coffee production were identified in vulnerability assessments with both farmers and experts, together with other sector experts. These hazards include, for example, an increased occurrence of droughts, erosion and rising temperatures (heat stress). Based on these assessments suitable adaptation practices were implemented in pilots on the ground. They included shading, ground cover, improved fertilization and irrigation.

The results of the project fed back into the core work of UTZ around the UTZ Code of Conduct[3]. Implementing the Code’s good agricultural practices already helps certified groups adapt to climate change. Improving water management helps producers adjust to decreased water availability in the future. Choosing suitable crop varieties and improving soil fertility increase resistance to droughts. Furthermore, making efficient use of resources using less energy from non-renewable sources and reducing waste and pollution reduces farmers’ contribution to climate change[4].

However, the effects of climate change differ from region to region. Some regions might not be affected, while others face severe impacts. The UTZ Code of Conduct therefore asks each certified entity to analyze their situation and to assist members in designing and implementing measures that alleviate the impacts of climate change where needed (for guidance on this topic see the guidance document available at the UTZ’ homepage)[5].

During the course of the C3 project a lot of experience was built on how to set up trainings in the Vietnamese context. This manual ensures that this experience is disseminated to other farmers, trainers and certified entities as they also have to address climate change in order to comply with the UTZ Code of Conduct. More importantly, it shall help coffee farmers be well-prepared for a future with changes in local micro-climates.

1 Bunn et al 2014
2 IPCC, 2014
3 Available at https://utz.org/resource-library/?fwp_media_type=documents&fwp_language=english&fwp_main_categories=code-of-conduct
4 The mentioned practices are covered (in order as they’re mentioned) under control points G.B.68, G.B.108, G.B.109, G.B.110, G.B.36, G.B.46, G.B.48, G.B.68, G.B.70, G.D.119, G.D.114 in the UTZ Core Code of Conduct, Version 1.1, For Group and Multi-Group Certification, 2015
5 Control point G.D. 114, UTZ Core Code of Conduct, Version 1.1, For Group and Multi-Group Certification, 2015

This manual is structured as follows: chapter 2 presents general information on climate change, chapter 3 the concepts of adaptation and mitigation, chapter 4 describes different training methodologies including vulnerability assessment seminars and farmer training methods and chapter 5 farming practices that coffee growers can implement in order to become more resilient against climate change and to reduce their own impact.

Most chapters include background as well as very practical information. To make it easier for trainers and farmers to distinguish the practical information from the background, we highlighted them in blue boxes, called "How to implement". In some chapters they contain information on how to conduct a specific training; in others they contain information that should be considered when implementing a certain practices. What unifies them is that they contain information that should be considered when practically implementing the advice elaborated in this project.

2. CLIMATE CHANGE – AN INTRODUCTION

2.1 WHAT IS CLIMATE CHANGE AND WHAT ARE ITS CAUSES?

Climate change is a natural phenomenon and is defined as any significant change in measures of climate, such as temperature or precipitation, lasting for an extended period of time, typically decades. This definition by the Intergovernmental Panel on Climate Change (IPCC) is internationally recognized and includes the natural climate change phenomenon as well as climate change caused by human activity. The IPCC is the leading international scientific body on the assessment of climate change under the auspices of the United Nations.

Persistent human activities like driving cars, farming, burning coal and cutting down forests produce greenhouse gases (GHG) – mainly carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and haloflourocarbons (HFC). These gases gather in the atmosphere, trap heat and thereby speed up the natural climate change phenomenon:

The earth receives energy from the sun in form of short wave radiation. Solar radiation passes through the atmosphere to reach the earth's surface. The earth absorbs some of the energy and radiates the rest back into the atmosphere in form of infrared radiation, which is then absorbed by such greenhouse gases. Thereby infrared radiation remains in the atmosphere, which leads to global warming. An increased amount of GHG in the atmosphere in turn leads to changes in our climate.

Figure 1 describes this process:

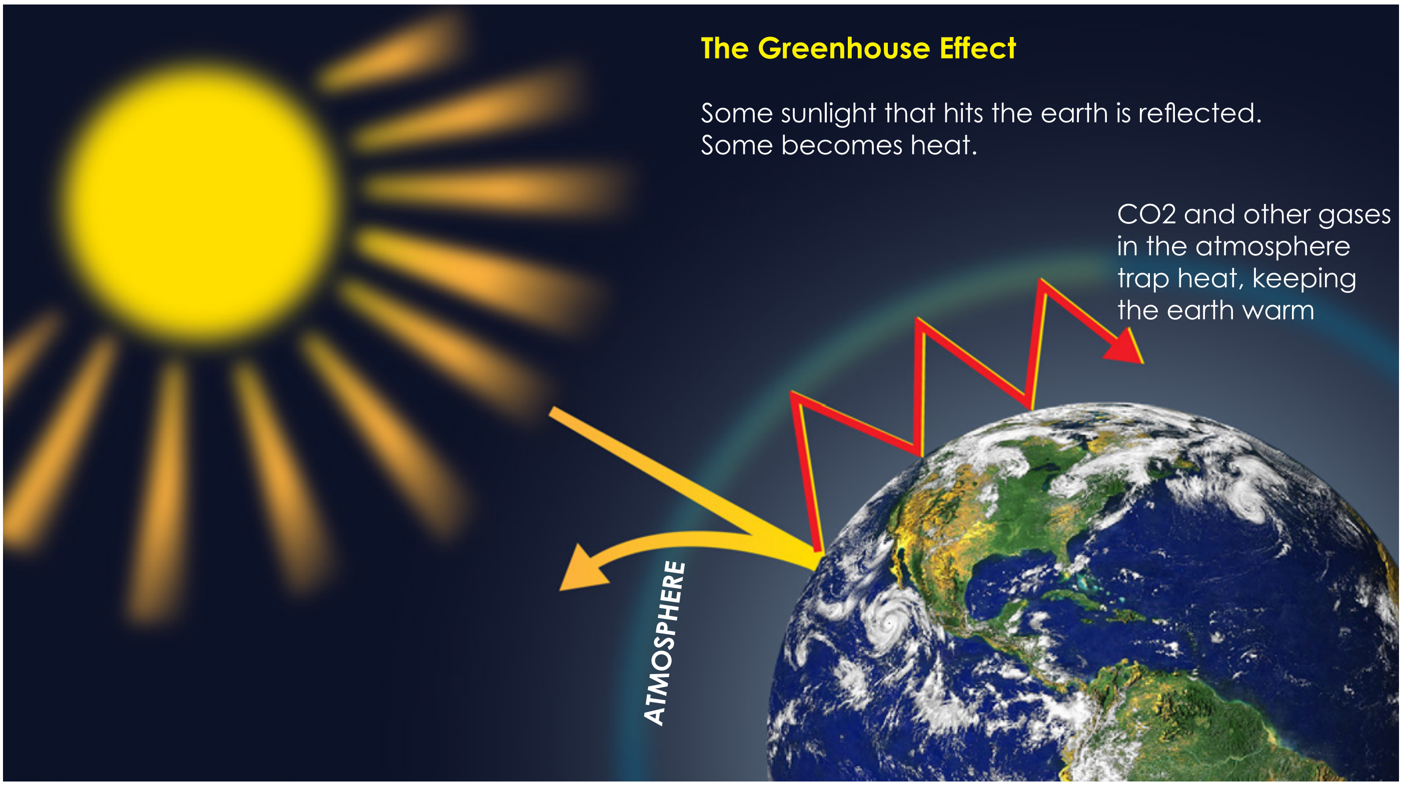


Figure 1: The Greenhouse Effect (Adapted from Department of Ecology, State of Washington)

On global level there are several sectors causing greenhouse gas emissions. The IPCC has identified 6 main sectors: electricity and heat production, buildings, transport, industry, other energy and "agriculture, forestry and other land uses" (AFOLU). The green sector, AFOLU, emits around 25% of global emissions, i.e. ¼ of total emissions worldwide:

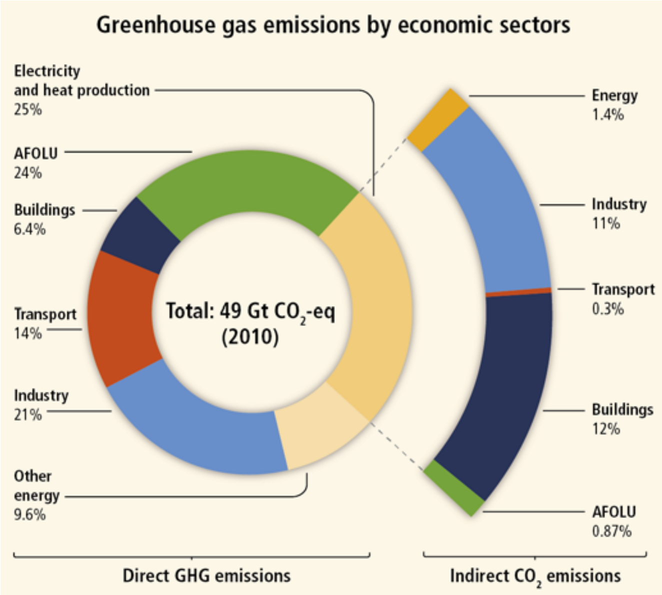


Figure 2: Global emissions by sector. Taken from IPCC, 2014.

Indirect emissions refer to GHG emissions caused by energy and heat production accredited to the specific sectors. As figure 2 shows, 0,87% out of the total 25% of emissions generated by energy and heat production can be accredited to agriculture, forestry and other land uses. In total AFOLU thus is responsible of 24,87% of global emissions.

In agriculture, such as coffee farming, there are several sources capable of causing greenhouse gas emissions. Emissions accredited to the sector are listed below; however, the list is not prioritized according to the volume each source emits, but rather structured to correspond to figure 3:

1. Emissions caused at the homestead (e.g. through cooking (with wood, coal etc.), building with wood or using electricity; mainly CO2 is released)
2. Emissions from livestock (natural digestion leads to CH4 emissions)
3. Emissions from soil disturbing activities (e.g. tillage leads to N2O emissions)
4. Emissions from farm machinery (e.g. tractors cause CO2 emissions)
5. Emissions from deforestation or destruction of vegetation (e.g. burning of biomass leads to CO2 emissions)
6. Emissions from fertilizer or pesticide application (lead to N2O emissions)
7. Emissions from energy generation on the farm e.g. through anaerobic digestion processes such as in bio-digesters (depending on the source of energy (manure, compost etc.) can lead to CO2, N2O or CH4 emissions)

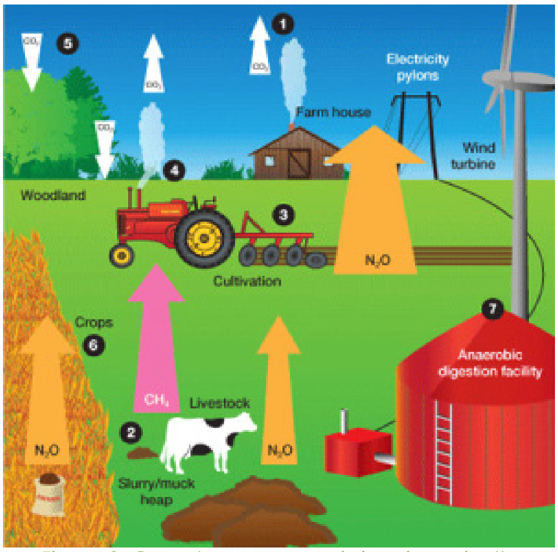


Figure 3: Greenhouse gas emissions in agriculture.
Taken from Occupy Monsanto, 2015.

However, the agricultural sector does not only release greenhouse gases into the atmosphere, but it also has the potential to store such gases. Biomass, i.e. biological material such as trees, shrubs, bushes or grass, absorbs CO2 through photosynthesis. As long as the biomass grows, it therefore stores increasing amounts of CO2 and thus reduces the CO2 in our atmosphere. Through natural decomposition or by humans harvesting, logging or clearing vegetation this CO2 is, however, released back into the atmosphere over time.

2.2 WHAT ARE THE IMPACTS OF CLIMATE CHANGE?

The increase of GHG caused by human activity thus warms the climate system. According to IPCC the warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and the sea level has risen[6], leading to many changes in our weather conditions.

Climate change is an internationally recognized problem and its impacts are noted on global level throughout many different sectors – agriculture being one of them. The main impacts of climate change are a rise in the intensity and frequency of extreme events such as storms and floods, increasing temperatures, changes in rainfall patterns, the melting of glaciers, the warming of oceans and the warming of the poles leading to a rise in our sea level.

These impulses by our climate are called **climate hazards** or **climate stimuli**.

In the future such hazards are likely to intensify. With regards to temperature and precipitation the IPCC predicts the following further future changes on global scale:

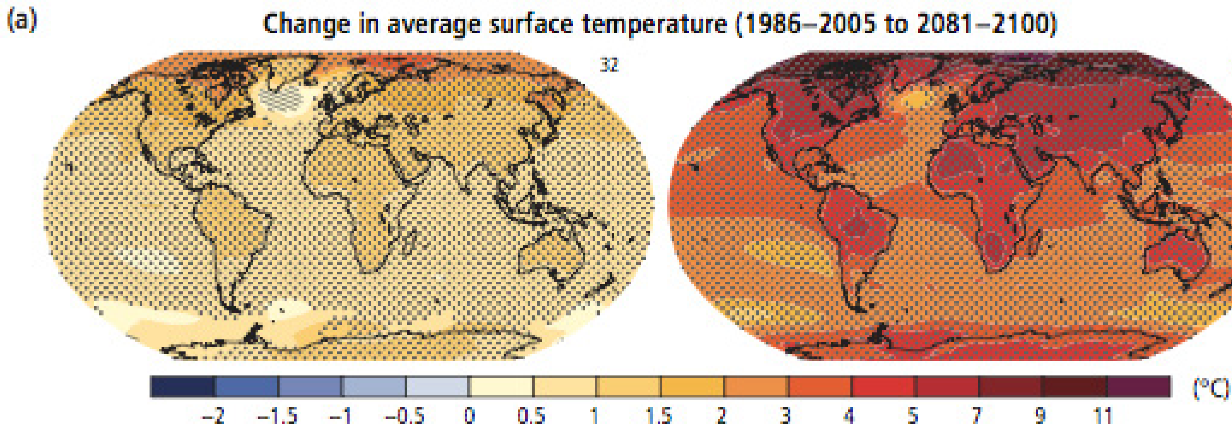


Figure 4: Change in average surface temperature (average between 1986-2005 on the left; predicted average between 2081 and 2100 on the right); taken from IPCC, 2014.

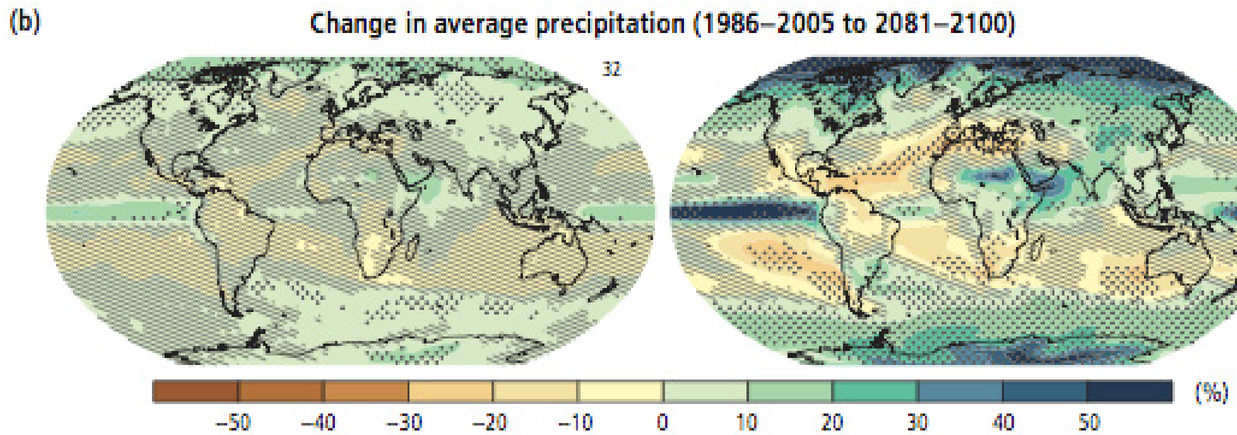


Figure 5: Change in average precipitation: average change between 1986 and 2005 on the left; projected change for period from 2081 to 2100 on the right; taken from IPCC, 2014.

6 IPCC, 2014

According to these predictions global surface temperature is likely to increase by 1.5°C until 2100 with more frequent hot and fewer cold temperature extremes over most land areas. In many mid-latitude and subtropical dry regions, mean precipitation will likely decrease, while in many mid-latitude wet regions, mean precipitation will likely increase. Extreme precipitation events over most mid-latitude landmasses and over wet tropical regions are very likely to become more intense and more frequent as global mean surface temperature increases. Furthermore, it is likely that the area under monsoon systems will increase and monsoon precipitation is likely to intensify. El Niño-Southern Oscillation related precipitation variability on regional scales is likely to intensify. However, it is important to understand that climate change impacts are site-specific depending on local conditions and local climatic changes.

For the agricultural sector these climate hazards are likely to translate into a loss in biodiversity, longer growing seasons, increases in pests and vector borne diseases and more unpredictable farming conditions. Ultimately, farmers especially in tropical areas and small-scale agriculture are expected to be among the ones hit hardest (see also next chapter).

2.3 WHAT ARE CLIMATE CHANGE IMPACTS ON COFFEE PRODUCTION?

The rate in which climate change normally appears does not cause major problems to flora and fauna. The fact that temperatures worldwide are increasing is not even a problem in itself. However, the fact that the climate is changing as rapidly as never before turns it into a problem. Due to this rapid change, plants and organisms are not able to adapt fast enough. Whereas normally this process would take hundreds or maybe even thousands of years, many plants and organisms now do not have enough time to adapt to the changing climatic circumstances. This is also the case in coffee. The fact that climate is changing is not an insuperable problem, but the rate it is currently doing so creates magnificent impact.

Increasing temperatures and changing rain patterns cause the main impacts in the coffee sector. Optimal conditions to produce Robusta coffee include temperatures between 22 and 26°C and annual rainfall around 1,500ml. For Arabica coffee temperatures between 15 and 24°C and 1500 to 2000ml of rainfall per year are ideal. Coffee plants are fairly vulnerable to even small changes in climatic conditions. Changes in rain patterns lead to changes in flowering, ripening and thus harvesting times; strong winds cause reduced flowering and the falling of coffee flowers and cherries; and changes in temperatures lead to more frequent or new pest and disease attacks. Additionally, erosion and washing out of soils (leading to a loss of soil fertility) can be caused by changes in local microclimates. Ultimately, coffee quantity and quality is jeopardized which endangers coffee producers' livelihoods (see also figure 6 and table 1).

Figure 6: Examples of climate change impacts on coffee production (from left to right): Reduced flowering; pests and diseases (spread, appearance and/or more frequent attacks); random flowering and having different stages of berry growth on one branch.

Looking into the impacts of specific climate hazards on coffee, examples include:

Table 1: Examples of climate change impacts per climate hazard

Climate hazard	Impacts on coffee production
Increasing temperature leading to high temperatures in coffee producing areas	• Reduced photosynthesis of the plant • Slower or no ripening process • Flower abortion • Changes in pest and disease incidents • Erosion and loss of soil fertility
Changes in rainfall patterns	• Several poor flowerings ("crazy flowering") throughout the year • Problems in coffee drying • Changes in flower development and fruit set • Wilting (in case of longer dry periods)
Natural extreme events (strong winds / storms, hail storms, frosts etc.)	• Falling of coffee flowers • Loss of plants • Changes in flower development and fruit set

2.4 HOW DOES THE COFFEE SECTOR CONTRIBUTE TO THE GLOBAL CLIMATE CHANGE PHENOMENON?

As mentioned before agriculture, forestry and other land uses are responsible for around 25% of global greenhouse gas emissions. This means the green sector is not only hit by climate change but also contributes to this phenomenon – and thus can and needs to be part of finding suitable solutions.

A carbon footprinting study based on 116 sample farmers of Latin American Arabica coffees (Mexico, Guatemala, Nicaragua, El Salvador and Colombia) concluded that on average 1 kg parchment coffee generates 8.3kg CO¬2 equivalents (CO2 e or CO2 equivalents include methane, nitrous oxide and carbon dioxide emissions)[7].

35 % of these emissions are caused by fertilizer production and application, including background soil emissions, 7 % are due to prunings and crop residues decomposing and 57% are caused by fermentation and wastewater.12

These emissions can be compared with driving a Volkswagen Golf for 50 km. In other words, the production of 1 kg parchment in this case generates the same amount of CO2e as driving an average car over 50 km.

2.5 CLIMATE CHANGE AND VIETNAMESE COFFEE PRODUCTION[8]

Coffee farming in Vietnam started around 100 years ago and started growing very fast since the 1980s. From a country little known as coffee origin it has developed into the world's second biggest coffee producer (behind Brazil) and the leading country in Robusta coffee production. In a very short time land under coffee and coffee yields increased drastically in Vietnam, which testifies favorable conditions for coffee production as well as ambitious coffee farmers.

However, in the recent 10-15 years, coffee farming has become more difficult due to, e.g. increasing temperatures, reducing ground water levels, erratic rains, storms, floods, landslides, hail storms and tornadoes. Soil erosion and degradation, water shortages during the dry season (Vietnamese coffee production is not rain-fed, but depends heavily on irrigation), increased pest and disease attacks lead to the need for more investments regarding labor and inputs, whilst productivity and quality are negatively affected.

According to the UNDP Climate Change Country Profile for Vietnam temperatures in the country have increased by 0.4°C since the 1960s with the most dramatic increase between November and April (the dry season). In southern Vietnam the temperature increase has been more rapid than elsewhere in the country.

7 van Rikxoort et al, 2014
8 For further information around climate change and Vietnamese coffee production see also "Climate Change and Vietnamese Coffee Production – Synopsis Report", c3, K. Linne, 2014

By the 2060s the frequency of hot days and nights is expected to further increase substantially, whereby "hot" day or night refers to temperatures of 10% above the current climate in a specific region and season (UNDP 2005).

A study carried out by the International Centre for Tropical Agriculture (CIAT) in 2012 predicts an increase in total rainfall from 1,736ml (2012) to 1,748ml in 2050 and average temperature increase of 1.8°C till 2050. Figure 7 shows a climate trend summary developed within the framework of this study:

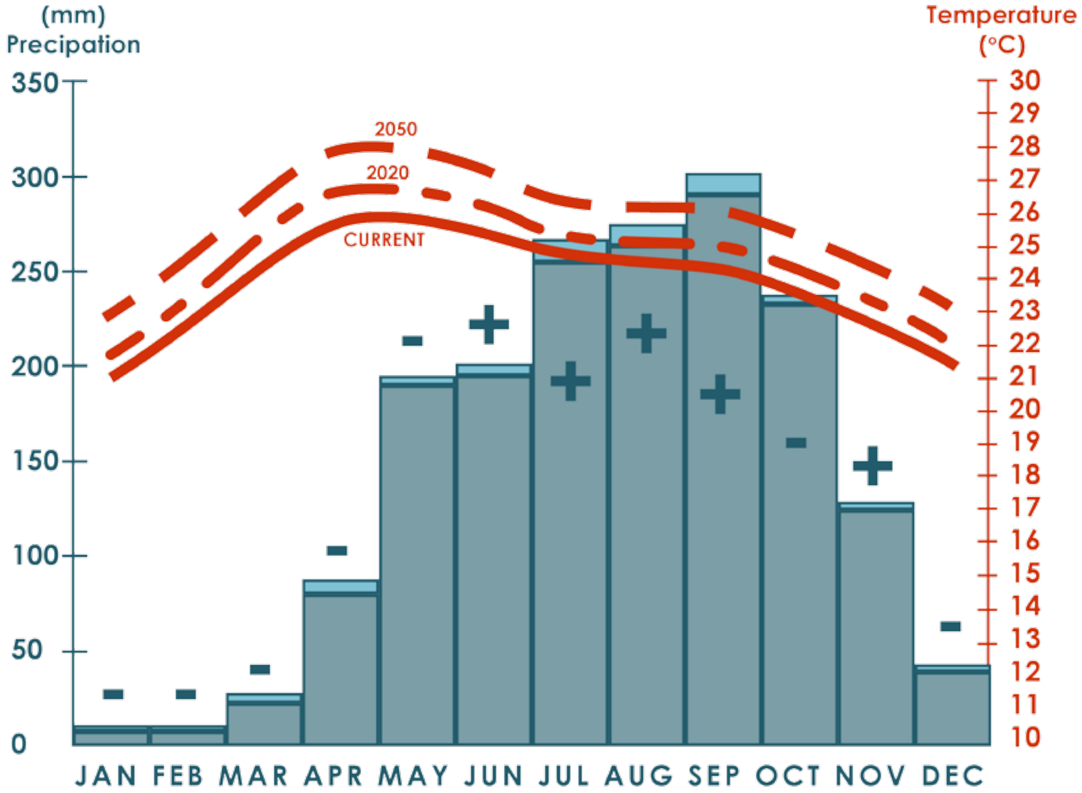


Figure 7: Climate trends in Vietnam. Summary plot taken from Läderach et al., CIAT 2012.

The blue bars represent precipitation per month and the red lines indicate monthly temperatures for the years 2012, 2020 and 2050. The climate trend summary shows a continuous increase in temperatures and changes in monthly rainfall (+ indicating an increase, - a decrease in the amount of rainfall during the respective month). In particular the temperature increase and decrease in amount of rainfall throughout the months March – May / June are concerning as this period is crucial for the fruit development in Vietnamese coffee production. This means water availability is very important throughout these months. Increasing temperatures are likely to lead to increasing evaporation transpiration rates: as it gets hotter water in soils or from water bodies evaporates at an increasing rate and at the same time plant transpiration rises. This increased "evapotranspiration", i.e. evaporation plus plant transpiration, is likely to lead to less water availability. Taking into account already decreasing ground water levels in Vietnam a lack of water and soil moisture can become serious issues for local coffee production.

According to the CIAT study with a focus on Robusta coffee some areas are predicted to decrease in climatic suitability and thus adaptation measures will be crucial. These areas are mainly located in Lam Dong and Dak Nong. Finally there will be production zones that become unsuitable for Robusta production in regards to climatic conditions. These zones are located in Dak Lak, Gia Lai and Dong Nai. Additionally there are expected to be areas where currently no coffee is grown, but that would climatically become suitable to do so. These are around Bi Dup-Nui Ba, Rung Thong, Da Lat and Ka Lon Song Mao. However, these regions are mainly protected areas in higher altitudes. However, it is of high importance to acknowledge that some of these areas are under the Vietnamese forest protection program and that the Vietnamese government has clearly defined agricultural boundaries for coffee production. Moving to such new areas is thus neither possible nor recommended.

Up to 2020 the losses in climatic suitability are mainly caused by a decrease in precipitation during the driest quarter coupled with an increase in precipitation during the wettest month. These changes will be responsible for 78% of the expected loss of 30% climatic suitability (mainly in Dak Lak and Gia Lai) by

2020 (CIAT 2012). Up to 2050 the driving factors for decreasing climatic suitability are an increasing mean temperature in the wettest quarter (around 1.7°C), increasing seasonality and increasing precipitation levels between August and October (by 26mm). The CIAT study predicts these changes to be responsible for 50% of the loss in suitability of up to 50% by 2050. Changes in the precipitation patterns may lead to changes in coffee flowering and ultimately in the ripening of the coffee cherries and their harvest. Coffee produced between 300 and 550masl is expected to be hit hardest, while coffee grown around 850masl and above may not experience major impacts.

Figure 8 visualizes these impacts on Vietnamese coffee production:

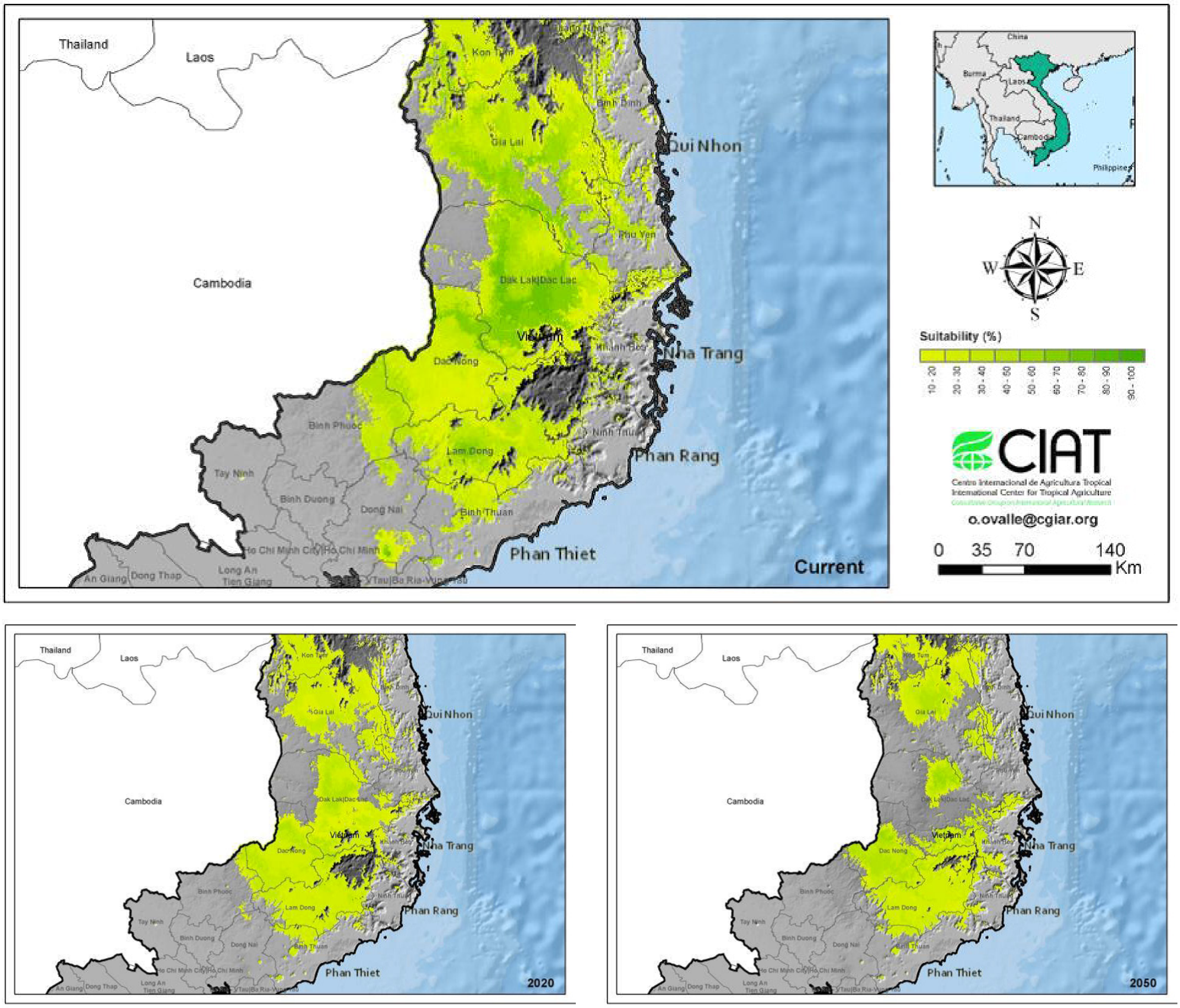


Figure 8: Climatic suitability for Robusta coffee production in Vietnam for 2011, 2020 and 2050. Adapted from Läderach et al., 2013.

3. HOW CAN COFFEE PRODUCERS RESPOND TO CLIMATE CHANGE?

3.1 CLIMATE CHANGE ADAPTATION

To maintain the income of coffee producers in the future they have to adapt to the changing climate. Climate change adaptation tries to minimize negative effects of climate change or to benefit from newly arising opportunities. The official IPCC definition is as follows:

> *Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation. (…)*[9]

Smallholder coffee farmers mainly have three options to adapt to climate change:

1. Adapting the production system, i.e. changing / adjusting farming practices
2. Adapting the coffee plant, e.g. through pruning, grafting or even a change to more suitable varieties
3. Creating an enabling environment, i.e. enhancing access to information and / or resources

Furthermore, adaptation has a social dimension when thinking about options to strengthen farmer families at household level, e.g. by looking into suitable construction material for the homestead or by diversifying income sources.

For adaptation purposes it is important to identify local impacts of climate change in coffee production systems. As most climate change predictions and future scenarios are developed on national level and or even broader regional level, it is important to include farmers' knowledge and experiences at the local level and combine these with scientific information available.
Local impacts of climate change very much depend on the following factors:

- Exposure of the system to climate change
- Vulnerability of the system
- Adaptive capacity of the system

Exposure is defined as *the degree to which a system (e.g. a coffee farm) is exposed to climate hazards* and *vulnerability* refers to *the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a climate hazard.* The *adaptive capacity* is *the ability of the system to adjust to climate change* (e.g. based on knowledge, access to information, resources etc.)[10]. Working with farmers it is best to discuss climate vulnerability by trying to understand reasons for being susceptible to climate change impacts. An easy example of this whole concept is rain during the dry period:

Formerly maybe there was no rain during the dry season, so people did not carry raincoats. Nowadays there may be rain during this time of the year (exposure), but people are not yet accustomed to carry raincoats as in their heads they still think that there will not be rain during the dry months (vulnerability). Ultimately, people get wet when it rains in the dry period. If people have access and enough resources (adaptive capacity) to obtain a raincoat, they can protect themselves against getting wet (adaptation).

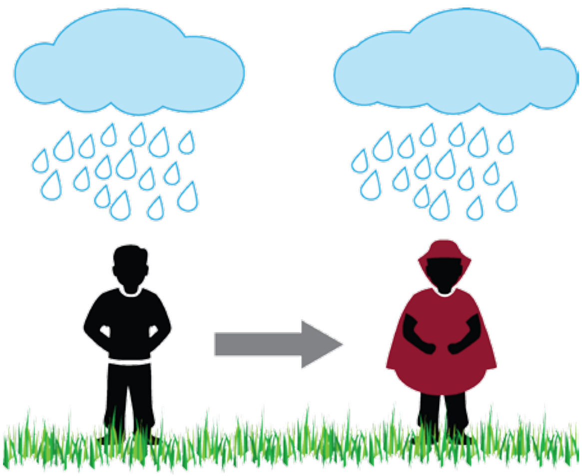


Figure 9: Adaptation

9 IPCC, Climate Change 2007
10 Adapted from United Nations International Strategy for Disaster Reduction (UNISDR) 2009

There are quite some adaptation examples to learn from. Such examples include:

- The Initiative for Coffee & Climate: http://www.coffeeandclimate.org
- The project "Climate Change Adaptation and Mitigation in the Kenyan Coffee Sector – Sangana PPP" (2008 – 2011): http://www.4c-coffeeassociation.org/assets/files/Documents/Reports-Brochures/SanganaPPP_GuideBook_4CClimateCode.pdf
- And of course, this project and the adaptation examples explained below in this manual.

3.2 CLIMATE CHANGE MITIGATION

Climate change mitigation tries to tackle this global phenomenon at its causes by either reducing greenhouse gas emissions or removing them. Removal includes activities to capture - or remove - GHG from the atmosphere and store them in ecosystem components such as trees, bushes, plants or soil (biomass). Reduction in turn covers activities to minimize or prevent emissions generated by a certain process or unit.

The IPCC defines mitigation as follows[11]:

> *An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.*

Coffee farmers can participate in mitigating climate change through both options – reduction and removal. By increasing e.g. the shade cover in their production systems or their windbreaks (always given that it is not endangering yields) they can help to remove CO2. By e.g. reducing their synthetic fertilizer use or by using fertilizers more efficiently they can help to reduce total emissions in coffee production (see figure 10).

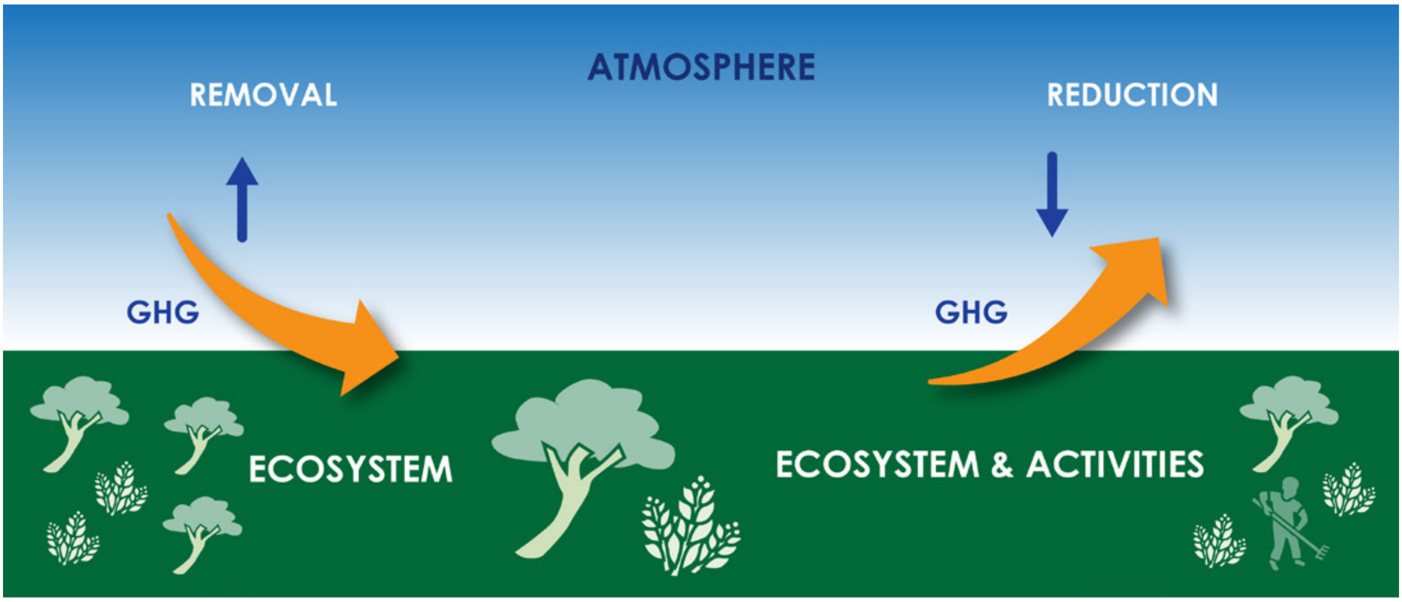


Figure 10: Removal and reduction of GHG in agriculture: Agriculture can mitigate climate change through either increasing the removal or reducing the emissions of activities and/or ecosystems.

For removal it is important to understand and to know the so called "carbon pools". Carbon pools are ecosystem components capable of emitting or removing (and storing) greenhouse gases into or from the atmosphere. They include above ground biomass (trees, shrubs etc.), below ground biomass (roots), dead wood (fallen trees and branches etc.), leaf litter (fallen leaves on the ground) and soil organic carbon (see figure 11).

11 IPCC, Climate Change 2007

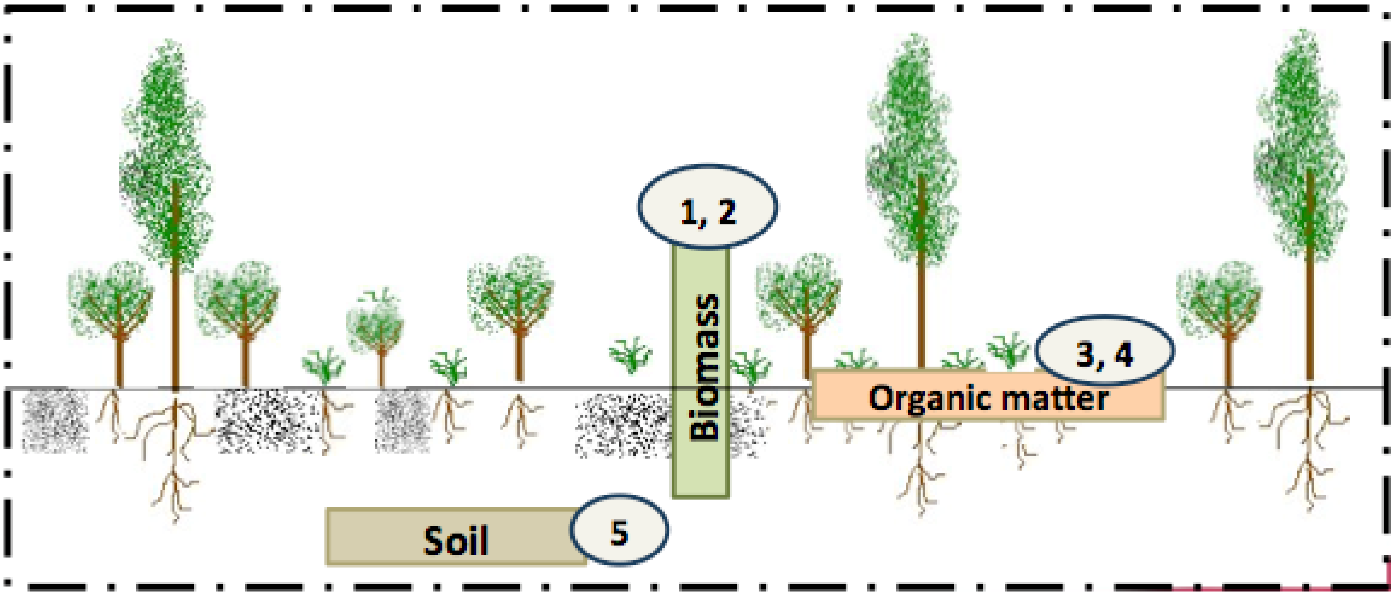


Figure 11: Carbon pools. Taken from Sangana PPP, 2010.

Emission sources are physical units or processes that liberate GHG into the atmosphere, such as manure, cows (gastric fermentation), burning practices, tillage, use of fossil fuels or fertilizer application (see figure 12).

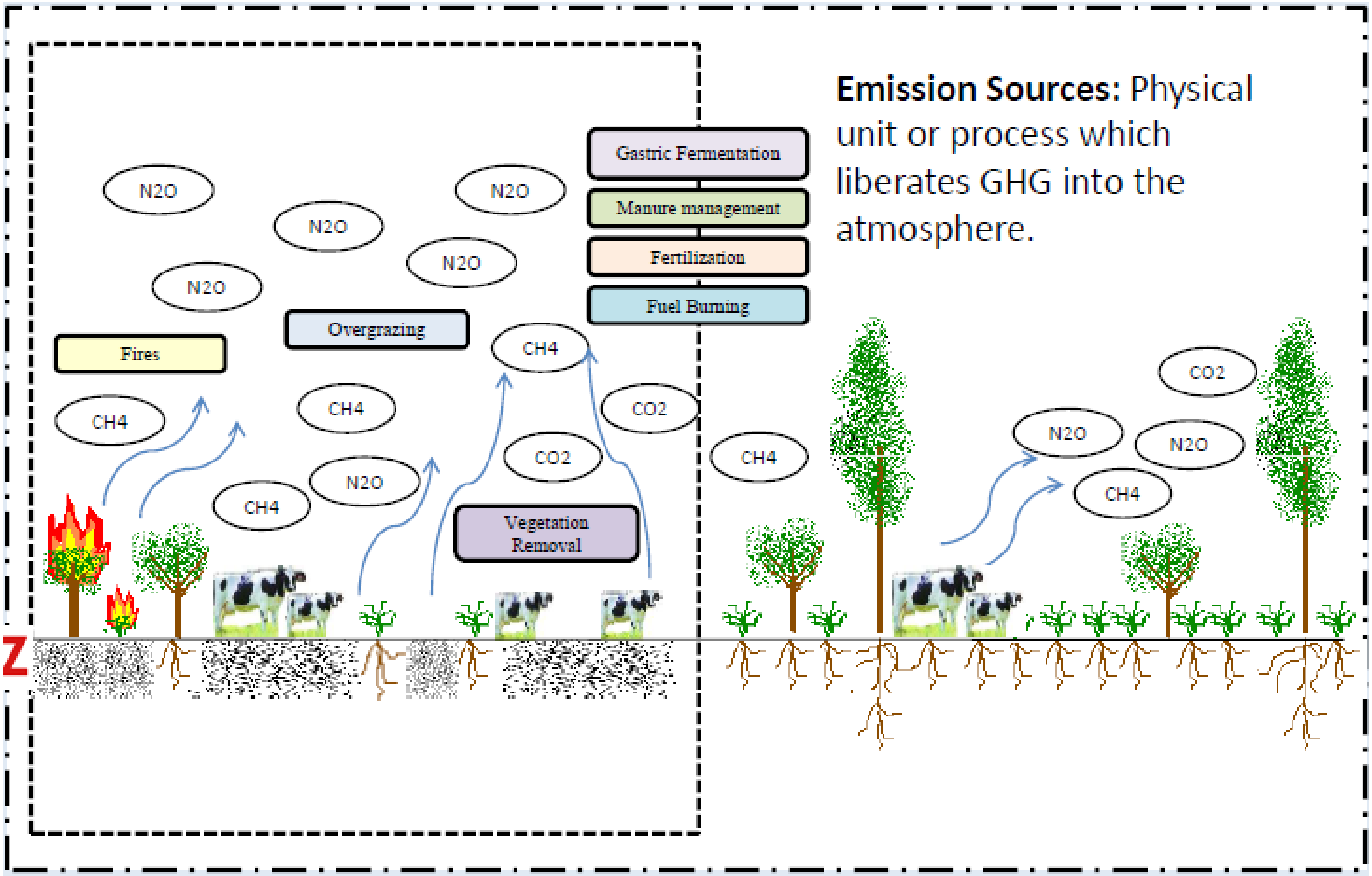


Figure 12: Emissions sources. Taken from Sangana PPP, 2010.

For farmers climate change adaptation is more important as it directly supports maintaining their livelihoods. Mitigation at farmer level is usually cumbersome due to complex data collection and quantification activities and because direct benefits for farmers might be little. However, both - adaptation as well as mitigation – are relevant in coffee production.

Figure 12 provides an overview on the differences between adaptation and mitigation:

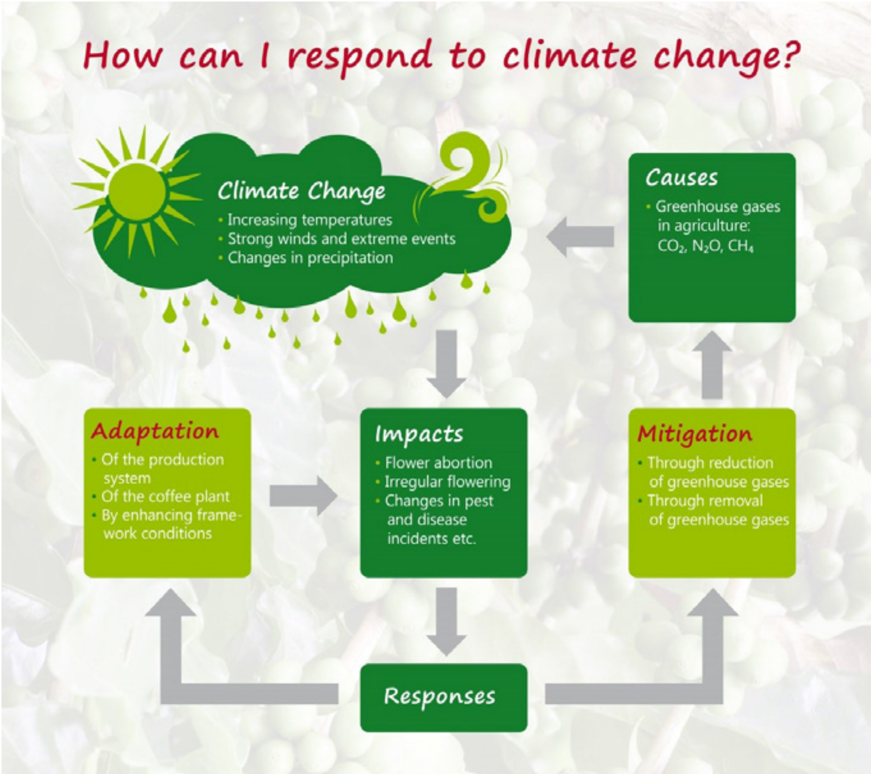


Figure 13: Climate change adaptation and mitigation. C3 poster.

4. HOW TO WORK WITH FARMERS ON CLIMATE CHANGE?

4.1 IDENTIFYING LOCAL IMPACTS OF CLIMATE CHANGE – PARTICIPATORY VULNERABILITY ASSESSMENTS

As climate data on local level is usually rare and studies on the topic often focus on national or even broader regional levels, it is important to include farmers' local knowledge and experience when working on climate change issues. By looking into scientific studies and further available climate change information (e.g. gathered through stakeholder interviews and / or desk studies) and coupling these with information obtained through farmers and the affected population it is possible to gain a holistic overview of the topic. As working on climate change challenges means working in an area of uncertainty – no-one knows for sure where and when which climate change hazards will occur – triangulating these different sources provides the best approach.

Participatory Vulnerability Assessments (PVA) help to assess climate change and its impacts on local level with farmers and potentially further affected representatives of the local population. In a PVA coffee producers analyze the changes they are experiencing and whether these are related to climate change issues. As a result of these assessments the producers propose adaptation as well as mitigation practices for their local contexts.

Different group work methods can be used for PVAs. The Coffee Climate Care project in Vietnam proposes workshops of 1.5 days with 25 to 30 farmers and the following group work sessions:

Day 1 (full day)	Day 2 (half day)
• Seasonal calendar • Two way vision • Priority resources • List of problems • Vulnerability matrix	• Problem tree • Sunray exercise

The following paragraphs give a short description on how to conduct these different sessions. For these sessions you need paper, masking tape or pins, pencils, pens and color pens/markers. When you form groups make sure to mix young and old, male and female participants.

Seasonal calendar (1.5 to 2 hours)
A seasonal calendar is a tool for documenting regular cyclical periods (i.e. seasonal) and significant events that occur during a year and influence the life of an organization. It provides a general picture of important environmental, cultural and socio-economic periods throughout the year. The seasonal calendar is of particular value as it allows local people to represent their understanding of seasons in congruence to cultivation. These are often different from 'official' seasons and the international calendar.

IN PRACTICE; SEASONAL CALENDAR

The participants are split up in four groups focusing on fauna and flora (for example, blossoming, ripening etc.), coffee production (planting/harvesting time, land preparation, fertilization etc.), other crops and climate (dry/wet season, extreme weather events etc.). Draw a circle on each (4) sheet of paper and mark the highest point of the circle as "beginning of the year/January". Explain that the lowest point of the circle represents the middle of the year and that reaching the top again represents a new year. Divide the circle into 12 sections, one for every month. Hand out one prepared sheet of paper with the format to each group so that they can prepare their own Seasonal Calendar (it is advisable to prepare these formats beforehand and after explaining the circle handing them out to each group). The participants should then add events (in the form of symbols or descriptions) for each of their fields for every month of the year. Once the calendars are finished, one representative of each group should present the outcome to the rest of the group. In the following, discuss with the whole group changes or uncommon events that have been observed with regard to seasonality of their environment in recent years. These can be events such as prolonged drought, increased rainfall, early/irregular flowering of trees etc. Record observed changes.

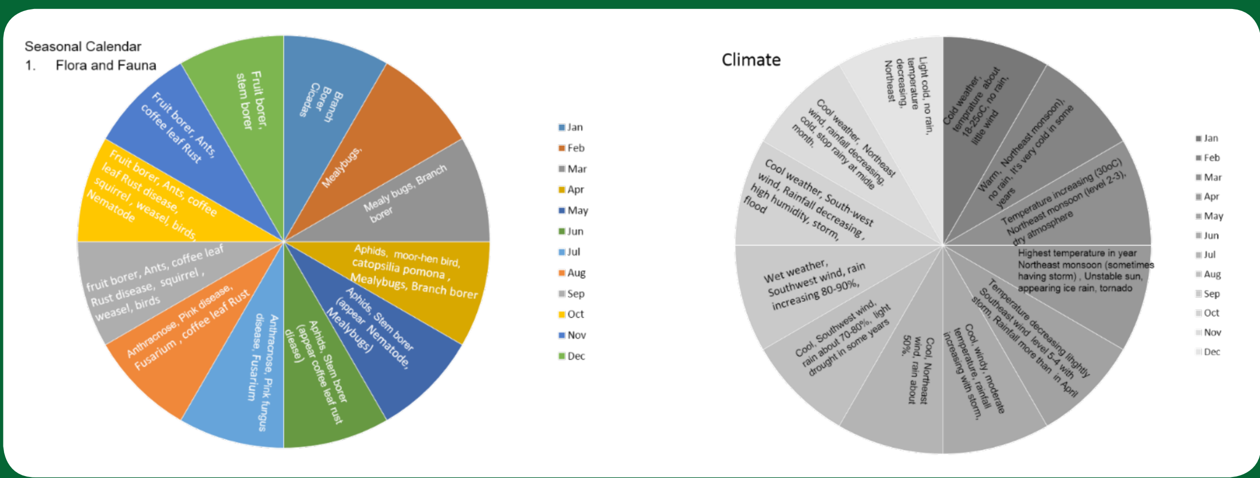


Figure 14: Example of two seasonal calendars developed in a PVA in Lam Dong, 2013; focusing on flora and fauna (on the left) and climate (on the right). The most important changes that were identified by producers during the discussions were the change in seasons

Two way vision (15 minutes or 1,5 hours if combined with a visit to the field)
In a two way vision the participants determine how they perceive climate change and its impact on their lives, and determine how they would like to see their future instead.

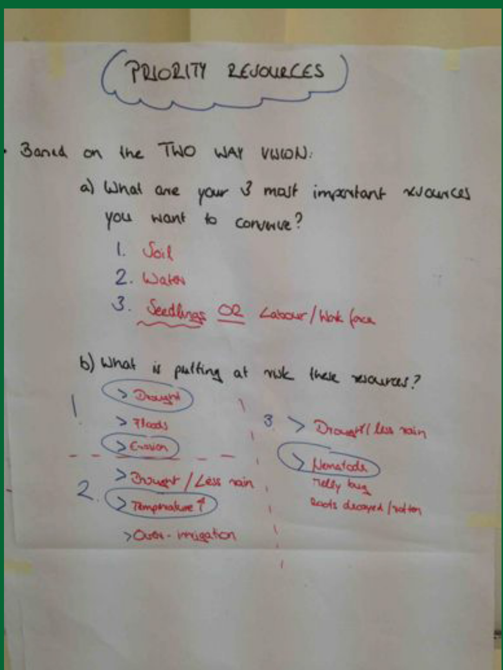
IN PRACTICE: TWO WAY VISION

Let everyone think of the future that is most likely to happen if everything continues as present, then ask them to think of what their "ideal" future would look like. Ask the participants to imagine they are wandering around their coffee farms and are to pick their most precious resources – something they could actually take into their hands (e.g. water, soil, a specific tree, a coffee cherry…). Each participant is to identify up to three resources. These do not have to be resources that they currently have, but those that they consider to be most important in their coffee production. Depending on where the workshop is carried out, producers can even be asked to go outside into a coffee field and come back with their resources. Furthermore, the participants should then think of anything that is endangering the conservation of their resources for their desired future if everything continues as at present.

Priority resources (1.5 hours)
The valued resources once identified may vary from participant to participant. It is therefore important to prioritize resources that are appreciated by the collective group rather than by the individual. This is the objective of the "priority resources" activity.

IN PRACTICE: PRIORITY RESOURCES

Ask each person to choose a partner and to share their three resources from the activity "Two Way Vision" and the reason for their selection. Each pair should discuss these and select just three, which they think are the most important. When all the pairs have completed the task, combine pairs into groups of four members. Ask each group to repeat the task, with each pair explaining their three choices, each foursome should then discuss and choose a new set of three. Combine the groups of four into groups of eight and repeat the task, then form groups of 16 and so on until there is only one group.



Finally, ask the larger group to present their three shared resources and the reasons for their selection. Review the resources that were given less importance. Ask "How did you decide on this?", "Were there major disagreements?", "What did you do when there were disagreements in the organization over resources?". Ask which other resources were discussed and note them down on a list.

Figure 15: Example result from priority resources activity during the PVA in Lam Dong. The three priority resources identified are soil water and seedlings.

List of problems (0.5-1 hour)
It is always important to allow producers to identify their own needs and arrive at possible solutions. This tool provides a simple but systematic way to help them in identifying and further defining specific issues. By listing the problems on a sheet (or sheets) of paper, this tool provides an effective framework with which they can determine priorities.

IN PRACTICE: LIST OF PROBLEMS

A List of Problems can be generated in several ways. The list might include items generated from many sources, including meetings, brainstorms, individual discussions, small group exercises, transects or theatre sessions. The list should be retained in the organization and continually revised to include more information throughout the process. Based on the Two Way Vision, everyone should name their identified problems, which threaten the resources they identified as most important. Note down all mentioned problems or challenges. In plenary prioritize the top 3-4 problems from the list. Highlight the chosen problems as well as the resources and hang the list up where everyone can see it. Try to be as specific as possible.

Vulnerability Matrix (45 minutes)
This method is used to determine the hazards that have the most serious impact on important resources as well as which resources are most vulnerable.

IN PRACTICE: VULNERABILITY MATRIX

List the resources identified in the priority resources activity down the left side of the matrix on the vertical. Use symbols if this will help participants to better understand. Then ask the group to identify the greatest hazards (based on the list of problems) to their production / to the prioritized resources. Hazards may be natural or man-made. Do not limit the discussion to only climate-related hazards, but you may want to prompt the group if they are not identifying environmental hazards. Further hazards may come up in the discussions, which can be added to the List of Problems generated earlier. The four most important hazards should be listed horizontally across the top of the matrix, again using symbols if necessary. Together with the participants score the hazards against the resources, identifying significant (3), medium (2), low (1) and no (0) impact of each of the hazards on each resource. Note down key points of discussion that lead to the scores assigned, and any disagreements on the scores. Add up the horizontal scores for prioritizing the resources and the vertical scores for the hazards.

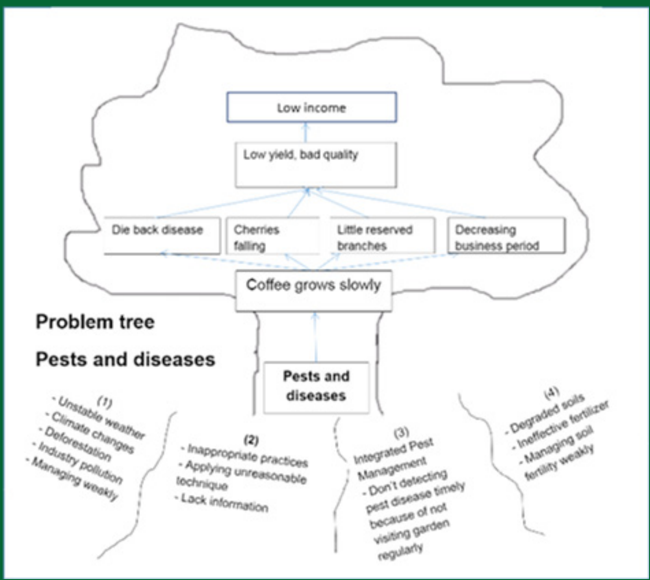
Problem tree (1.5-2 hours)
A clear understanding of a problem is essential when trying to determine what effective actions are needed to resolve it. The Problem Tree (also known as Root Cause Analysis) is a useful tool that enables the producers to identify causes and effects of a problem. Climate change is a very tricky topic and to remove the possibility of bias that the stated problems are the direct result of it, one
has to have a broad overview of all the contributing factors to decide whether climate change is among the dominant factors or not.

Working on a "problem" that is a climate stimuli (e.g. changing rainfall patterns or increasing temperatures) the group may need some more support in identifying causes; where a climate stimuli is analyzed, it offers great inputs for identifying mitigation options in the next activity (Sun Ray Exercise), while working on a "problem" that is a climate impact (e.g. newly arising pests in the region) offers great inputs for identifying adaptation options. Once the groups have completed their problem trees, have them present the results in plenary and discuss.

IN PRACTICE: PROBLEM TREE

As an example use one of the listed problems from earlier. Show a sample chart with a tree with leaves. Written within the trunk of the tree is a problem. Explain that your tree is sick. Point out the problem it is suffering from. Point out that trees often become sick due to problems in the roots from which it feeds.

Explain that to understand why the tree is sick, we must follow the problem back to the roots. Let the participants brainstorm over the causes of the problem by asking the question "why?". Draw a root for each cause and write the cause on the root. Repeat the question "why?" for each cause mentioned to identify secondary causes. Write these lower down on the roots, below the primary causes identified. Allow participants to continue until they can identify no more secondary causes.



Then ask the participants to identify effects or impacts of the problem. Draw a branch for each effect and write the effect directly on the branch. For each effect identified, repeat the question of the impact to reveal secondary effects. Place these higher up in the branches above the primary effects. Allow the participants to continue until they can identify no more effects of the problem. After this demonstration split the participants into different groups and give each group one problem from the prioritized list and ask them to follow the same process, identifying the root cause(s) of the problem and the effects on their production and ultimately their livelihoods.

Figure 16: Example problem tree on pests and diseases from the PVA in Lam Dong.

Sunray exercise (1.5 hours)
The Sunray Exercise allows for the producers to brainstorm on ideas for solving a problem in a structured and logical manner. It is a visual method of developing solutions and breaking them down into achievable activities.

Once local adaptation / mitigation needs and corresponding practices have been identified it is important to prepare suitable training sessions. Where possible, local trainers can be formed and trained in order to develop such trainings.

IN PRACTICE: SUNRAY EXERCISE

Split the participants in the same groups as before, each group working on their problem from before. Hand out a template with a sun and problem written in the middle of the sun to each group. Ask the groups to brainstorm and come up with general solutions needed to address the (root) causes of the problem. Write the solutions on small pieces of paper and stick them at the end of the rays (or write directly on the flip chart paper). Ask the groups to think of how to achieve each of the general solutions at the end of the rays. Write the answers on separate pieces of paper and place them on the rays under the solution. Add new rays if they are needed. Where the group has identified large or complex activities for achieving the general solutions, break them down into smaller activities by adding more ideas off the rays. Keep working at them until all possibilities are exhausted. Check that all the rays end with a full solution to the problem. Take out what is not needed and add new solutions where necessary. Rearrange items if necessary (this is why working with small pieces of paper (post-its) is recommended). Nominate one person from the group to present the final sunray results in plenary.

4.2 PREPARING LOCAL TRAININGS

To work with farmers as a local trainer requires skills and also resources, mainly time that farmers and trainers invest in the trainings. Besides agronomical insight regarding the respective crop – in this case coffee – it is important to respect the farmers and their own ideas and to have a good understanding of local customs. Local trainers bridge the gap between farmers and research organizations or other institutions and initiatives generating information, best practices and training approaches regarding climate change in the coffee sector. Therefore they must be able to prepare trainings in a manner suitable for the farmers, i.e. using appropriate language and methods and considering resources available to the farmers. Furthermore, local trainers have to be able to motivate farmers by breaking down training topics and sessions according to their needs and capacities. At the same time the trainers have to be able to access and understand relevant information on the respective training topics – in this case climate change issues – e.g. through existing training manuals, training sessions for trainers or even own research activities on the internet. Therefore, literacy is a key skill of a local trainer in order to deliver trainings and information on local level.

To establish oneself as a new local trainer in a specific region it is important to know the surrounding farmers, their culture and customs and their farming knowledge and practices. It is therefore recommended to visit the farmers individually at least once before a training in order to get to know their farms and farming practices. At a later state, visiting the farmers on a regular basis is beneficial to create a friendly relationship and to offer site-specific advice where possible and needed.

Farmers learn best when trainers use different methods throughout a training session (see figure 17):

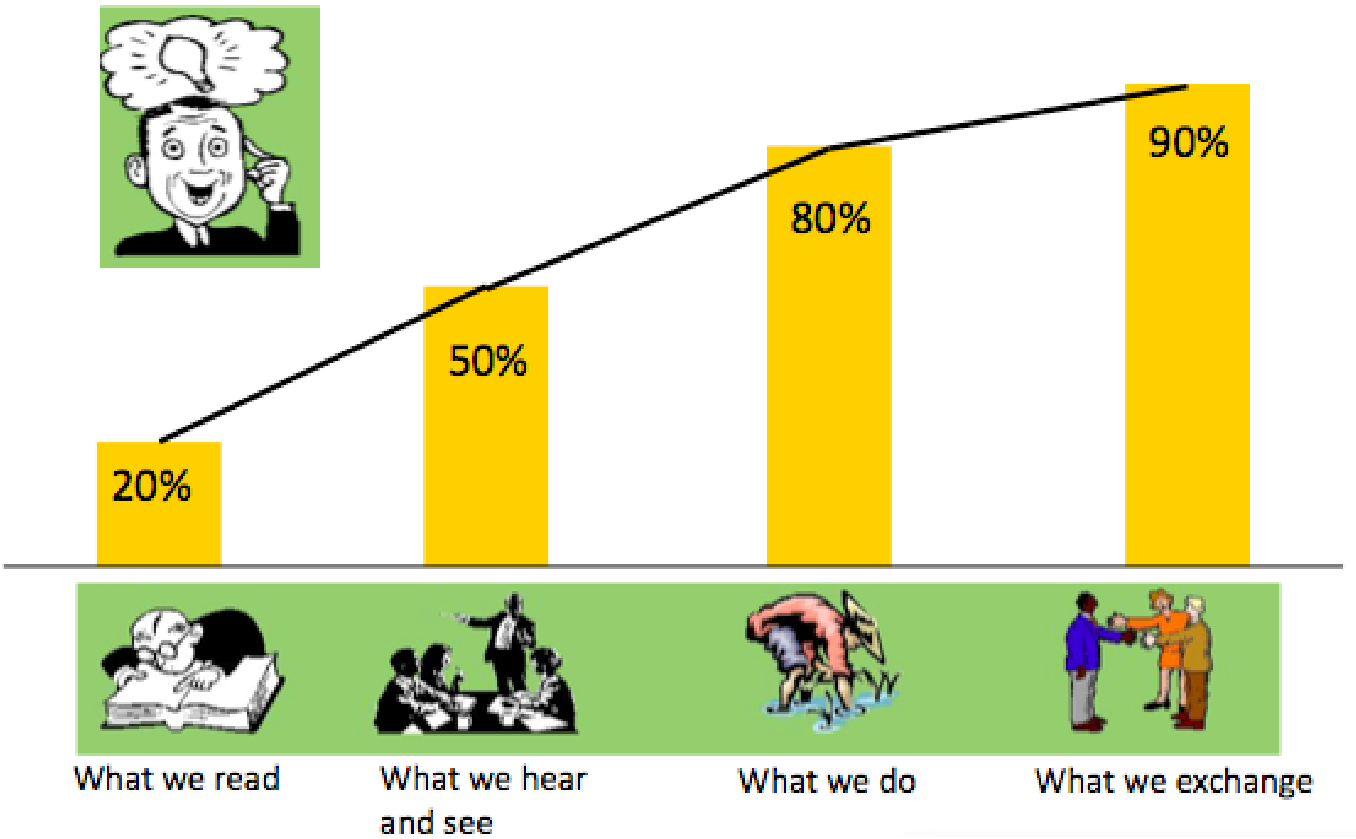


Figure 17: Training methods and farmers' uptake. UTZ Certified, 2013.

A mix between sharing information with farmers through lectures / inputs, practical exercise and having farmers discuss the respective topic among themselves generates the best training results.

IN PRACTICE: ASPECTS TO CONSIDER WHEN PLANNING A TRAINING

For planning a suitable farmer training on relevant climate change topics the local trainer needs to consider the following aspects:

- What is the specific training topic / what is the current training need of the farmers in regards to climate change?
- What is the learning objective, i.e. what should the farmers have learned after the training?
- Who and how many to invite to the training (based on the training objectives: men, women, young, old farmers, further community members, farmers that have been trained on relevant topics previously…)?
- How to best organize and structure the session in order to achieve the training objective?
- Where is a good location for the training (considering accessibility for the farmers and that a field visit might be beneficial; relevant examples should thus ideally be in walking distance)?
- Which trainings methods are best suitable for the training objective? Are there existing materials that can be used?
- Which resources are necessary? Are these available?
- What would be a good time frame for the training so that farmers can easily participate?
- How to ensure that participants have learned what was intended – is a form of evaluation needed?
- If there is more than one local trainer: Who will play which role during the training?

In order to ensure a thorough training preparation a training concept (or session plan) is recommended.

Table 2: Example of a training plan. C3 project.

SESSION PLAN					
Training topics: Adapting coffee cultivation to climate change					
Objectives:					
1. Helping farmers to understand climate change, its causes and negative impacts					
2. After training, farmers will implement some farming practices aiming to adapt to and mitigate climate change					
Period: 3 hours					
No.	**Contents**	**Methods**	**Person in charge**	**Period (minute)**	**Training aids**
1	Introduction			3	
1,1	C3 project/ Training topics and objectives	Presentation	Trainer	2 0 (20sec-1min per person)	Page 1 of flipchart
1,2	Introduction attendees	Get to know each other casually by introducing oneself and own expectations; 20 seconds to 1 minute/ person. Trainer presents first.	Everybody	10 (5min movie + 5 min discussion)	None
2	Climate change introduction movie	1. Watch C&C film with everyone 2. Ask farmers to give comments, the trainer encourages them to participate, supplements and writes their comments in A0 paper. Conclusion: "That's the content which we will learn today."	Trainer		Film and projector

3	**Negative impacts of climate change**	**3.1 Guiding questions:** Before starting the lesson, the trainer and trainees share some information regarding changes in current coffee farming compared to the past. The trainer will actively ask for contributions by trainees, for example: "We have been coffee farmers for many years in this region...but it is very difficult for us to have the chance to share information with each other. So today, we share and learn from each other the difficulties and advantages in current coffee farming and in the past. As the basis for discussing the topics this morning, let me ask some questions please."		3	
	For each question well answered by a farmer, the trainer suggests everyone clapping hands.	**Question 1**: Do you notice differences in underground water levels in our coffee production region compared to 15 years ago?	Trainer		A0 paper and markers
		Invite some farmers to answer, write all their answers in A0 paper, hang it on a place where everyone can easily see, then together discuss the answers and mark the correct answers; finally give thanks to all people who give answers (Absolutely not repeat, analyze or comment any incorrect answers).	Trainer / assistant		
		Question 2: Do you notice differences in current temperature compared to 15 years ago?	Trainer	3	A0 paper and markers
		as above actively encourage participation	Trainer / assistant		
		Question 3: Do you notice any differences in rainfall patterns compared to 15 years ago? If so, how?	Trainer	3	A0 paper and markers
		as above actively encourage participation	Trainer / assistant		
		Question 4: Do you notice any differences between current pests and diseases on coffee and those 15 years ago? The trainer suggests some pests and diseases such as steam borer, branch borer, remind farmers later to discuss in combination with topic of shade trees.	Trainer	5	A0 paper and markers
		as above actively encourage participation	Trainer / assistant		
		Question 5: Do you notice any differences in current soil fertility on your coffee fields compared to 15 years ago? For example, is the soil color darker or lighter, is the soil harder or softer... these comments will be combined with soil erosion, soil fertility declining because of lacking of soil protection during farming, and to use them in the topic of soil fumus protection...	Trainer	5	A0 paper and markers
		as above actively encourage participation	Trainer / assistant		

		3.2. " Summing up of results from discussions on negative impacts of Climate change: "All your comments to the 5 questions above show that they are all negative impacts caused by climate change that make us have difficulties in coffee farming. So what is climate change, what are causes, we would like to invite you to watch some information on the flipchart/screen".	Trainer	2	None
4	**What is climate change?**	Use slides of flipchart to explain for trainees, then take time for inquiry, if any. When explaining "Greenhouse effect" please note the two issues: One is the general principle: natural light from the sun enters the atmosphere and turn into heat; keeps the earth warm, brings light for living organisms to live. The second one is: Emission from living, manufacturing (including Co2, N2O, Nh4) in the atmosphere absorb more heat from sunlight and make the earth heat up. This phenomenon is called the greenhouse effect. The more greenhouse gases we emit, the more the earth heats up, and once the earth gets hotter many extreme climate phenomena happen which cause the results as discussed by you above.	Trainer	2	Page 2 of flipchart
5	**The causes of climate change**				
	General causes	Present - explain - ask and answer based on the contents and images mentioned on page 3 of flipchart to explain clearly for trainees. Then take time for inquiry, if any.	Trainer	2	Page 3 of flipchart
	Causes from coffee farming	As above but emphasize effects related to coffee production at farmer and factory level. The main causes from coffee farming include: Misuse of inorganic fertilizers, deforestation, excessive water use in irrigation, waste, burning, old equipment, improper fertilizing, transportation, coffee drying. To make trainees have insight and responsibilities as well as support them to minimize bad impacts on climate change, the trainer invites some trainees to give their points of view on whether they can change their farming habits with respect for the environment and community; the trainer also disseminates this idea to all trainees for them to redisseminate to their families, friends, relatives in the regions.	Trainer	3	Page 3 of flipchart
6	**Impacts of climate change**	Present and explain contents shown by images in page 4 of flipchart, then come back to the summary of contents which the trainees answered to 5 questions written by the trainer on A0 paper. Let the trainees ask questions, if any.	Trainer	1	Page 4 of flipchart

7	**How does climate change affect coffee farming?**	Introduce page 5: In the beginning, explain 3 images on causes of climate change, then use the knowledge, principles in agriculture to explain negative impacts of climate change on agricultural production, especially coffee: having many pest and diseases, increased input cost, decreased productivity and quality that lead to low income and make coffee farmers' lives become difficult...	Trainer	5	Page 5 of flipchart
		Coming back to the farmers' answers written on A0 paper and combining with contents in images on page 6, the trainer affirms that their initial identification is the same as the analysts', and scientists', and emphases that "We have the right view, standardized comment about risks, challenges which will happen to us later. Therefore, from today we need to think what we need to do for our lives, so that later generations can continue to effectively work in agriculture... The trainer invites some farmers to give their points of view in this content.	Trainer	5	Page 6 of flipchart
	Inquiry	Discuss and explain all relevant questions from farmers.	All people	5	
9	**Introduction of good practices climate change adaptation and mitigation in coffee farming.**	Depending on practical situation of each training area, the trainer selects 3 main topics related with the issues of this area to train farmers, other topics can be skimmed.			Select content, using page of flipchart accordingly
		Proposal: Class in August-September/2014: shade management including windbreak trees, fertilizer and soil fertility management (cover crops). the second period class is at the end of 2014: water management, drying house; if there is enough time, it should review some important contents related to topics which were trained in August. The details of each practice are mentioned in the flipchart, trainer must link knowledge and GAP during the discussion/presentation with farmers. At the end of this session give farmers more times for asking question.	Trainer	20	From page 10 to 19. (Only relevant pages are opened, the non-relevant pages can be skimmed)
10	**Conclusion and training evaluation**	Summarize all contents which were discussed on poster of farmers. Ask and answer then guide to take training evaluation to have lessons learned.	Trainer	10	Page 18 of flipchart
11	**Breaks time and moving to demonstration garden**			30	Candies, biscuits, water
12	**Visiting demonstration garden**	Divide class into 2 groups, going with the house owner; the husband will be in charge of 1 group, the wife will be in charge of the other group. this couple will share their experience which has been done on the fields in the recent time and discuss result. The trainer supports 2 groups in discussion.	House owner	40	Demon-stration gardens
	Total time for implementation			**147**	

IN PRACTICE: STEPS FOR ORGANIZING A TRAINING

Once all the questions as listed above have been clarified the following steps are necessary to prepare for a successful training:

- Invitation of the participants: oral invitation, written invitation – depending on local customs
- Preparation of all needed material (including printing) and other resources (transport, water for participants etc.)
- Reservation of the training venue if applicable
- Reservation of accommodation for the trainer if applicable

4.3 DIFFERENT TYPES OF LOCAL TRAININGS

There are different types of local trainings and according to the training objectives, local customs and available resources it is important to opt for the best suitable one:

1. Classroom training:
   The whole training is held at a specific site, most likely inside, and training methods range between inputs by the trainers and mainly group or plenary discussions. This training type should only be used for giving a first introduction to a new topic or for starting off a Farmer Field School (see below).

Figure 18: Farmer classroom training.

2. Farmer Field School:
   A fixed group of farmers meets regularly to learn about and discuss new farming practices and potentially to create a pool of experts (graduates of the Farmer Field School). An experienced trainer (agronomist) prepares and facilitates the sessions. Often Farmer Field School sessions are held within a farm and venues change, so that all farms of the group members are visited. This training is a good option for learning from hands-on experience in the field and allows for a good exchange between the farmers as they gain confidence when always meeting the same fellow farmers. Where possible Farmer Field Schools also include actively practicing the specific farming practice (related to the topic and objective of the session) on-site.

Figure 19: On-farm training of farmers guided by an agronomist.

3. Demonstration plots:
   Demonstration plots are set up to demonstrate the best possible implementation of a specific farming practice and its effects. They can be part of a farmer's plot or belong to a community, research center or big estate. They are often used as field training centers, i.e. for holding trainings in the specific practice, or for exchange visits (see below). Where possible, farmers can also practice the specific farming practice (topic and objective of the session) on the demonstration plot. This training type is highly effective as farmers can see and experience the positive effects of improved practices in their own environment. Setting a new demonstration plot is resource-intensive, though, (time, funds, material etc.) and until the effects of the displayed practice can be seen it takes time. In smaller settings it is therefore useful to opt for (parts of) an existing farm and turn it into a demonstration plot. This can also be the farm of the trainer so that local trainings can always be held at his / her farm and turning the site into a demonstration plot can be part of the training, i.e. after a first input and discussion on the farming technique, the practice is then jointly implemented.

Figure 20: Demonstration plot in Dak Lak province.

4. Exchange visits:
   Farmer groups visit coffee farms in other regions or from other farmers to exchange and learn from each other. For this training type it is good to provide guiding questions and orientation prior to the visit to prepare for observation potential on the farm(s) and then to discuss findings after the exchange visit. Such guiding questions can include:
   - What is the relevance of the practice in regards to climate change?
   - How to implement the specific farming technique?
   - What kind of effects (positive and negative) does the owner of the farm hope for / already experience (soil, coffee plant, humidity, water availability, shade, temperature, pest and disease attacks)?
   - Is this technique relevant in my area?
   - Are relevant resources available in my area?
   - What is necessary so that farmers apply this technique in their area?

This training type is usually quite costly and it is important to thoroughly identify suitable farms to visit upfront. If resources are available and appropriate farms are found, it is a good measure to introduce new farming techniques to farmers, as a journey and exchanging with farmers from another area usually sticks to farmers minds.

Sometimes a mix of the above-mentioned training types presents the best option for a specific topic and training objective. This largely depends on the complexity of the topic and resources available.

4.4 MONITORING AND EVALUATION

Holding local trainings is important to bring new techniques and agronomic knowledge to farmers. However, the purpose of training should always be to pass on knowledge and ultimately to motivate farmers to adopt the practices, which are beneficial to them. Therefore, it is important to verify whether the training has brought across the relevant information.

In regards to climate change adaptation and mitigation it may not only be important to evaluate the trainings, but also the implemented measures. One tool to do so is the cost-benefit analysis. The purpose of this tool is to assess the profitability of a specific option in a specific region. A cost-benefit analysis can be prepared before a farmer changes to a specific farming technique and thus can offer valuable information whether a change is profitable or not. However, such an up-front analysis is always based on many assumptions and can only be as good as the available information before implementation of the practice. It can also be prepared after changing to a specific practice and then helps to monitor and evaluate its effects.

The cost-benefit analysis compares a farm with the specific adaptation / mitigation practice and without it, i.e. data is collected before the practice is implemented and then again once the practice is implemented or, in the case of an upfront cost-benefit analysis the business-as-usual scenario of the farm is assessed (inputs, outputs, yield etc.) and then climate change scenarios are factored in. This will deliver two scenarios of the same farm, which can form the base for discussing whether or not it makes sense to adopt a specific adaptation / mitigation practice.

Cost-benefit analyses are usually quite complex and labor intensive and are carried out by experts. Further information on cost-benefit analyses regarding climate change can be found at: http://toolbox.coffeeandclimate.org/index/tool/id/60

Furthermore, the Initiative for Coffee & Climate has developed a "case study format", which helps to capture experiences of farmers worldwide with the implementation of several adaptation practices. This tool looks into the results of the implementation of a specific adaptation measure, its advantages and disadvantages, relevant implementation steps and how farmers coped with the specific measure. The already established case studies are available at: http://toolbox.coffeeandclimate.org/index/info-points. For Vietnam a case study on water saving irrigation techniques is available at: http://toolbox.coffeeandclimate.org/userdata/case/pdf/case-study-water-saving-irrigation-technique_vietnam.pdf

IN PRACTICE: EVALUATING A TRAINING

Depending on the set-up and available time of the training, it is not realistic to evaluate every training. However, where possible a simple evaluation technique can be used:

- Prepare a flip chart paper drawing 2 long lines:
    - Left to right
    - Bottom to top
- On each end of the lines write one of the following criteria to be rated (see also figure 16 below):
    - Contents (Could you follow the whole session through? Was the topic complex/easy?)
    - Methodology (Did you like the way the workshop was held / the mix between group work, plenary discussion and inputs?)
    - Relevance of the topic (Are the topics discussed relevant for you?)
    - Duration (Is the session too short/too long?)
- Mark 10 points on each line from 0 to 10, starting always at the centre where all lines meet and going up to the end; in total you should now have 4 lines showing 10 points.
- Ask the participants to rate each criterion from 0 (bad performance) to 10 (good performance).
- Leave the room for 5 to 10 minutes to allow the participants to evaluate the session and enter when the participants are through with the evaluation.
- Revise the outcome.
- If there are specific criteria with a low score, ask for reasons and possible recommendations on how to improve. Ask what the participants liked best. Take notes of final comments.

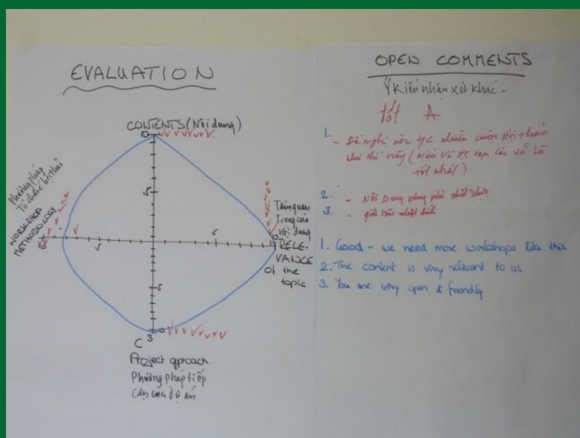


Figure 21: Evaluation from the sensitization sessions with C3 farmers in Lam Dong, Vietnam.

5. CASE STUDY VIETNAM: SUITABLE ADAPTATION / MITIGATION MEASURES IN THE COFFEE SECTOR

5.1 AWARENESS RAISING

Relevance in regards to climate change

The majority of the coffee farms in Vietnam aim to maximize productivity. This means that farmers structure their farming activities according to what they think is best for achieving the highest yields. However, this does not always mean that they implement good or sustainable agricultural practices. Forests or parts of vegetation are cut for expanding agricultural boundaries; shade trees are considered to take away space for a potential coffee plant; nutrition management is not based on actual proven soil needs, but on which fertilizers are available and affordable; and as water is a free resource in Vietnam irrigation is often done according to the slogan "the more the better". In addition, environmental awareness in Vietnamese communities is rather low.

As soils were fertile and conditions in regards to temperature, precipitation and water availability were favorable, such unsustainable practices did not affect farmers' yields and incomes too much in the past. However, with changes in the local microclimates of the coffee production areas throughout the country (see chapter 2.5), they also hit the farmer directly: coffee farming systems that are based on unsustainable farming practices not only contribute to climate change, but are also more vulnerable towards climate hazards.

Although farmers might be aware of the changes in their microclimates, awareness raising is necessary to stress the link between their farming activities and the global climate change phenomenon – in regards to why their coffee plots are affected (vulnerability and adaptation) and how their farming contributes to climate change (emissions and mitigation).

IN PRACTICE: AWARENESS RAISING

Relevant information farmers need to know includes:

- Why and how is coffee farming affected by climate change?
- What do farmers have to expect in regards to changes in Vietnam?
- How can farmers prepare for such changes and adapt to changing climatic conditions? What are exemplary adaptation options?
- Where does farming cause emissions and are farmers therefore part of the problem? How can they mitigate such emissions?

The C3 project developed a training manual for sensitizing farmers on climate change issues. The manual is available on the UTZ homepage (utz.org or contact thiet.nguyen@utz.org) and can offer further guidance on how to raise awareness among farmers.

In Vietnam, smallholder plots make up more than 95% of the land under coffee. Such plots are owned by individual households. At present, only 30% of the farmers are organized in farmer groups of 50 – 100 persons by state companies, traders, projects and / or certification schemes. These 30% can be reached rather easily, whereas reaching the remaining 70% poses quite a strong challenge.

As climate change adaptation and / or mitigation is important for the whole coffee sector, awareness raising strategy should take the following into account:

- Climate change adaptation is best included in national action programs
- Coffee actors (certification schemes, traders, processors, civil society organizations etc.) working on sustainability issues need to integrate awareness raising activities on climate change adaptation and mitigation into their programs

Relevant information needs to be published through different media channels regularly, especially weekly programs related to Agriculture & Rural Development on the national television station.

Figure 22: Awareness raising sessions with farmers .

Based on its experience on climate change work in Vietnam, the C3 project suggests the adaptation options mentioned in this chapter. Further issues that are relevant with respect to climate change and that future climate change projects could look into include: afforestation / reforestation / maintaining existing forest cover, cover crops / mulch, research on drought-resistant and disease resistant varieties, renewable energy and energy efficiency.

5.2 IMPROVEMENT OF WATER MANAGEMENT

Relevance in regards to climate change

Future changes in rainfall and temperatures (see chapter 2.5) are likely to increase evapotranspiration resulting in water scarcity throughout parts of the year. In addition, groundwater levels are declining. Because water is free of charge in Vietnam, farmers do not consider it as precious a resource as it actually is in the current situation.

Robusta coffee needs large volumes of water for flowering and fruit development in the dry season (December / January to April / May). However, in the past five years most lakes in the main coffee regions in the five Central Highland provinces have dried up during this time of the year. Formerly, farmers drilled wells around 70-80 meters deep, sometimes even up to 100 meters deep. Nowadays, groundwater levels have declined and even such deep wells are not reaching groundwater levels. Water for irrigating coffee is thus becoming scarce.

Figure 23: From flowering to fruit developing and ripening Robusta coffee needs a lot of water.

Previously the average amount of water for irrigation was 650 litres per tree and irrigation round (usually there are three rounds per year, whereby some regions may require up to four rounds) leading to the need of 2,860 m3 of water per hectare and year. Therefore the whole country used 1,760,000,000 m3 of water for irrigating 600,000 hectare under coffee. This is quite a large amount of water.

According to new recommendations by the Ministry of Agriculture & Rural Development (MARD), the amount of irrigation water should decrease by 40% to 400 litres per tree and irrigation round; i.e. 1,760 m3 of water should be used for one ha per year. Having 600,000 hectare under coffee in the country irrigation needs would then amount to 1,056,000,000 m3 per year for coffee, which is still a lot of water considering water availability constrains. In any case, saving water in coffee farming is very urgent.

There are two traditional irrigation methods in Vietnam: basin irrigation and sprinkler irrigation. In addition to these two methods, over the past three years the Vietnamese Western Highlands Agroforestry, Sciences and Technical Institute (WASI) was involved in developing a combination of water and nutrients application using drip irrigation. Drip irrigation is the most efficient system and can help to save water. However, it is also usually the most expensive. Which system should be chosen therefore depends on local factors and the availability of resources; thus, no general recommendation can be offered.

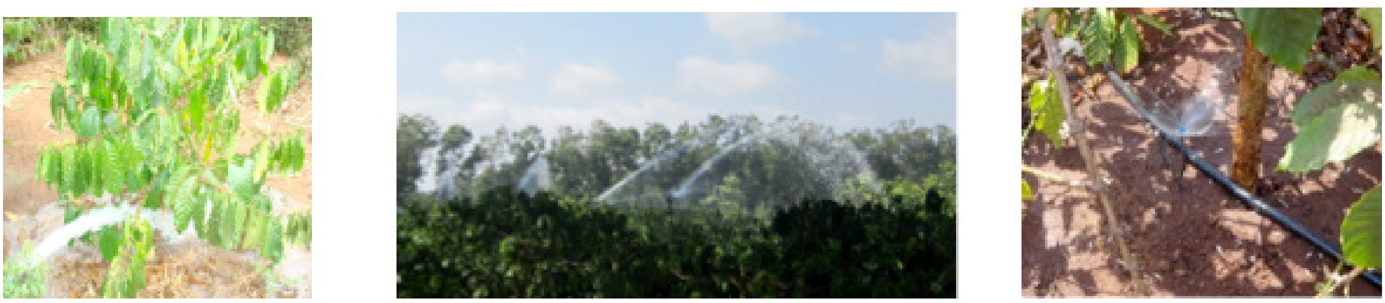


Figure 24: Different irrigation techniques – basin, sprinkler and drip irrigation.

Important aspects to consider for saving water are stated in the following sub-chapters.

5.2.1 Correct timing for irrigation

After harvesting, coffee trees need a dry period of around two months to start developing their flowers. Determining timing for irrigation that is best for the growth of the gardens and the coming harvest's yield will be more and more important in the future under the predicted climatic changes.

IN PRACTICE: CORRECT TIMING FOR IRRIGATION

- Scheduling the first irrigation round: Depending on weather conditions and harvesting activities producers should irrigate for the first time between the end of January up to the first/ second week of February. The exact timing can be different per location and year, but can be recognized by looking at soil moisture, amount of wilted trees and flowers that have developed the shape of a sparrow's beak (see figure 21; when about 30-40% of the flowers have developed that shape, the plants should be irrigated).
- Scheduling the second irrigation round: After the first irrigation round those flowers that were in the shape of a sparrow's beak will start blossoming simultaneously, while a second group of flowers will develop. It is important to wait until the maximum amount of flowers has developed and to check soil moisture as well as the level of wilted leaves to decide when to irrigate for the second time. Normally, the period between two rounds of irrigation is between 22 and 25 days. It can even be longer - between 28 and 30 days - depending on the level of dryness and vegetative cover of each coffee farm.
- Scheduling the third irrigation round: The same factors as between the first and second round define the timing of the third round of irrigation.
- Scheduling the fourth irrigation round: Depending on the level of dryness some regions need to be watered four times a year, whereas others only need three rounds. In case a fourth round is needed timing depends on the factors as described above.

Figure 25: Flower with the shape of a sparrow's beak, simultaneous flowering and flowering after irrigation.

5.2.2 Controlling the amount of water for irrigation purposes

It is important to measure and to control the amount of water used per irrigation round. Despite general beliefs that more water will lead to more blossoming and thus ultimately to higher yields, over-watering can have damaging effects on the coffee trees.

IN PRACTICE: MEASURING WATER USAGE DURING IRRIGATION

There are different techniques to measure water usage during irrigation (for the examples we assume that one tree needs 400L, as is the current recommendation by the MARD):

- Basin irrigation: Use a tool of which you know how much water it can hold (i.e. a barrel that can hold 100 liters), then stop the time it takes to fill it with water. Multiply the amount of water needed for the irrigation of one tree with the time just stopped. This indicates the time (usually minutes) it takes to irrigate one tree. As an example: it takes 4 minutes to fill a 100 litre barrel; the tree needs 400 litres per irrigation round: 4 x 4 barrels (i.e. 400 litres) = 16 minutes. This indicates that using the same watering device (hose) one tree should be watered for 16 minutes.
- Sprinkler irrigation: Calculate or look up the actual output of the irrigation machine for spraying water within one hour and consider how many faucets are arranged and how many trees need irrigation. For example: one tree needs 400 litres; the machine sprays 4,000 litres through all faucets in one hour.

Let's assume the plantation has 1,000 coffee trees. In one hour the machine sprays enough water for ten trees. 1000 trees divided by 10 trees watered in 1 hour = 100 hours. This indicates that in total the machine needs to run 100 hours to water all 1000 trees.

- Drip irrigation: Check / look up the actual capacity of one faucet: how many litres does it spray within one hour per opening, how many pipelines and how many openings need to be arranged for one root system. From that you can calculate how many hours one pump should operate. For example, a system recommends two pipelines with 3 openings per root system, thus 6 openings in total, and pumps 6L per opening per hour. A tree thus receives 36L in one hour. To make sure each tree gets at least 360L, you would thus have to irrigate for 10 hours.

5.2.3 Ground cover after irrigation

Besides enhancing / maintaining soil fertility, ground cover helps to keep soil moisture high and soil temperature low. Thus it helps to reduce climate change impacts on coffee. It therefore makes sense to ensure good ground cover especially after each irrigation round. Ground cover can include cover above the coffee trees – ground cover with a high level e.g. shade trees or forest / agroforestry systems -, or on a low level below coffee, such as bushes, grass, leaf litter, branches etc. The coffee stems should at all times be covered by dried branches, leaves or rice straw.

5.3 PREVENTION OF SOIL EROSION

Relevance in regards to climate change

Future climate predictions for Vietnam foresee less rainfall during the dry months between December and May and a slight increase in rainfall during the wet season between June and November. This, together with increasing temperatures can lead to more frequent and severe floods, landslides and soil erosion; which in turn may result in the loss of valuable topsoil (the top 10 – 15cm of the soil) and a reduction in soil fertility. Further reasons for poor soil fertility include soil mineralogy, nutrient leaching in slope areas with strong rainfall, agricultural practices like ploughing and improper fertilizer management. Soil fertility determines quantity and quality of the coffee harvest, defoliation, and flower abortion and poor tree growth. Poor soils can thus lead to devastating effects on coffee farmers – especially as its effects are severed due to climate change.

Figure 26: Soil – topsoil with high humus content has a typical dark brown color.

IN PRACTICE: PREVENTING SOIL EROSION

As coffee is quite often produced in slope areas, preventing erosion is a continuous effort. Several measures can be looked into:

- Knowing and controlling the pH level and the nutrient status of the soil: Application of lime in case of acidic soils (below 6 - 7) and application of sulphur in case of alkaline (above 7) soils
- Designing coffee lines in terraces to prevent erosion
- Arranging a basin around each tree for water and nutrient collection
- Planting leguminous cover crops supplementing natural grass, which is cut down (mechanically) periodically (before fertilizer application), to conserve soil moisture, temperature and fix top soil and nutrients
- Planting shade trees (see also chapter 5.4) and maintaining / expanding forest cover
- Using the residues of pruning and other organic matter (mulch) to cover the soil for the same reasons as planting leguminous crops
- Opting for good fertilization practices (e.g. buying high quality fertilizer, application of 5kg of inorganic fertilizer every year per tree, where not possible due to financial constraints half the plantation can be fertilized with half the amount in successive years)

Figure 27: Designing coffee lines and terraces, leguminous soil cover and shade trees.

Coffee is not the only crop having to battle with erosion and loss of soil fertility. Therefore lessons learnt can be derived also from other farming systems such as rice, tea or soybeans:

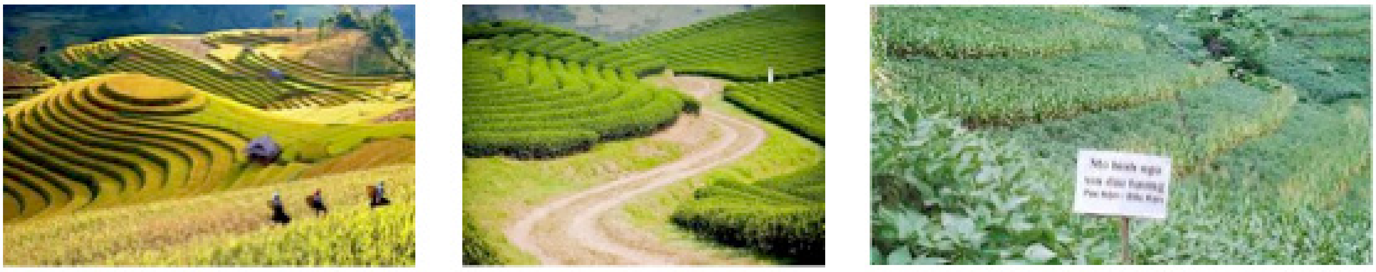


Figure 28: Rice field in northwest Vietnam, tea field in Moc Chau, soybean field in Bac Kan.

5.4 SHADE MANAGEMENT AND WINDBREAKS

Relevance in regards to climate change

For Arabica coffee, the ideal temperatures range from 15 to 240C. Between 25 and 30oC photosynthesis decreases and above 30oC it stops altogether. If temperature drops to 5oC or less coffee trees stop growing. Therefore Arabica grows and produces well in Vietnam at 1,000 meters above sea level and above. Robusta coffee prefers hotter temperatures – ideally between24 and 30oC. Above 35oC Robusta coffee stops photosynthesis and under 7oC the trees stop growing. Therefore Robusta coffee grows and produces well in Vietnamese regions up to around 500 meters above sea level. Considering the CIAT predictions that coffee produced between 300 and 550masl is expected to be hit hardest, while coffee grown around 850masl and above may not experience major impacts, trying to regulate temperatures in coffee farms is very important to protect future Vietnamese coffee production.

Furthermore, strong winds can damage roots (of Arabica as well as of Robusta) and negatively impact on sucker growth. Especially young coffee trees are affected by wind when the stem rubs against the soil due to excessive movement. Among older tress such winds can cause falling of flowers, leaves and fruits, breaking of branches and dislodging of roots during the wet season.

Good shade management and windbreaks can help to confront predicted climatic changes and protect coffee plantations.

IN PRACTICE: WIND BREAKS

Windbreaks should be planted at an angle of 90° to the main wind direction, and in different bands: One main band should be planted around the plantation to keep away the strongest winds; sub-bands within the plantation should protect against the remaining wind. The main band should contain about 3-4 rows of trees and the distance between different main bands should be around 70 to 100 meters. To save space on the plantation, sub-bands can contain as few as 1-2 rows on each band; the distance between them should be 40-50m (a tree of 10m can protect about 50m of plantation against winds; see figure 28). Depending on the species the distance between trees and rows can be adjusted. Woody trees with deep main roots and without falling leaves in the strong wind season should be chosen. In Vietnam, for example, acacia is a good species for the main band, and the distance in this case would be around 3m between rows as well as trees within a row.

Figure 29: Planting a young avocado tree as shade tree, pepper on a live stick as shade tree, durian shade trees.

On small farms of below one hectare the above-mentioned arrangement is not possible. Such farms should only plant shade trees when new or replanting coffee, or supplement coffee trees with shade trees once they start harvesting the coffee. Depending on the type of tree and its canopy width they should grow shade trees at a density of one tree per 70 to 100m. If multiple small coffee plots are adjacent to each other, it is advisable to coordinate the planting of shade trees such that the larger coffee area is protected well by the overall arrangement of windbreaks and shade trees. Depending on the region Avocado, Durian, Pepper climbing on alive-stick, Macca or other crops can be used as shade trees. All these trees also bring more income from their products.

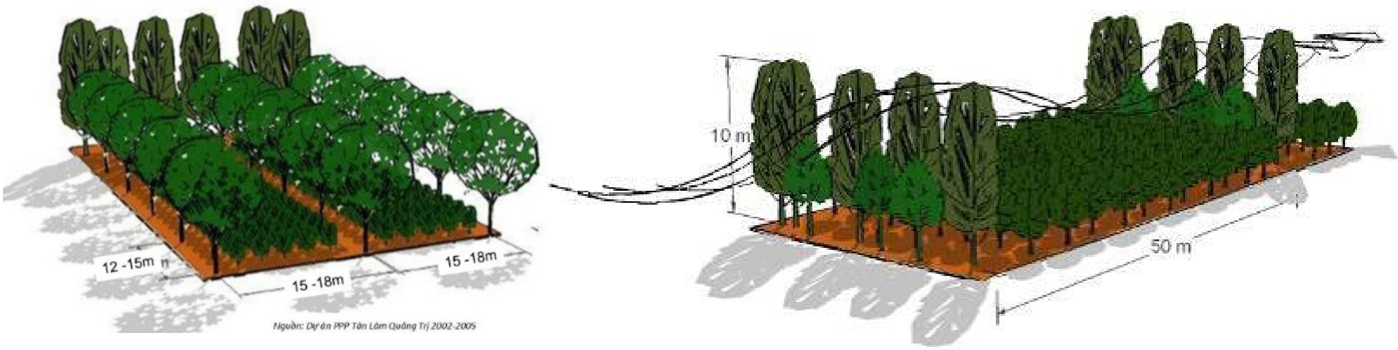


Figure 30: Shade trees and windbreaks in a coffee farm. The left panel shows the optimal distances between different trees. The right shows the flow of wind being distorted by the main band of windbreaks.

Windbreaks and shade trees offer several benefits for coffee farming:

- Both influence the micro-climate climate with a potential to decrease maximum temperature by 2°C or more; this helps to alter evapotranspiration and also enhances water availability.
- Tree roots help to channel water through their root system and extract nutrients from lower soil layers (see Figure 30).
- Windbreaks reduce wind speed and break wind direction and thereby protect coffee trees from wind damage.
- Trees provide organic matter for soil coverage and soil fertility.
- The strong tree roots reduce direct impact of heavy rain on dry soils, i.e. prevent erosion and altering of soils that are being washed out.
- Depending on the variety they provide income diversification by other products (wood, pepper, durian etc.).
- They remove carbon dioxide from the atmosphere supporting climate change mitigation.
- Reduce the damage to coffee in the region with hoarfrost (rime).

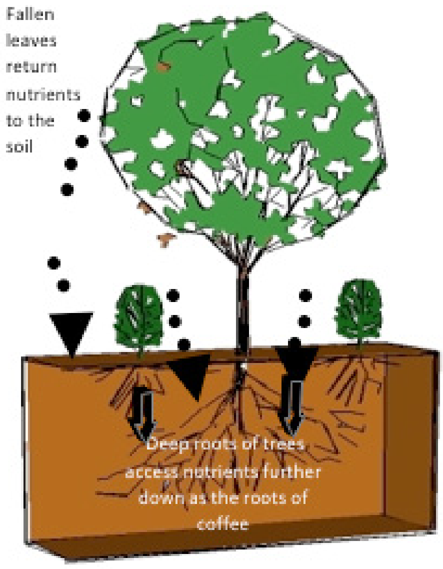


Figure 31: Recycling of nutrients from lower soil layers through shade trees: The roots extract nutrients from lower layers which are added to top layers when leaves fall to the ground and decompose. Taken from: Tan Lam's PPP project in Quang Tri Vietnam

IN PRACTICE: SHADE TREES

The following aspects are important to consider for growing shade trees:
- Shade trees need to be pruned before the rainy season to avoid breaking and to increase the light. Otherwise, falling branches can cause damage to coffee trees and wet conditions can cause molding for the coffee trees. The distance from the coffee trees to the lowest branches of shade trees should be at least 1.5 to 2 meters to make the garden clear and limit fungal development.
- Branches should not be pruned in the dry season except if they get too bushy.
- The height of the trees should be controlled by cutting the top.
- If the trees produce a crop that is harvested, nutrients have to be supplemented for the shade trees based on the specific crop they produce.

5.5 FERTILIZATION MANAGEMENT

Coffee is a crop with a high demand for nutrients. Therefore, in addition to the nutrients readily available in the soil, a balanced-mineral nutrient fertilizer has to supplement the production annually. Furthermore, coffee prefers non-compacted soil with high humus content and pH levels between 6.0 and 7.5 (see picture 28). The pH level defines the ability of the plant to take up nutrients from the soil.

Figure 32: Balanced growth with right amount and balance of N,P and K.

As mentioned above, climate change causes heavy rain, erosion and nutrient washout, and droughts make it difficult for plants to absorb nutrients in the dry season; high temperatures also reduce the ability of trees to photosynthesize and thereby convert mineral nutrients into organic nutrients to feed the plants.

Vietnamese coffee production is quite intensive pH levels and organic matter content of the soils has become low, limiting the ability of the plants to extract nutrients. Proper fertilizer management (organic as well as inorganic) is therefore crucial for good harvests.

The application of chemical fertilizers is one of the major sources of greenhouse gas emissions. Therefore it is not only important to ensure good soil fertility as an adaptation measure but also to keep the amount of chemical fertilizers applied as low as possible (without jeopardizing the quantity of harvests!) in order to mitigate emissions.

Applying fertilizers appropriately not only helps trees take up nutrition well but also decreases the amount of fertilizers, (anti-) nutrients that are washed out, minimizes evaporation, reduces N2O emission and contributes to mitigating climate change.

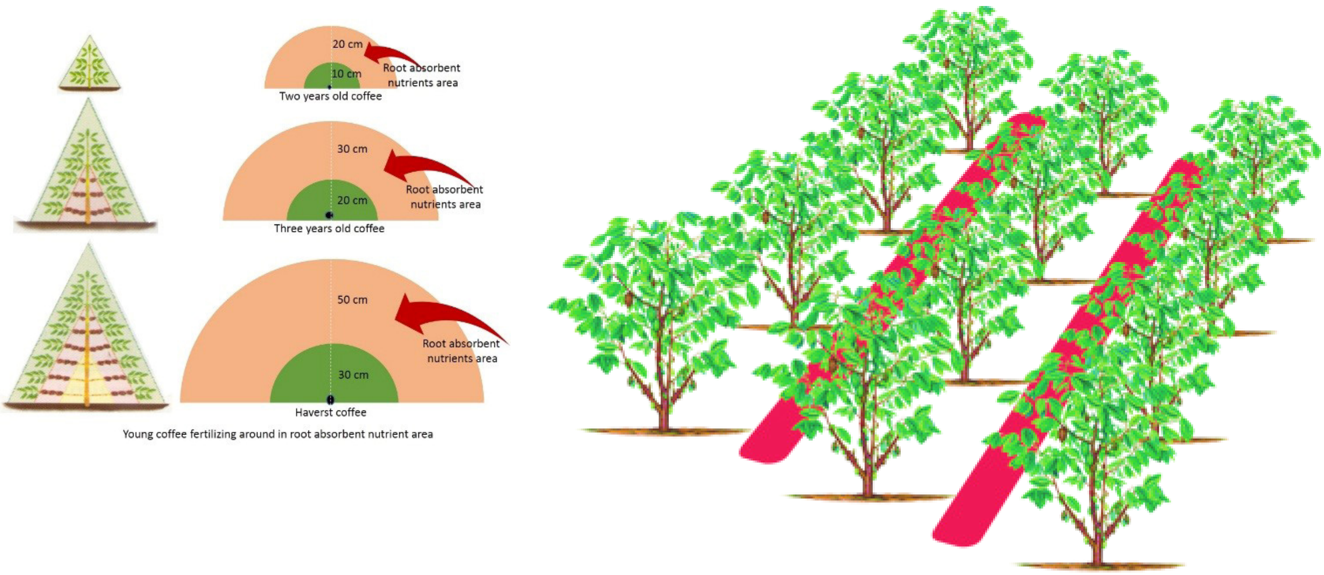


Figure 33: Targeted application of fertilizers. The left panel shows targeted application in circles around small trees, the right in lines under closed canopy. Taken from: Thiet UTZ Vietnam and Cocoa PPP project

IN PRACTICE: AMOUNTS AND CHOICE OF FERTILIZERS

Based on the nutrient demand of 1 ton of coffee, the following numbers can be used as a reference for the amount of fertilizer needed per ha (at a productivity of 3 tons/ha/year):

N from 270 kg to 290kg (pure)
P from 80 kg to 100 kg (pure)
K from 280 kg to 300kg (pure)

In addition, 15 m3 to 20m3/ha of manual fertilizers made from coffee husks or other agricultural by-products should be applied. If there is enough material, it should be applied annually; if not at least 50% of this amount should be applied to half a hectare per year. In order to increase pH as required, 600kg to 800kg of lime / ha/year should be applied, continuously for 3 years. After that an additional pH test should be conducted to decide whether to continue or stop.

IN PRACTICE: APPLICATION OF FERTILIZERS

In the 3 elements fertilizer NPK, N evaporates and is washed out the easiest. Also, trees are most sensitive to a lack N. A lack of N leads to thin leaves, poor growth, and weak branches that are susceptible to diseases. Especially for Arabica, protein insufficiency is one of the main causes for the drying branches after harvesting.

To prevent losses due to evaporation or washing out of fertilizer it is important to:
- Select fertilizers which evaporate as little as possible;
- During the first application of fertilizers, apply it in combination with water to the covered soil surface of irrigation basin ;
- During the other times only apply fertilizers when the soil is moist
- Dig trenches with a depth of 10-12cm around half the canopy if the coffee trees don't have a closed canopy yet
- If the coffee trees already have a closed canopy, dig a long line from tree to tree. Fertilizers should then be spread evenly and the covered with at least 8-10 cm of soil.

5.5.1 Timing for fertilizer application

IN PRACTICE: TIMING FOR FERTILIZER APPLICATION

The following gives a good rule of thumb for determining the exact timing for fertilization: "Look at the Sky – Soil – Tree".
- Look at the sky to guess weather: You should not fertilize without watering or rain when it is sunny. The soil must have enough moisture and the temperatures should not be too high to help trees absorb and photosynthesize.
- Look at the soil to know soil status: if possible the best way to determine soil status is a soil sample analysis. This can be taken as the basis to invest in and apply additional nutrients. In Vietnam, because of intensive nutrient application in the last 15 years of coffee production, the pH and organic content of the soil in most of the coffee regions are low. Such soils don't have very good nutrient absorption. Therefore, applying lime in combination with organic fertilizer every year is important. Especially when replanting gardens, not applying organic fertilizers will lead to low productivity and high susceptibility to diseases in periods of harvesting.
- Look at tree to evaluate the productivity and growth of the garden: adjust the amount and contents of N, P, K appropriate to the actual situation of the trees (check manuals on good agricultural practices about how to recognize a lack of N, P or K). In addition to the 3 basic factors mentioned above, and in order to avoid nutritional competition, it is important to trim trees to remove ineffective branches, weed under canopy at areas where fertilizers are applied and cut grasses close to ground.

Based on the specific weather characteristics in the coffee growing areas in Vietnam, the physiological cycle and nutritional demand of coffee trees follows the following pattern over a year:

- From December to January: The period of floral initiation; the nutritional demand of coffee trees is medium.
- From February to April: The period of flowering. The nutritional demand of coffee trees is medium.
- From mid-April to the end of the rainy season (mid-November): The period of potential branch development for the next year and fruiting. The nutritional demand of coffee trees is high to very high, more specifically:
    - From mid-April to June: the nutritional demand of coffee cherries is low but the demand of potential branches for the next years is very high.
    - From June to August: the nutritional demands of coffee cherries and potential branches are very high.
    - From August to the end of rainy season: the nutritional demand is medium.

Depending on the capacity of a farm, fertilizing should be done 3-4 times a year.

- First time in February.
- Second time in April if the rainy season is early or in May if it is late. Before applying, check whether the soil is moist enough.
- Third time in July, if applying four times; in August if applying three times;
- Fourth time in September.

After harvest during the dry season from December to the end of March, field sanitation should be finished. The soil is not moist enough for roots to take up nutrients. During this period, additional nutrients should be applied by spraying foliar fertilizers 2 to 4 times when coffee trees have enough water. Spraying should be done early in the morning or late in afternoon.

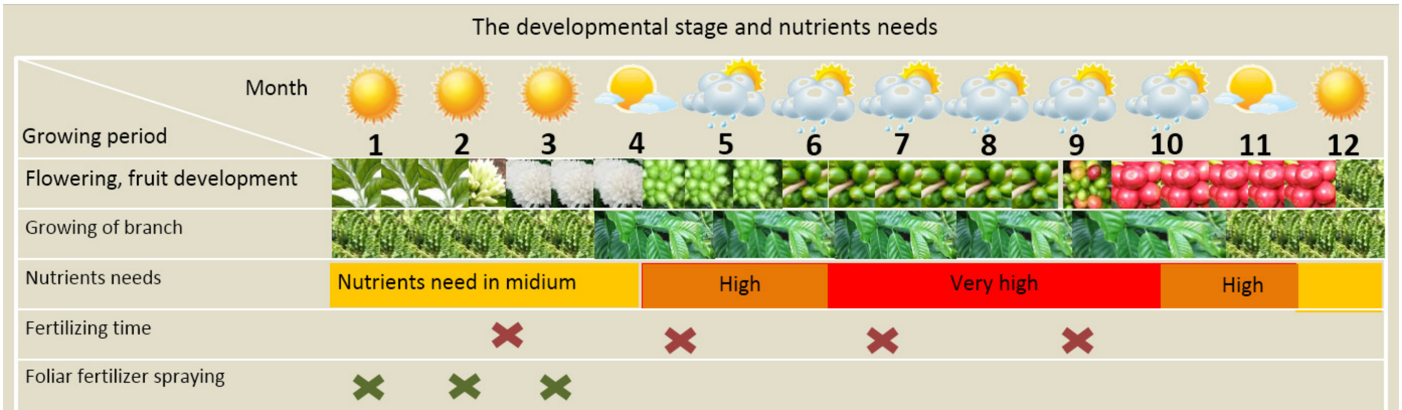


Figure 34: Developmental stages and nutrient needs of coffee plants. Taken from: Thiet UTZ Vietnam

5.6 PEST AND DISEASE MANAGEMENT

Relevance in regards to climate change

Insects or pests attack coffee leaves, stems, roots and fruits (coffee cherries). For example, nematodes attack coffee roots, the coffee berry borer attacks the coffee cherries and Helopeltis theivora (mosquito bugs) attack young coffee branches and leaves. Pests that attack coffee leaves tend to be more present during drier periods, whereby pests attacking coffee roots rather appear during wetter seasons.

Not only pests pose a threat to coffee farmers, but so do diseases. The most commonly seen disease in coffee plantations is Hemileia vastatrix (coffee leaf rust). Such fungi usually appear and spread during the rainy season, as they prefer humid conditions.

For Vietnam less rainfall during the dry months between December and May and a slight increase in rainfall during the wet season between June and November as well as increasing temperatures are predicted. Therefore climatic conditions are likely to become more favourable for pests preferring drier and hotter settings. However, due to (over-)watering also pests such as nematodes need careful management.

Weaker trees, leaves and roots are more vulnerable to pests and diseases. It is therefore important to consider all climate change adaptation practices when trying make plants more resistant to pests and diseases.

Changes in pest and diesease attacks in turn may translate into higher input costs while at the same time reducing yield quality and quantity. It is thus important to train coffee farmers around adequate pest and disease managament in order to protect their crops.

To avoid damages caused by pests and diseases, the first measure is to regularly visit the field and to observe the situation of pests and diseases and development of trees in order to implement measures accordingly.

IN PRACTICE: COMMON PESTS AND PREVENTIVE MEASURES

- Aphids sucking young branches, young leaves and young fruits, develop throughout the year except during the rainy season. If their density is low, chemical products don't need to be applied because natural enemies will kill them. If their density is high, the chemical products must be applied according to the guidelines of good agricultural practices. Please note that only diseased trees shall be sprayed, not all.
- Fruit mealy bugs: if their density is low, they should be handled manually; in case of a high density, a high pressure water pipeline can be sprayed directly at the mealy bugs to remove them. If using pesticides, they should be used properly and only at diseased trees.
- Stem borer and branch borer: growth of these two borers will be limited when coffee gardens have shade trees because direct sun shine is reduced. The best way to handle the branch borer is to cut and burn diseased branches. For the stem borer, using light traps in the early evening is very effective.
- For cicadas, mealy bugs and nematodes that attack roots: preventive farming measures should be used by regular applying manure fertilizers, keeping vegetation covering soil surface, and not cleaning weeds. Using chemical products not only is not effective but also destroys the soil environment, affects underwater source, and destroys beneficial microorganisms in the soil.

Figure 35: Common pests (from left to right): stem borer (Xylotrechus quadripes), aphids, branch borer, mosquito bug (Helopeltis theivora)

IN PRACTICE: COMMON DISEASES AND PREVENTIVE MEASURES

To avoid fungi damaging fruits, branches and leaves, it is important to keep coffee gardens well-ventilated in the early rainy season by pruning branches of shade trees until they cover about 20-30% of the garden, to shape potential coffee branches for the next year at the first pruning, and to regularly cut off diseased branches to keep ventilation throughout the rainy season. Besides spraying, a mixture of Boocdo can carefully be applied twice with and interval of 12-15 days for the whole garden after the 2nd offical rain (about late April to early May). In addition of preventing fungus developing on coffee trees, this will also provide the microelement copper that helps trees develop.

If all the above has been done, and diseases still appear with high density, appropriate pesticides should be applied to each disease as specified in the guidelines.

Figure 36: Common diseases (from left to right): coffee leaf rust, pink fungus disease, dieback disease.

5.7 ADAPTING THE COFFEE PLANT - RESISTANT VARIETIES

Relevance in regards to climate change

As microclimates are changing and management practices need to be adjusted also the coffee variety planted is an important factor to consider. In the past coffee varieties were mainly selected based on productivity and quality. Furthermore, the current coffee plants are well-adapted to past climates, but not necessarily to an environment with high temperature and prolonged drought, so productivity and quality of coffee in some areas have already decreased.

Buzzwords in this regards are “drought tolerance” and “pest / disease tolerance”. “Tolerant” here does not mean that such coffee varieties are completely resistant to drought or a specific pest/disease. It rather means that such varieties perform better under dry conditions and pest/disease attacks than other varieties. A drought resistant variety, for example, may not dry out as much or as quickly as other varieties during a period of drought and it is likely to take less time to recover after a drought has hit the region. This is based on a higher water use efficiency than in other varieties. Therefore productivity will not be affected as hard with such varieties than with others.

Figure 37: Grafting seedling to tree with healthy root

Whenever new coffee trees are planted it is thus key to choose a variety that is likely to perform well under changing climatic conditions as predicted by the scientists. Especially for smallholder coffee farmers it is not possible to renew their whole plantation(s) as this would mean reduced or even no income for 2-3 years. However, when renovation activities are planned or when single coffee plants are uprooted, it is wise to be aware of and informed about environmentally and climatically suitable varieties for the particular region.

IN PRACTICE: COMMON DISEASES AND PREVENTIVE MEASURES

To avoid substantial losses in the future, it may be useful to consider the following when selecting appropriate varieties:

- When planting new areas or replanting existing ones, contact coffee research institutes for advice on drought-resistant and disease resistant varieties with high productivity. The Ministry of Agriculture and Rural Development has recommendations which species should be used in Vietnam. Such varieties are, for example, such as TR 7, TR 8, TR 9, TR 10. TR 11, TR 12, TR 13.
- Select well-developed trees with high disease and drought resistance in the last 20 years and take scions for grafting and propagation through branch grafting.
- Make seedlings from nurseries by grafting branches of strong trees with deep healthy roots that can take up water in deep layers during the dry season, for instance, Coffea liberica. Trees of varieties that don't adapt well to the current weather situation, but that have good roots, can be replaced gradually by grafting.

In addition, tree management should follow recommendations of good agricultural practices concerning tillage, making soil bags, selecting young trees to put in soil bags and taking care of seedlings, thus ensuring a good condition before growing. Seedlings should show strong growth, should be free of disease, have a normal form with 6 pairs of leaves, and a height of the stem of 20-25cm, with the base of the seedlings having a diameter of 10cm with a root of 3-4mm.

The best time for growing young trees is early in the rainy season in May or June latest. This way best use is made of the cool period, rain and moisture that help coffee trees grow in the longest favorable environment and ensure that the root develops strongly and provides a good basis for entering the next dry season.

During new-, replanting and re-cultivating gardens the soil should be tilled, holes should be digged and mixed with fertilizers at least one month before planting. In addition, at least 10kg of organic fertilizer, 0.5kg of phosphate, and 0.3kg lime per root are mandatory.

Note: To avoid regrettable risks in the future through the selection of inappropriate varieties, it is strongly recommended to contact research centers or institutes for getting good varieties with guarantees on origin and nursery.

Figure 38: exemplary nursery (taken from WASI).

Figure 39: New vegetative clones that offer high productivity under new climate conditions in Vietnam

(in clockwise direction TR7, TR11, TR12, TR13).

5.8 SOLAR DRIERS

Relevance in regards to climate change

Harvested fresh coffee is dried from around 60% to around 11-12% moisture content in the producing countries. This process is directly linked with final coffee quality as over-drying often results in defective beans, while insufficient drying attracts bacteria and fungi.

Vietnamese coffee producers, especially smallholders, usually apply dry processing, which means that after sorting and cleaning the whole coffee cherry is dried in the sun on concrete, brick patios or scaffolds. (Note: For wet processing the coffee pulp is removed before drying, thus only the pure coffee bean is dried. Through wet processing the coffee usually dries quicker in around 4 to 6 days.)

In the target regions of the C3 project Arabica coffee is mostly harvested between September and December, while Robusta harvest takes place between late October and December. Therefore most of the harvesting is done during the rainy season, which is not ideal. There are very few sunny days from September to late October, which is unfavorable for coffee drying as explained above. For this purpose the coffee is heaped into roughly 45cm high rows and then needs frequent raking. According to future climatic conditions, the rainfall amounts and times are likely to change, which could make sun-drying of coffee even more difficult. Ultimately this may affect coffee quantities and qualities sold and thus farmers' incomes.

IN PRACTICE: SOLAR DRIERS

Solar driers help to protect drying coffee against sudden rains that have a bad effect on the coffee quality. Materials used are very simple: bamboo or coffee wood can be used from the coffee gardens and white plastic nylon plates that let sunshine pass. With these materials, the useful life of a drying house is about 2 years in Vietnamese conditions. A metal house frame and hard plastic roof will make the driers life longer, but need higher initial investment.

Advantages of solar driers are:

- Avoid coffee getting wet when it rains.
- Temperature inside drying house will increase by 15-20% when it is sunny, thus shortening the drying time.
- Simple, easy to build and low cost.
- Save energy used for drying such as electricity, fuel, labor and reduced emission causing greenhouse.

Figure 40: Solar driers in Lam Dong, Ben Tre and Daklak.

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REMEMBER THAT

…coffee growers adversely affect climate change by (see chapter 2.5)

- using agro-chemicals excessively, including chemical fertilizers and pesticides
- generating large amounts of wastewater
- deforestation and insufficient tree planting
- failing to protect soil fertility
- leaving plant residues untreated in fields or dumps
- post-harvest losses through, for example, improper drying
- pruning coffee and shade trees too much
- using inefficient equipment
- burning and uncontrolled disposal of waste
- household activities

…coffee growers can adapt to and mitigate climate change by

- raising awareness about climate change (chapter 5.1)
- planting more trees as windbreaks, shade trees, and cover crops to protect coffee, improve soil fertility and absorb CO2 (chapter 5.4)
- saving water in irrigation (chapter 5.2)
- using agrochemicals moderately (fertilizers + pesticides), leveraging all resources of compost or manure as fertilizer for coffee (chapter 5.5.1)
- applying fertilizers targeted to the plant (chapter 5.5.2)
- controlling erosion and protecting soil fertility (chapter 5.3)
- planting new variaties (chapter 5.7)
- using integrated pest management for pest and disease control (chapter 5.6)
- reducing waste, including optimal processing with, for example, solar driers (chapter 5.7)
- preventing deforestation, minimizing burning practice
- saving fuel and energy through efficient machinery and utilizing renewable energy

REFERENCES

- Bunn et al, A bitter cup: climate change profile of global production of Arabica and Robusta coffee, Springer 2014; http://link.springer.com/article/10.1007%2Fs10584-014-1306-x#page-1 last accessed 12/08/2015

- IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. / p.47; http://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf; last accessed 07/08/2015

- UTZ Core Code of Conduct, Version 1.1, For Group and Multi-Group Certification 2015; https://utz.org/?attachment_id=3622; last accessed 12/08/2015

- Department of Ecology, State of Washington: http://www.ecy.wa.gov/climatechange/whatis.htm; last accessed 07/08/2015

- IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. / p.47; http://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf; last accessed 07/08/2015

- Occupy Monsanto: https://occupymonsanto.wordpress.com/category/uncategorized/page/2/ ; last accessed 07/08/2015

- IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. / p.2

- IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. / p.61; http://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf; last accessed 07/08/2015

- Linne, Input for participatory vulnerability assessments and first introductory training, C3 2014 https://www.utz.org/wp-content/uploads/2015/12/003_ImplementationGuidance_VulnerabilityAssessment_small_201404.pdf

- van Rikxoort, Schroth, Läderach, Rodríguez-Sánchez, Carbon footprint and carbon stocks reveal climate-friendly coffee production, 2014

- Läderach, P. et al; Future Climate Scenarios for Vietnam's Robusta Coffee Growing Areas, CIAT 2012

- IPCC, Climate Change 2007: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-a-d.html; last accessed 07/08/2015

- United Nations International Strategy for Disaster Reduction (UNISDR) 2009: http://www.unisdr.org/we/inform/terminology; last accessed 07/08/2015

- c3 with support from Kerstin Linne, 2014: Trainer Poster

- IPCC, Climate Change 2007: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-a-d.html; last accessed 07/08/2015

- Linne, Input for the C3 Kick-off Workshop in Lam Dong, C3 2013

- Sangana PPP, Training on on-farm carbon monitoring, Romero et al, GIZ 2010

- Linne, Input for the C3 Kick-off Workshop in Lam Dong, C3 2013
- Linne, Climate Change and Vietnamese Coffee Production - Participatory Vulnerability Assessment - Implementation Guidance, C3 2014: https://utzcertified.org/attachments/article/26584831/003_ImplementationGuidance_VulnerabilityAssessment_small_201404.pdf ; last accessed 07/08/2015
- UTZ Certified, Guidebook on agricultural extension – participatory methods, 2013
- Linne, Input for the C3 Training of Trainers in Da Lat, C3 2014
- Linne, Climate Change and Vietnamese Coffee Production – Farmer Sensitization Session, Training Manual, C3, 2014
- Linne, Evaluation from the sensitization sessions with C3 farmers in Lam Dong, Vietnam, C3, 2013
- C&C, The Initiative for Coffee & Climate, Template for Case Studies, 2013