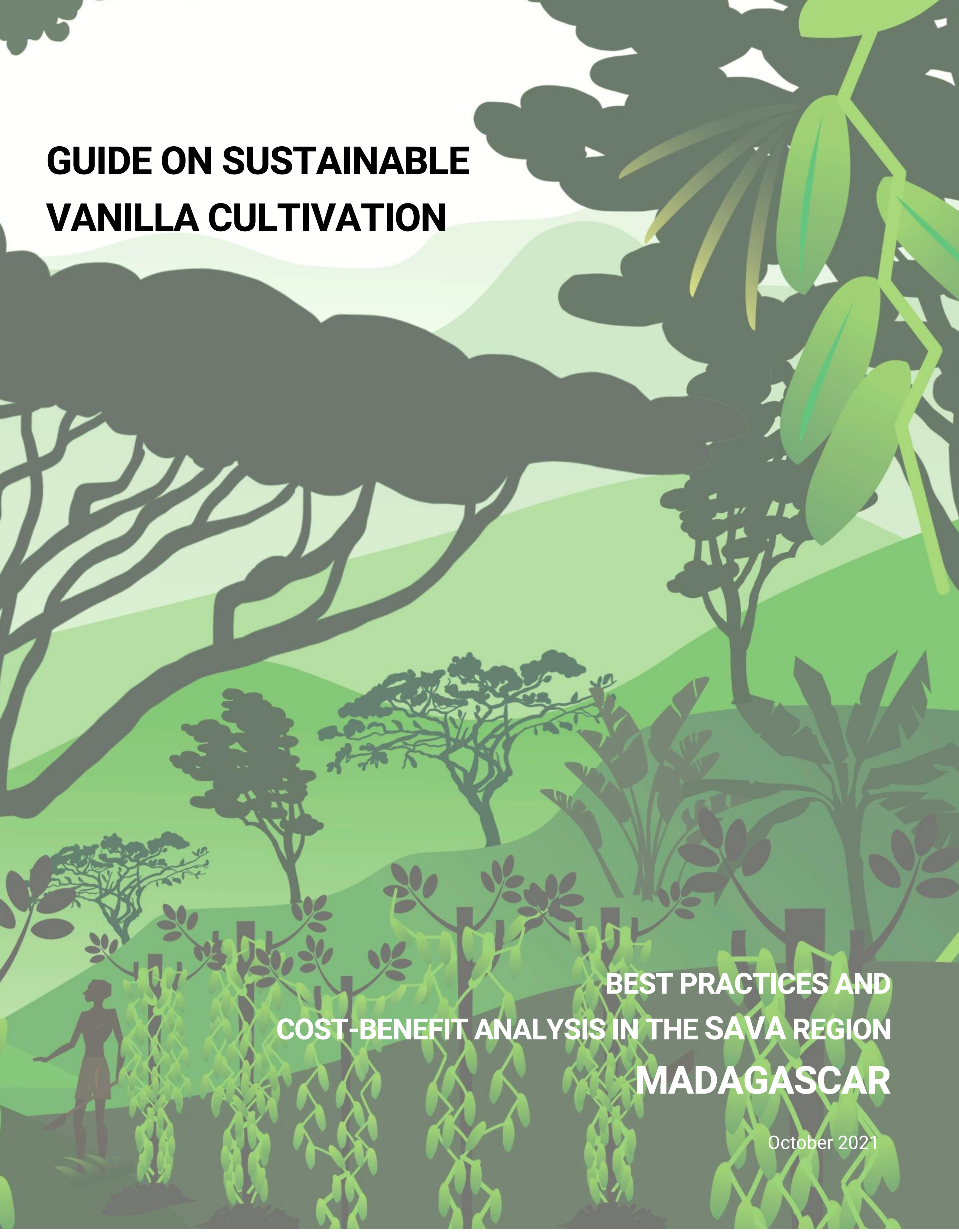
GUIDE ON SUSTAINABLE VANILLA CULTIVATION



BEST PRACTICES AND COST-BENEFIT ANALYSIS IN THE SAVA REGION

MADAGASCAR

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KINOMÉ

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The executive summary along with the strategic recommendations were shared for review and comments with seventy-two practitioners and academics with expertise in vanilla, climate finance and the plant and spice industry. Two interactive online workshops were also held to receive feedback. The results of these consultations are incorporated into this document.

SUMMARY

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ACRONYMS & ABBREVIATIONS

CNV	National Vanilla Council
COBA	Local communities
CS	Cultivation system
CS	Cultivation system
CSR	Corporate social responsibility
CSR	Corporate Social Responsibility
DAAB	Agribusiness Support Department (MAEP)
DAPEVB	Department for the Support and Promotion of the Green and Blue Economy (MEDD)
DAPV	Plant Production Support Department (MAEP)
DBH	Diameter at breast height
DCE	Department of Foreign Trade (MICA)
DDC	Department for Development and Cooperation (Switzerland)
DFAPP	Department for Agricultural Training & Professionalization of Farmers and Fishermen (MAEP)
DHP	Diameter at breast height
DIANA	Diego-Ambilobe-Nosy-Be-Ambanja (region)
DTBS	Diversity Turn Baseline Study
DTP	Diversity Turn Project
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization's Statistical Database
FFEM	French Fund for the Global Environment
FOB	Free on board
FOFIFA	Foibem-pirenena momba ny Fikarohana ampiharina amin'ny Fampandrosoana ny eny Ambanivohitra; National Center for Applied Research in Rural Development
GDP	Gross domestic product
GEC	Community savings groups
GEVA	Antalaha Vanilla Exporters Group
GEVM	Madagascar Vanilla Exporters Group
GIZ	German Gesellschaft für Internationale Zusammenarbeit (Germany)
Ha	Hectare
IDH	The Sustainable Trade Initiative
IFC	International Finance Corporation
INSTAT	National Institute of Statistics
ITW	Interview

MAEP	Ministry of Agriculture, Livestock Production and Fisheries
MD	Man-day
MD	Man-day
MEDD	Ministry of the Environment and Sustainable Development
MGA	Malagasy Ariary
MICA	Ministry of Industry, Trade and Handicrafts
MRV	Monitoring, reporting and verification
NCBA-CLUSA	National Cooperative Business Association - Cooperative League of the United States of America
NGO	Non-governmental organization
NGO	Non-governmental organization
OSDRM	Organization for the Support of Rural Development in Madagascar
PACT	Private Agencies Cooperating Together
PIC	Integrated Growth Poles and Corridors
PNV	National Vanilla Platform
PPP	Public-private partnership
R&R	Renovation & rehabilitation
REDD	Reducing Emissions from Deforestation and Forest Degradation
RFA	Rain Forest Alliance
ROI	Return on investment
RPN	Income for nature
SAVA	Sambava-Antalaha-Vohemar-Andapa (region)
SVI	Sustainable Vanilla Initiative
SYMABIO	Malagasy Organic Agriculture Union
TC	Total carbon
UEBT	Union for Ethical Biotrade
UMO	Labor unit
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
USD	United States dollar
WB	World Bank
WWF	World Wildlife Fund

PRELIMINARY NOTE

This report was written following a first version of the guide developed by a consultant commissioned by The World Bank in 2020. This guide has been expanded to include more technical aspects and enriched with new sections relating to natural capital assessments in different cultivation systems and the cost-benefit analysis of transitioning from current practices to even more environmentally demanding ones.

This additional information is the result of interviews with private sector stakeholders, associations, public institutions and data obtained by research (see the details of the interviews listed in Annex 1). A field analysis aimed at collecting further analytical data had been planned but could not be carried out due to the Covid-19 pandemic related closure of the SAVA region in April. To replace this analysis, field data from a research project (mainly the Diversity Turn project) were assessed. We also added some other specific data to this, in particular data obtained via focus groups with the main vanilla stakeholders in the SAVA region.

Exchange rate used: 1 USD = 3,745 MGA

EXECUTIVE SUMMARY

Vanilla cultivation is one of the most important economic drivers in Madagascar but currently it is unsustainable mainly due to price volatility and inconsistent transmission of farming practices. **These cultivation methods, characterized by high plant densities and a lack of adequate care, promote the spread of diseases (phytophthora and fusarium) which reduce yields or even lead to the total loss of production.** This guide carries out an analysis of vanilla cultivation practices in SAVA, the main producing region of Madagascar. It first proposes cultivation practices which, if correctly applied, will avoid yield losses by ensuring stable and sustainable productivity over time. It then analyzes how this transition can be made.

Proposal for sustainable practices

The sustainable practices thus proposed aim to maintain the functionality of agroecosystems (fertility, carbon, water etc.), the diversity of production systems and the sustained maintenance of vanilla plants and plots. The differences between sustainable and unsustainable practices are summarized in the table below:

	Observed in unsustainable practices	Objective of sustainable practices
Functionality	**Loss** of functionality: • Global scale: reduction of a protective role in the face of climate change • Local scale: soil erosion/leaching; loss of usable plant material • Vanilla plant cultivation: weakening of vines; plant health risk	**Conservation** of functionality: • Global scale: carbon storage, water, humidity, pollination • Local scale: functional diversity of the plot (structure, composition); soil fertility • Vanilla plant cultivation: conserving the vigor of vanilla plants
Practices involved	• Total slash-and-burn • Clearing and stripping the soil • Burning plant waste	• Biodiversification of the agroforestry system • Valorization and diversification of the functionality of vanilla-associated plant species • Valorization of local waste and materials
Required investments and care	**Extensive** and **unsuitable** maintenance: • Little nutritional intake (weakening of the vines) • Inadequate configuration of vanilla plants (overloading of vines) • Little bunch reduction (too many bunches)	**Sustained** maintenance: • Plot management • Nutritional intake • Vanilla plant configuration • Flowering management • Health prevention • ORGANIC treatments/fertilizers

Two uses are envisioned for these new practices:

- The **perpetuation** of vanilla plots already in place which are currently in natural forests (30% of crops) or in regrowth following slash-and-burn in a forest to set up *tavy* farming crop burn-regrowth cycles (70% of crops).
- The **implementation** of new vanilla cultivation on **non-forest**, nutrient-poor soils to increase vanilla production without putting pressure on natural forests.

What are the costs and benefits of transitioning to these practices?

A cost-benefit analysis of the transition to these new practices has been carried out.

Costs:

- **A transition from current systems to sustainable systems,** changing practices and keeping vanilla plants in the plot would cost **USD $660/ha over a period of two years**. These costs include labor to redevelop the plot (management of fertility, density, shade, water), equipment and support costs (supervision, certification, land security, financial compensation).
- **Implementation of new cultivation systems on depleted non-forest soils would cost USD $4,750/ha over four years.** Exceedingly high labor costs would be incurred in the first two years to redevelop the plot as well as financial compensation for four years until the new system goes into production.
- **An additional annual labor cost for sustainable practices of more than 60%, increasing from USD $370/ha/year** for current production (i.e. 133 man-days) to **USD $600/ha/year** for sustainable production (i.e. 217 man-days - days) would be required. This additional cost comes from the higher level of care and maintenance, pollination or harvesting work in the plots.

Benefits:

- The first benefit is to ensure the **sustainability of production**: compliance with best practices makes it possible to keep the system fertile, manage disease outbreaks and preserve local conditions that are favorable and resilient to climate change. This sustained production not only makes it possible to avoid declines in yield commonly observed but also to **sustain farmers without forcing them to use new land**.
- In **ecological** terms, numerous ecosystem services can be provided, mainly the **conservation of biodiversity**, **soil fertility** and the **end of the burn-regrowth system**. Annual carbon storage could not be assessed but the sustainability of vanilla cultivation systems would allow for the preservation of **51 TC/ha in forest cultivation and the storage of 14 TC/ha in regrowth cultivation on average.**
- In **economic** terms, transitioning to sustainable systems **increases the quality** of the vanilla beans (appearance, size, level of maturity) and paves the way for **certifications**. This increase in quality, associated with training for vanilla collectors and processors who buy green vanilla in bulk should lead to higher selling prices for green vanilla on account of this enhanced quality.

A multiyear cost-benefit analysis allows to conclude:

- **With regard to the transition from current systems to sustainable systems,** using an economic analysis (assuming constant prices) comparing current and sustainable incomes:
  - **A net gain for the sustainable systems would be achieved after three years** in the case of a transition **in plots with declining yields** (diseases, plant senescence) towards a sustainable vanilla system. This is the most advantageous and therefore most acceptable transition in economic terms for farmers.
  - **A net gain for the sustainable systems would be achieved after seven years** in the case of an **implementation of a vanilla cultivation system.** This gain is achieved when permanent and sustainable yields are noted.
- **With regard to the implementation of new cultivation systems on depleted non-forest soils:** this type of innovative implementation is rare in the field today. A return on the large investments made for this system is possible **six years** after the initial investment.

How to successfully transition to sustainable practices?

The transition to these large-scale sustainable practices requires systemic change and involves many challenges including the substantial and chronic poverty of the population, cultivation habits favoring food crops (and favoring *tavy* farming practices that put pressure on natural forests), little investment in vanilla-related work and price volatility inducing opportunistic behavior (hasty expansion of plantations in times of high prices, followed by underinvestment).

Several tools must therefore be levered to overcome these barriers:

- Land-related tools: securing plots and access to land and establishing a land registry are prerequisites for avoiding uncontrolled vanilla expansion. This is done in addition to the regulation of forest areas in order to avoid deforestation linked to agriculture generally.
- Technical tools: local and long-term supervision of farmers to gradually change practices and encourage them to invest time in the maintenance of vanilla plots.
- Social tools: combine the support given to farmers with social support aimed at targeted costs by adapting to local needs (financial education, food aid especially during the hungry gap season, education assistance).

This transition is financed in the form of numerous initiatives by exporters, importers or NGOs. Faced with the significant support needed to overcome social hurdles, these initiatives are however limited to aid given to approximately 1,000 farmers. To date, they have not reached a scale sufficient to drive systemic change in Madagascar's vanilla sector.

To achieve systemic change, two strategies can be considered:

- Strengthen the initiatives in place by attracting new public and private funding to scale up the support.
- Following the renovation and rehabilitation (R&R) approach already used in other agricultural sectors, create a fund that brings together public and private funds and as many vanilla stakeholders as possible.

One of the major risks of this sustainability process is the low demand for certified vanilla. Demand for conventional vanilla remains strong. It is thus worth considering public sector participation (or certain initiatives for that matter) aimed at covering the more expensive needs such as the mapping of national vanilla growing area or the creation of a vanilla plantations registry. This type of traceability effort is very costly for the private sector and for cooperatives currently undergoing certification and sustainability processes in general. However, it remains one of the best ways to manage the risk of deforestation. Some countries like Côte d'Ivoire, with almost a million cocoa farms, have started mapping their location. By way of comparison, Madagascar officially has 80,000 vanilla farmers.

Such mapping would also facilitate overlaying the data with maps of protected areas and monitoring natural habitat disturbances to confirm that the vanilla sector does not have a negative impact on biodiversity. Also, contrasting the data with maps of school attendance rates in vanilla cultivation areas would help to manage child labor risks.

The study attempted to quantify the cost of transition to sustainable vanilla cultivation practices in the SAVA region, and the overall budget has been distributed among the public sector, the private sector and development organizations. Thus, it would take USD 137 million for 100% of the current surface area under vanilla cultivation (65,000 ha, to be confirmed by additional studies) to become sustainable and for any future expansion of vanilla cultivation areas (estimated at 3% per year) to take place solely on non-forest soil (approximately 19,000 ha for the next 10 years).

In this budget, public authorities would provide USD 82 million to finance:

- 100% of the plant material needed to ensure quality;
- 100% of external costs aimed at full traceability (different from certification linked to labels). In fact, geolocation of plots and development of documentation constitute the highest costs when it comes to traceability, a fundamental element to assess and confirm the zero-deforestation performance of the vanilla sector. The sector can hardly meet this cost without confirmed demand for certified vanilla.

- 50% compensation for loss of earnings;
- 50% of labor costs, useful to encourage the establishment of the cultivation system on non-forest degraded land.

The remaining costs could be financed by the private sector and development agencies.

Thus, Madagascar will be able to boast 100% traceable and sustainable vanilla. In addition, farmers will be able to sustain their yields (yields tend to drop in poorly maintained and unsustainable plots) and therefore stabilize their plantations (rather than move into new land). All of this helps to preserve forests, adapt agricultural practices and fight poverty.

Developing sustainable practices in vanilla cultivation and promoting such environments would be a definite game-changer for the vanilla sector in Madagascar, the largest vanilla-producing country in the world.

INTRODUCTION

Vanilla (*Vanilla planifolia or V. fragrans*) occupies an important place in Madagascar's economy and is one of the flagships of the country's agricultural and food sector worldwide (see Box 1).

> *Box 1. Madagascar's vanilla be the numbers*
>
> **Global exports:**
>
> - Madagascar is the world's largest producer with more than 3,000 tons/year (FAOSTAT, 2021).
> - Vanilla exports accounted for 26 percent of Madagascar's export earnings in 2017 and about 6.8 percent of national GDP (World Bank, 2019).
> - More than 80,000 farming households and more than 6,000 intermediaries are involved (World Bank, 2019).
>
> **Situation in the SAVA region:**
>
> - This is the main vanilla producing region of Madagascar: 80% of Madagascar's bourbon vanilla production takes place here (CNV International & Fairfood International, 2018).

However, in recent years, significant income prospects have contributed to the development or start of vanilla plantations in other regions with favorable ecosystems.

This document will be based on the reality of the SAVA region, an area representative of the different farming practices and impacts.

A large portion of the rural population lives below the poverty line and can only subsist on the resources provided by their surroundings, in the form of extraction rather than a structured exploitation *per se*.

The vanilla industry is no exception to this. However, the consequences of the impacts on the environment and living spaces are terribly negative and represent a short-term threat for these populations. Rural population demographics also aggravate the specific threats faced by the agricultural sectors, mainly concerning food or cash crops.

Nowadays, poverty reduction in agriculture is a priority and any sustainability perspective must not only take into account specific parameters but above all associate them with changes in the environment whether or not said parameters are directly impacted by the sector's activities.

The government is part of this approach, which combines both the improvement and development of existing sectors, while integrating a clear notion of sustainability through initiatives supported by various technical and financial partners.

OBJECTIVES OF THE GUIDE

For the SAVA region

Madagascar is the world's leading vanilla producer (see 1.1) and almost all of it is produced on the northeast coast of the island, in the region known as SAVA (Sambava, Antalaha, Vohemar, Andapa). SAVA was the main area of arrival and development of vanilla cultivation in Madagascar. Knowledge and experience have been accumulated in this area for more than a century. The SAVA region also combines a diversity of landscapes, with contrasting pedoclimatic conditions: a dry zone in the north, a semi-humid zone of low-rise mountains in the west and a perhumid zone in the south. Finally, since 2013, it is the region that adapts most to variations in vanilla prices (extensions of cultivated areas, increase in thefts etc.). The various observations and diagnoses made for this sector in Madagascar apply mostly to this region and, to a lesser extent, to other producing zones (Analanjirofo, Atsimo-Atsinanana and DIANA). All of the initiatives, meetings and surveys in the various development phases of this guide were thus undertaken in the SAVA region.

Objectives of the guide

The challenge of this guide is to mitigate the negative impacts of traditional practices aggravated by recent changes due to market trends.

Today, the technical procedures historically used are responsible for the degradation of plots (disappearance of undergrowth, degradation of fertility) and are a driving force of local and regional environmental conditions (climate deterioration), affecting vanilla quality and yields and the socioeconomic status of rural households.

In a bid to curb these negative impacts, technical improvements must be put forward that are aimed at:

- Stopping the expansion of vanilla cultivation into sensitive, forest or protected areas.
- Supporting the careful maintenance of existing plots in order to maintain fertility and therefore yields.
- Rehabilitating degraded areas by restoring fertility through adequate vanilla agroforestry systems (and other crops), expanding cultivation areas without impacting the environment.

In summary, the purpose of the guide is **to provide farmers with tools for optimal production of green and/or processed vanilla, ensuring decent income without compromising the future of rural populations by preserving environmental services** (forests, land, water, climate balance).

Rationale for the initiative

While the initial goal of this draft manual is to encourage the entire agricultural sector, from farmers to exporters, to make national production sustainable, practical actions must be focused on current and future vanilla farmers and possibly buyers who can help speed up the process through their purchasing policies and technical assistance capacity. Indeed, the farmers are the first to use and affect the rural environment. The goal is therefore to facilitate the adoption of agricultural strategies by vanilla farmers that allow them to grow crops outside traditional forest settings (undergrowth) and preserve forest areas, reducing direct and indirect negative impacts inherent to vanilla production. Here too, it is first necessary to understand the reasons for the failures of the tests carried out over the past fifteen years.

In support of this initiative, a major effort to enhance traceability capacities could be made by the government by financing the most expensive items such as the mapping of national croplands or the development of a vanilla plantation's registry. This type of traceability effort is very costly for the private sector and for cooperatives currently undergoing certification and sustainability processes in general. However, it remains one of the best ways to manage the risk of deforestation.

The improved practices proposed will result in a (often significant) revision of the current practices and knowledge of vanilla farmers. These practices constitute changes that will have socioeconomic effects and require considerable effort and work.

Transition to a more sustainable system is challenging, time-consuming and expensive. Farmers will be in a better position to accept and put these improvements into practice if they can rely on various types of support (financial incentives, easier access to land, technical supervision) and if they have increased awareness of environmental issues, particularly in isolated peri-forest areas.

Once this practical groundwork is effectively laid, the sector will then use a regulatory framework established by the ministries involved (agriculture, environment, trade…) via instruments linked to localized certification requirements. These structural changes will establish a national standard to be applied and monitored until export. This will send a positive signal to Madagascar's vanilla stakeholders and consumers.

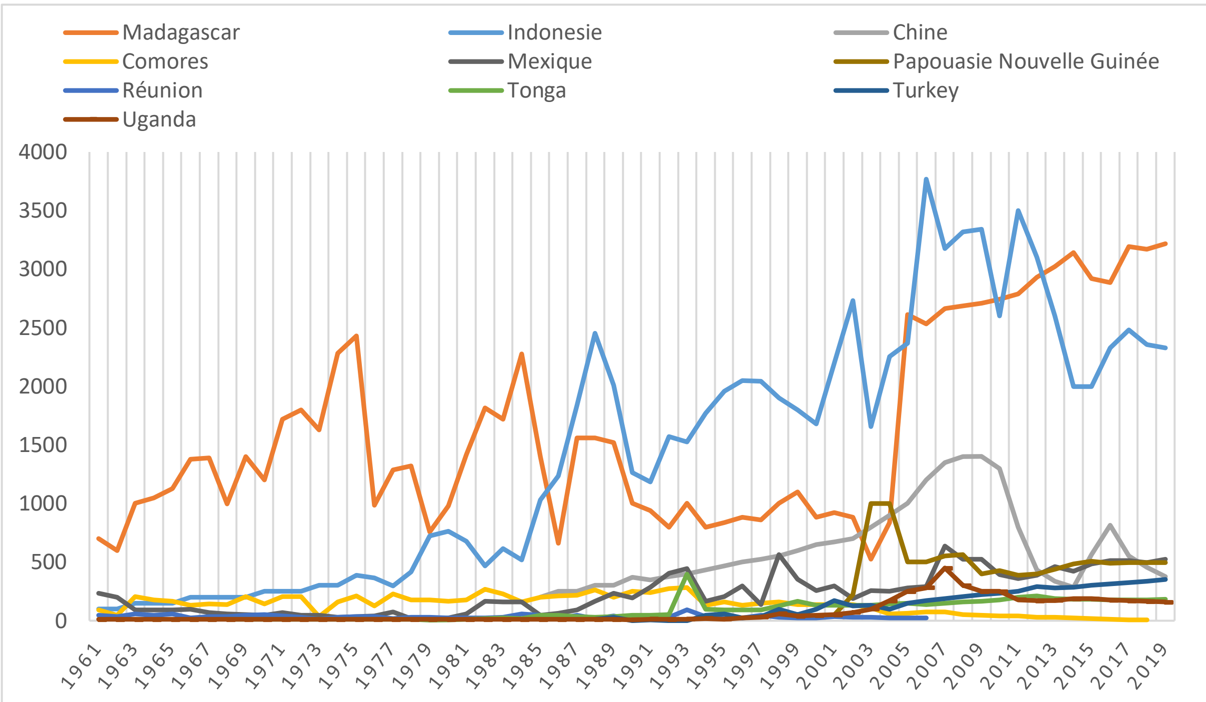
This represents an ambitious undertaking. However, preserving the natural resources of this region comes at a cost. Undoubtedly, putting it into practice will also require access to training, financing and technical assistance.

1. BRIEF OVERVIEW OF VANILLA IN THE WORLD AND IN MADAGASCAR

1.1. *The global vanilla industry and its effects in Madagascar*

For several decades, the production of vanilla beans for the flavoring industry has mainly come from Madagascar, ranging from less than 1,500 tons to more than 3,000 tons of processed vanilla[1] depending on the year (see Figure 1 and Box 2). The other main producing countries are Indonesia, Mexico and China.

Figure 1. Production of processed vanilla (in tons) among the top 10 producers (FAOSTAT, 2021)



In Madagascar, after liberalization following the end of control by the Caisse de stabilisation at the end of the 1990s, the local market has been subject to the uncertainties of a relatively unpredictable demand from consumers, impacting both farmers and the industry itself.

As a result, cyclone Hudah in 2000, coupled with lack of knowledge about available supplies, gave way to speculation by a group of Malagasy collectors and exporters on vanilla lots already purchased from farmers, pushing export prices to USD $400/kg.

This episode, although brief, led to a strong boost in vanilla production in Madagascar and other aforementioned countries, which made world production increase considerably in 2005 and which in turn brought export prices down to USD $20/kg, pushing farmers in some countries to resort to other relatively more profitable crops.

[1] *Processed vanilla comes in the form of shiny brown sticks obtained by scalding and drying green vanilla, i.e. the fresh vanilla bean harvested from the orchid of the vanilla vine.*

Since the end of 2013, we have seen more stability from the industry. The drop in production in some countries has led to a price increase in the local Malagasy market, giving rise to the current situation.

Madagascar farmers, faced with the impossibility of substituting vanilla with other cash crops, have continued to grow it despite exceptionally low market prices, preventing them from earning a decent living from their work.

In 2012-2013, with prices still very low at a maximum of USD $28/Kg for export-quality vanilla, the first potential signs of a gap between world supply, overwhelmingly of Malagasy origin, and demand had appeared. Few cared about this at the time. Starting in 2013, the vacuum packing of insufficiently dried vanilla was observed. Vacuum bagging black vanilla at the end of preparation and during export is a standard practice commonly used to maintain the quality of the processed vanilla. However, this practice can be used speculatively with insufficiently dried vanilla in order to have more weight to sell (Salva Terra, 2018). Vacuum packing has been banned in Madagascar since December 2013.

Box 2. Madagascar vanilla production data

The analysis of the trend in vanilla production was possible by using the figures provided by the FAO (FAOSTAT, 2021) which represent official and long-term data. However, this was a topic of debate during the guide introduction workshops (especially for the figures regarding Indonesia and Madagascar). According to stakeholders present, the stock of processed vanilla is underestimated, making the statistics less reliable. FAO's data regarding vanilla produced in Madagascar (Figure 1) are thus significantly different from export data obtained from the Malagasy customs service (Table 1). As for Madagascar's processed vanilla exports, some sources point out to larger figures than the ones published by FAOSTAT: 80% of the overall global volume, according to Chalmin et al., 2017.

Table 1. Processed vanilla exported (in tons) by Madagascar

Season	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Vanilla beans	1,665	2,860	1,641	1,297	1,583	1,427	1,435
Crushed vanilla	122	194	129	104	105	58	49
Total	**1,787**	**3,054**	**1,769**	**1,401**	**1,688**	**1,485**	**1,484**

Source: Malagasy Customs)

2014 was a good harvest in terms of quantity and quality, but prices linked to underestimated demand were still on the rise, reaching more than USD $75/kg for export-quality vanilla at the end of the season. The 2015 season had a low yield (less than 1,500 tons) and contributed to accentuating the effects foreseen starting in 2013, which include a premature and immature harvest of green beans, either due to theft or as an early protection measure by farmers against these thefts and almost systematic vacuum packing for speculative purposes.

Not all farmers prepare their vanilla and not all master the many stages of the process. In addition, immediate cash requirements push the sale of green vanilla. The wealthiest have the ability to wait for better remuneration via the so-called bulk market (in reality the sale of processed vanilla).

During the 2018 and 2019 seasons, the green vanilla market reached its highest price at 200,000 MGA/kg (i.e. approximately USD $55 in 2019). In 2021 the prices fall again, leading the State to establish a reference price.

Speculation and adulteration

Speculation and other consequent bad practices appeared both in the field production stage (early harvests, thefts) and in the preparation/storage phase (vacuum storage, prohibited since the 2015-2016 season). This impacted quality (a decrease in the level of vanillin, development of chemical substances changing the flavor).

Rural and environmental impacts

The effects on rural dynamics were immediate. Planting vanilla became a primary goal for anyone who had a bit of land, no matter how unsuitable for cultivation.

Land pressure was therefore very intense in almost all the pedoclimatic zones of the SAVA region but also on the entire eastern coast.

According to some stakeholders in the sector, the price increase was made known to farmers through mobile phones (which were not very accessible in 2004), and this contributed to this uncontrolled expansion of vanilla plantations.

1.2. Brief history of vanilla in the SAVA Region

At the end of the 19th century, vanilla began to be cultivated in northeast Madagascar, today the SAVA region, from its northern zone in the district of Vohémar (Iharana) to around Masoala in the south and up to a highland region of Andapa district.

At that time, the forest on the east coast up to an average altitude of 250-700 m was ideal for immediate cultivation and production.

Thus, vanilla has developed and spread in these naturally favorable environmental conditions known as ''undergrowth'', relying almost entirely on the existence of forests and forest regrowth in the region.

Figure 2. Location of the SAVA Region (adapted from Hänke et al, 2018)

Over the decades, the plant knowledge and selection and crop and plot management have developed and given a wealth of knowledge to sector stakeholders, first and foremost the farmers, but also to others via documents published by the European Union and more recently by the Madagascar government.

Vanilla is a garden plant (Hibon). Apart from very general rules, vanilla cultivation is empirical in nature and depends on the personal ideas of each farmer (Bouriquet). Recently, due to situational and climactic changes, vanilla no longer follows this theory (Nany Fleuron).

1.3. Current production

In 1970, Madagascar produced about 1,000 tons of vanilla thanks to 40,000 farmers on 10,000 ha. Over the past five years, vanilla exports from Madagascar have been closing in on 1,500 tons/year (see Table 1). Several reports mention 80,000 vanilla farms. Nevertheless, the current area under cultivation is in reality 100,000 ha, of which approximately 65,000 ha are located in the SAVA region, and more than 150,000 families cultivate vanilla, having implemented many price-driven cultivations. (Source: Estimates by Eric Marinot, cross-checking official and unofficial communications from private development and sector stakeholders). This undoubtedly adds social and environmental pressure.

1.4. Dynamics of land use in this context

In the SAVA region, vanilla cultivation is now taking place on soils that were originally forest. Recent works (Martin, D. 2021) and observations from the field study by Mr. Eric Marinot made it possible to detail how these soils are used. This use is summarized in Figure 3:

1st step: Deforestation:

First of all the **natural forests** are deforested. Deforestation in the Sava region is common. Indeed, in traditional farming practices, deforestation is the most common way to access agricultural land and secure land for future generations (Zaehringer et al., 2015). 2 types of forest degradation are possible:

- A cutting of trees creating **degraded forests** for the use of wood as a source of energy (Hänke et al., 2018) or for sale or construction. This degradation also makes it possible to implement agroforestry cultivation.
- Slash and burn of the forest (deforestation) to carry out slash and burn cultivation.

2nd step: Installation of the cultivation:

In degraded forests, **forest-derived vanilla cultivation** can be established that will correspond to the cultivation system 1 (**CS1**) defined in 2.3.1 (30% of vanilla crops, Hanke et al., 2018).

- Disease management in this cultivation system is often poor. When too many diseases develop (usually after 7-10 years of cultivation: Marinot, 2020), cultivation is abandoned and the plot is also subject to slash and burn deforestation.
- After slash and burn, itinerant **slash and burn cultivation** (*tavy* or *tetika*) of rainfed rice or other food crops is set up. These crops are grown without inputs and impoverish the soil.

3rd step: Regrowth:

Once the soils are too poor to be used, they are left to **regrow**, allowing their fertility to naturally increase (Randrianarison et al., 2016b). In these areas, herbaceous plants first grow, then trees can be observed growing starting 4 years after burning (Martin, 2021). Biodiversity thus increases the more time regrowth is allowed to take place. However, this increase is impeded by the emergence of invasive plants (Randrianarison et al., 2015).

4th step: Reuse of regrowth areas:

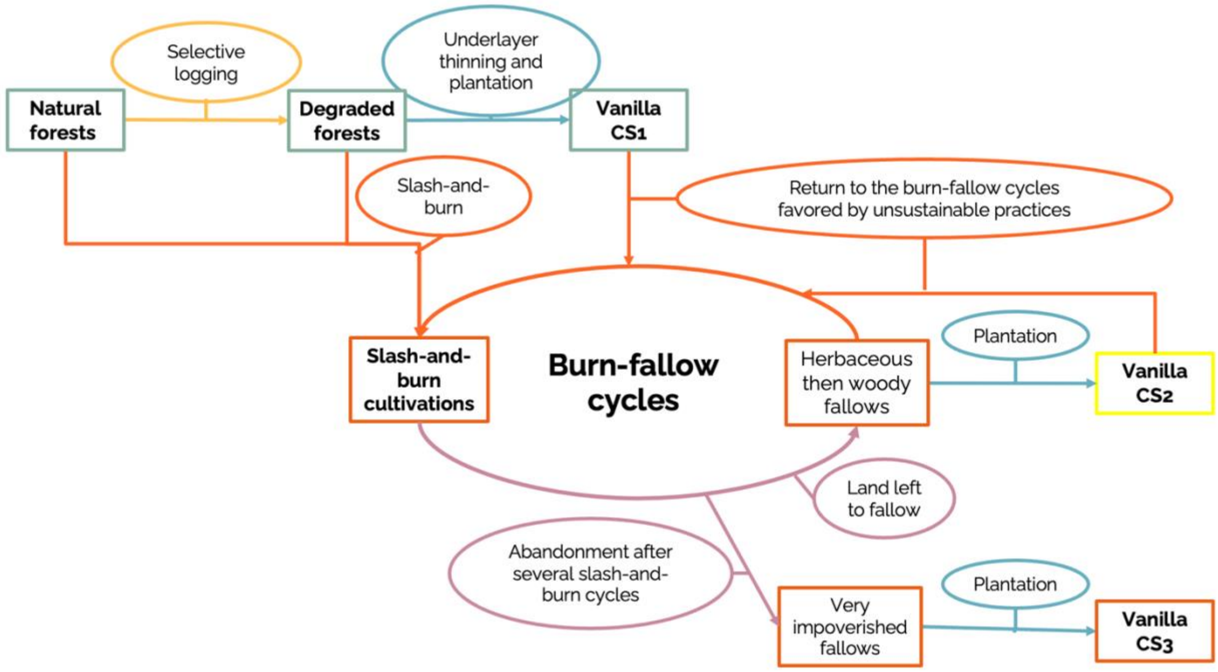
The increase in nutrients present in the soil thanks to regrowth allows for their reuse in cultivation. Here there are two possibilities:

- Either these regrowth areas are burned again to grow rice or to grow other slash and burn crops. This thus represents the start of a **burn-regrowth cycle** (Styger et al., 2009) consisting of: 1-2 years of rice cultivation (called *tavy* rice) for at least 3 years of regrowth (Michelon, 2006). Soils regenerate less and less quickly following each cycle (Randrianarison et al., 2016b). The slash and burn cycle is a major use of land associated with vanilla (cf. Figure 3). Indeed, it helps to provide homes with food. Land left to regrowth represents a potential source of food for households and its burning is generally determined by the needs of the moment. Thus, the duration of regrowth is very variable and is generally too short due to demographic pressure, which accelerates soil depletion.
- These lands are used to cultivate vanilla derived from regrowth which will correspond to cultivation system 2 (**CS2**) defined in 3.1 (70% of vanilla cultivation, Hanke et al., 2018). However, the regrowth must still be fertile enough for the development of CS2 cultivation (meaning only 1st or 2nd cycle regrowth). When the soil is very depleted (non-forest soils), a new vanilla cultivation system that is capable of restoring the fertility of these soils must be considered. This will correspond to cultivation system 3 (**CS3**). This was proposed following the field study carried out by E. Marinot in 2020.

Historically, the vanilla plots were installed in spaces corresponding to CS2: in the lowlands near the villages, on the edge of the *tavy* rice plots by a summary thinning of the undergrowth of the forest edges or in the secondary regrowth areas that were subject to *tavy* beforehand. Following the increase in vanilla prices, many vanilla cultivations have been established directly in remote natural forests (in CS1 systems) after the consequent degradation of the forest undergrowth and selective cutting of valuable species.

In this land use system, the slash and burn cycles have a central role to play. The cultivation of *tavy* rice is indeed rooted in the traditions of the region. The different stages of this use cycle can be summarized in Figure 3.

Figure 3. Illustration of the traditional slash and burn (tavy) rice cultivation cycle and its application to vanilla



It is important to emphasize that farmer practice is less obvious than what is presented in Figure 3 with more random cycles and different regrowth durations that are dictated by family emergencies. This can be illustrated for example by the burning of a CS2 cultivation despite its profitability for food needs as was observed several times in the field.

While the *tavy* system is a shifting slash-and-burn system, vanilla cultivation is, in theory, a cash crop established perpetually in the same location. The characteristics of these plantations and the sustainability of current practices are analyzed in more detail in the next section.

2. ANALYSIS OF THE SITUATION AND CURRENT PRACTICES

2.1. *Characteristics of vanilla plantations in SAVA*

Vanilla cultivation and the vanilla production calendar in SAVA

Table 2 presents the main stages of the cultivation and production of vanilla in SAVA.

Table 2. Physiological stages and the technical cycle of a vanilla plant in cultivation

Month	January	February	March	April	May	June	July	August	September	October	November	December
Precipitation	↑	↑	↑	↘	↘	↘	↓	↓	↓	↗	↗	↑
Temperature	↑	↑	↑	↘	↘	↘	↓	↓	↗	↗	↑	↑
Season	Southern hemisphere summer Heavy rains High temperature			Gap season Notable drop in rainfall Temperature drop			Southern hemisphere winter Reduced rainfall Low temperature			Gap season First rains Temperature rise		
Plot maintenance	• Intense looping • Nutritional intake • Soil mowing • Reducing shading to fight against diseases • Disease control			• Reducing shading to stimulate induction • Stop looping			• Soil maintenance			• Plot maintenance • Large nutritional incorporation • Disease control		
Induction Pollination	• End of pollination			• Stress and flower induction • Topping (if needed!)			• Flower induction			• Appearance of flower buds • Intensive pollination		
Harvest Transformation Sale	• Bean growth			• Maximum length reached • Start of bean maturation			• Ripening of the beans (yellowing at the end) • Beginning of the green vanilla harvest • Scalding, parboiling and first drying			• End of the green vanilla harvest (September) • Opening of the bulk market (September) • Refining vanilla • Export (late November - early December)		

adapted from E. Marinot

Characteristics of vanilla plantations in the SAVA region

The results of the collection of data on "traditional" practices carried out by Mr. Eric Marinot's team in 2020 is summarized below (Table 3).

Table 3. Summary of data and traditional systems identified

Elements	Main characteristics
Origin and nature of the plots	Almost 100% of the vanilla plots come from former forest areas that were formerly rich in humus and forest-type shade trees and which are now mostly degraded.
Soil fertility in the field	The vanilla plots have been depleted of humus and are therefore unsuitable for proper production. These plots are put into food crop rotation or left fallow. This represents approximately 60% of the plots analyzed.
Location of plots	More than 70% of the plots are on slopes. Most of the plots on the hilltops have become unsuitable for growing vanilla because of burnings and droughts. The cultivation plots in the lowlands, which are frequently flooded and covered in silt, have become scarce because they are not suitable for vanilla cultivation.
Age of plots	It has become increasingly difficult to find plots over 10 years old. Because of diseases, farmers renew their plantations after 6-8 years of cultivation.
Average plot size	About 98% of vanilla farms are small, consisting of 500 to 4,000 plants per plot. Some farmers may have up to three plots.
Density (plants/ha)	1,500-7,000 plants/ha
Shading rates observed (%)	Coastal areas: 50-60% Intermediate impacts: 30-40% Mountainous areas: 0-20%
Productivity (green kg/ha)[1]	From 2003 to date, productivity has continued to drop. Productivity as a function of green vanilla bean production is estimated for the (2018/2019 season): • Coastal areas: 150-250 kg/ha (<150 g/plant) • Intermediate impacts: 100-150 kg/ha (+/-100 g/plant) • Mountainous areas: 200-300 kg/ha (<200 g/plant) The distribution of the total area of plantations by zone type has not yet been established. However, it should be mentioned that the Helvetas NGO and the IRDE have recently carried out an important project characterizing the agro-ecological zones in the SAVA region as a function of altitude, rainfall, average annual temperature and ETp. • In the 1970s, the yields reported by the literature ranged from 1-1.5 tons/ha up to 5 tons/ha. These high yields were obtained thanks to a production of 2-3 kg of green vanilla beans per plant in the plantations. But this production could drop to 100 g/foot on hills with degraded soils (Hubert, 1970). • In 2019, in the rural commune of Ampondra in Vohémar district, a plot of 1.5 ha or around 2,000 vanilla plants produced around one ton of green beans or 500 g/plant and in the rural commune of Andrakata, a plot of 1 ha or about 1,200 plants produced up to 500 kg of green vanilla.

Source: Study by Eric Marinot, completed by Kinomé

[1] *Some plots show high productivity but they are not representative of their area because they remain confidential. These variations in both plant density and mass yields of green vanilla per plant illustrate the fact that stakeholders are not able to use the mass data produced per ha but only consider productivity per plant because the densities of plants per unit area differ considerably within the same plot and from one field to another.*

Field management: A brief description of current practices

The (optimal condition) undergrowth activities carried out by the vast majority of farmers based on the needs of vanilla plants are summarized below (Table 4).

Table 4. Summary of information on current practices in the traditional systems analyzed

Maintenance practices	Main characteristics
Fertility restoration management	Complete lack of fertility management
Nutrition management	Almost non-existent because vanilla plantations are established on humus-rich forest soil.
Shade management	Limited and imprecise because it is naturally provided by existing trees and partially pruned in the hot season once or twice a year
Water management	Irrigation in the dry season not practiced
Humidity management	Little addressed or not addressed at all. This is due to the generally favorable consequences of the first two parameters.
Mulching management	1 or 2 times a year
Temperature management	Little considered or not considered at all given the above parameters
Wind management	Practically unnecessary under forest cover and generally not addressed
Planting and cuttings	The optimal length and the drying period are not necessarily respected, and vines are planted increasingly frequently without much care and with minimal soil preparation.
Looping	Regularly performed 2-3 times per year as plant growth requires
Topping	Performed manually if necessary.
Selection of vines for flowering	Rarely practiced
Flower induction management	Mainly occurs with little involvement as a result of the above parameters
Management of pollination and fruiting	Non-existent because all the flowers are pollinated apparently without visible damage as the forest soils are rich. The long-term vision of the farmers concerning the duration of the total cycle is thus not addressed. This takes place from August/September to December/January, depending on the year.

2.2. Current cultivation practices

Health of farms visited

Almost all of the farms visited show signs of fusarium wilt and phytophtora to varying but significant degrees. The rate varies from 40 to 60% of the vanilla plants in a plot and explains the drop in productivity of vanilla fields.

These diseases are characterized by:

- A rotting of the root system which leads to the total loss of the plant after a few weeks, in the case of fusarium wilt;
- A rotting of the aerial root which leads to the loss of part of the infested stem or to the beans of an infested cluster falling.

Farmers' reactions to these phytosanitary problems

Farmers know how to control these diseases by thinning the plots, reducing the shade of the vanilla plants to modify the overly humid climate (the optimal shade being 40-60%) and giving the plots a little more sun. This practice is effective in controlling the proliferation of these diseases, but it makes the vanilla plot increasingly vulnerable to drought starting in the first dry season it experiences and to heavy rains that cause erosion.

Field degradation process

These successions of short-term practices without a long-term vision push farmers to abandon their vanilla fields and to look elsewhere for new forest areas to clear for new vanilla plots.

Due to a lack of awareness and technical supervision, farmers cannot identify the origin or the cause of these diseases and will repeat this environmental damage eventually.

Also, when the density is too high (> 2000 plants/ha), as has been the case for several years, pruning of shade trees is ineffective.

2.3. Environmental damage linked to current unsuitable practices

Lack of informed management

Figure 4 shows a significant increase in vanilla production from 2003 to 2005 which is linked to the price surge from 2000 to 2004 (Figure 5). This increase has resulted in a significant increase in surface area under cultivation. The new vanilla plots were made by degrading new forests (vanilla implementation in CS1) and reallocating areas previously used for other crops for vanilla (vanilla installation in CS2). These new cultivations were implemented without preventative measures, traceability of the new cultivation or health controls of the plant materials intended for the new plots. They have been associated with poor practices driven by high prices (excessive pollination and shade, insufficient ventilation, etc. see section 2.2) and significant densification of fields that has not been accompanied by an increase in productivity. This favored the development of fusarium wilt and phytophtora, an overproduction of vanilla as well as a drop in productivity per ha.

Figure 4. Change in production and plots under cultivation (FAOSTAT)

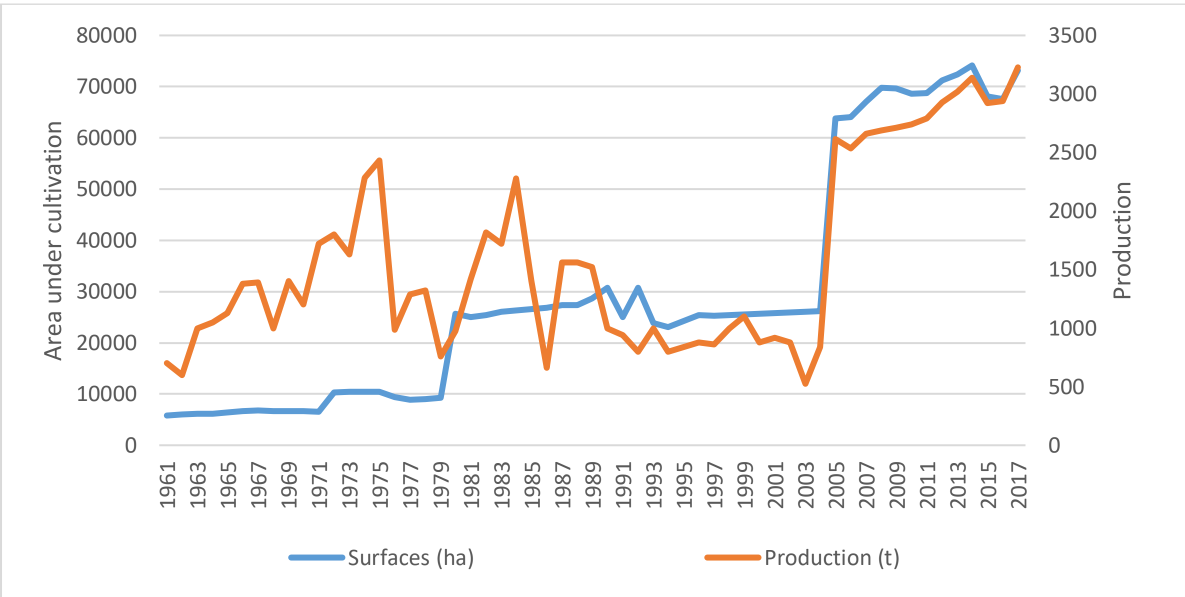
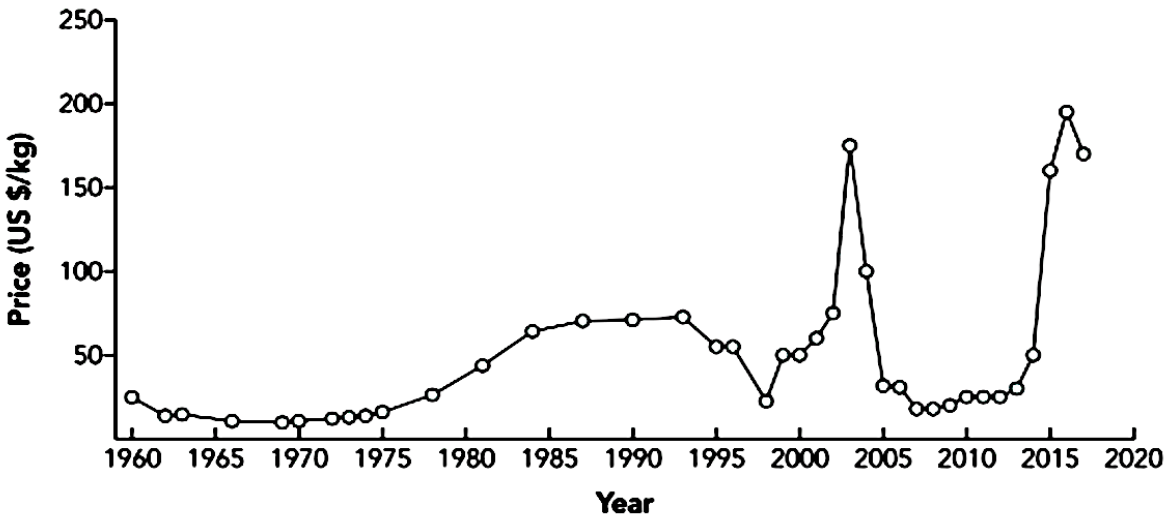


Figure 5. Local black vanilla prices in Sambava from 1960 to 2017



Source: Regional department of agriculture, 2018

This poor logic in the management of vanilla production could also be observed in the field. During contact and discussions with stakeholders in the field, at no time was the investigator able to observe, discuss or record the existence and/or practice of any integrated planning and management system with processes and/or continuous improvement systems for vanilla cultivation:

95% of farmers interviewed were not familiar with the term or concept of sustainable agriculture.

The investigator was not able to observe a soil fertility management system (composting facility) or a soil conservation system (anti-erosion system) on any farm visited. On the other hand, a large number of abandoned vanilla plots were observed to be transformed into slash and burn cultivation (rice, corn, cassava), leading to the deforestation of the residual natural forest present in the CS1 systems.

The exchanges conducted with the farmers revealed the complexity of curbing the irrational management of the sector which causes deforestation and soil erosion.

Direct cause: the case of fusarium wilt

Vanilla plantations in Madagascar are highly subject to parasites, mostly fusarium wilt, a fungal disease whose causative agent is always present in cultivated soils but which develops and then becomes pathogenic and destructive mainly due to bad choices (poor cultivation practices).

This disease impacts the productivity of cultivated plots and can even cause their total destruction and make cultivation impossible for years. Historically and under normal conditions, one ha in a traditional vanilla cultivation system could easily produce 400-800 g of green beans per plant. Currently, a plot with parasites gives an average of 250 g of green beans per plant. To compensate for this lack of productivity, farmers and other newcomers attracted by remarkably high prices have massively extended cultivated areas without prophylactic support measures, and this has only worsened the situation.

As a result, large areas of forest have disappeared to gain a minimal production increase by comparison.

Indirect cause: Deforestation and climate change, an example

A plot of 0.5 ha, located in Vohémar which produced around 600 kg of green vanilla in 2003 disappeared due to a prolonged drought. This vanilla plot was a good example of an adapted approach. On existing wet and bare soil comparable to an irrigated rice field and near a water source, the farmer has also planted shade trees and stakes. This vanilla plantation located outside the forest produced nearly 1 kg of green vanilla per plant for almost 10 years before completely disappearing following the massive deforestation that took place upstream and which resulted in the drying up of the source of water and increased drying of the surrounding area.

2.4. Environmental analysis at the farm level

Soil analysis

The soils in these areas demonstrate very superficial profiles and are therefore very shallow (less than 20 cm deep). The slightest exposure causes erosion which very quickly reveals either sandy or ferralitic or, more rarely, slightly clayey textures unsuitable for directly planting crops. A cross-section of soils observed in the field is shown in Figure 6.

As analyzed in 1.4, the soils are thus very fertile in natural forests and lose their fertility regularly with each slash and burn cycle.

Figure 6. Very shallow topsoil

Cultivated plot analysis

The field study was able to observe the depletion of soils during the burn-regrowth cycles that happen regularly following the abandonment of a CS1 vanilla cultivation system (see Figure 3). Crops grown during the burn-regrowth cycles following the slash and burn of a natural forest or CS1 vanilla system are generally observed in the following order, depending on nutrient requirements: rice *tavy*, maize and finally cassava. However, these cycles can be interrupted by the implementation of a CS2 vanilla cultivation system if the soil is sufficiently fertile.

Associated with this loss of fertility, the field study was able to regularly observe areas that have been depleted and unusable for several years, thus presenting an obstacle to future generations (due to loss of agricultural land). Moreover, this type of area can constitute a local erosive "spot" in addition to being useless for cash or food production.

Cultivated village perimeter analysis

The different soil states of the land use itinerary (1.4) on the cultivated perimeter of villages can be observed from the air (Figure 7).

Figure 7. Typical regression of an area where vanilla crops are found.

2.5. Environmental analysis at the landscape level

Clearing, "topsoil stripping" and excessive cutting of forests and other groves due to the implementation of vanilla cultivation modify the effects of the rains, namely because, when water arrives, the ground cannot intercept it, causing a high-water concentration in micro-catchment basins and thus damage that impacts village life (scree, clogging of springs, etc.).

Another very frequent finding concerns the erosion of many watersheds and how this covers up lowland rice fields in production areas with silt.

Farmers perceive changes in environmental conditions and hazards that they attribute to deforestation: a rise in temperature, drought, disruption of rainfall, floods, erosion, a drop in the water table, clogging of springs, silting of rice fields, etc.

2.6. Analysis of the sustainability of the vanilla sector

Despite the volatility of international prices, the sector represents the main activity and the economic pillar of the SAVA region. Although representing the main income of the farmers and a major contribution to the GDP of Madagascar, vanilla involves certain environmental risks to be managed accordingly. Indeed, in the SAVA region, the vanilla cultivation areas are close to protected areas and areas where slash and burn (*tavy*) rice cultivation is still practiced. The plantations are implemented in the undergrowth of natural forests or post-*tavy* brownfields.

The lack of technical knowledge of non-forest vanilla cultivation makes farmers apply pressure on their own environment. These traditional plantation models have persisted since the introduction of vanilla in Madagascar at a time when the farmer to forest ratio made it possible to produce and extend the fields without significant impact and without visible short-term consequences.

Until recently, vanilla cultivation has contributed to the reduction of natural forest cover as stakeholders in the vanilla value chain (from farmers to foreign industries) and development programs were not sufficiently aware of the urgency of implementing actions to reduce the long-term negative impacts of this process.

The relatively recent pressure of fungal diseases, mainly fusarium wilt and phytophtora, are the symptoms and consequences of agricultural practices aimed at increasing production. They have in fact led to the conversion of diseased fields to rainfed slash-and-burn crop cycles (accelerating all the more the degradation of the land) and the colonization of new forest areas to be exploited, thus perpetuating this vicious circle in increasingly restricted areas.

The vanilla price spikes of the past and especially the price spike from 2013 to 2019 reinforce these effects:

- Increase in cultivation areas with poor agricultural practices
- Excessive densification (> 2000 plants/ha) of crop fields, making the plots even more vulnerable to diseases
- Decreased productivity per vanilla plant and per unit area
- Decreased vanilla bean quality due to disease and early harvesting prompted by the spread of disease.
- Increase in the contagiousness of diseases by creating new hotbeds.

Vanilla, being the economic and financial engine of SAVA today, represents its own short-term threat. To save this sector, the region's forest system and the associated ecosystem services, a set of viable and sustainable solutions must be identified in light of the following challenges:

- Increased pressure on forest areas causing even larger areas to be cleared which in turn serves to fuel demand for timber linked to the massive influx of cash
- An increase in plant densities on existing plots in order to increase production
- Colonization of areas not conducive to vanilla cultivation via widespread and unorganized clearing
- Incursions into old growth and/or officially protected areas
- Indirect sampling linked to the first two points that accentuates the environmental impact on the areas concerned
- Cultural practices not adapted to “new” cultivation systems
- People without experience in farming or at least rice cultivation improvising a vanilla plantation

3. AGRICULTURAL BEST PRACTICES FOR SUSTAINABLE VANILLA

After decades of unchanged cultivation practices on land that has changed, unregulated plantations have appeared due to the attraction of supposedly "easy" money. This has impacted existing conditions and situations.

The consequences of this environmental pressure are enormous, particularly in the SAVA region, and are visible via the erosion and subsequent loss of fertility and competition with food crops, particularly rice.

Faced with global climate change and the massive deforestation of vanilla-producing areas on the east coast of Madagascar, the transition to good, sustainable and more environmentally friendly farming practices has become crucial. The objective of the following section is to provide vanilla farmers with tools and methods via a cultivation manual, a simple but effective tool for sustainable vanilla production without environmental impact.

This chapter will present the instructions that stem from the findings, observations and technical and scientific information concerning vanilla and its empirical sustainable cultivation in a **non-forest environment**, the type of cultivation that must be promoted today.

The practices and knowledge described, which clearly differ from current vanilla cultivation practices, should promote a significant change in management methods and a transition towards a reasonable cultivation of sustainable vanilla that respects the environment.

3.1. Approaches to improve practices

The recommendations and new guidelines to be offered to vanilla farmers must take into account the fact that the forest is shrinking rapidly while vanilla plantations are still growing. This results in a habitat/production imbalance.

It must been considered that, as practiced today, traditional cultivation is no longer the model conducive to making the sector sustainable, and therefore it is necessary to propose another that is consistent with the following points:

- Offer farmers a cultivation system(s) that no longer depends on forest areas and resources;
- Provide farmers with cultivation practices that make it possible to produce and generate income that cannot be impacted by fusarium and phytophthora;
- Integrate a planning and management system with continuous improvement processes into the technical and crop management procedures that is directly accessible to farmers in order to increase productivity (quality and quantity) per vanilla plant and per unit area via renewable resources.

Improvements towards more sustainable cultivation will require more effort at the right moment with acceptable practices and frequent *in situ* nutrient incorporation.

Types of existing systems to be improved

The role of each cropping system in the land use procedure has already been mentioned in Figure 3. . The system classification is described below (Table 5):

- Cultivation system No. 1 or CS1: Vanilla fields under forest cover
- Cultivation system No. 2 or CS2: Vanilla fields on soils that were once forest left to recede as part of the burn-regrowth cycles of *tavy* cultivation.
- Cultivation system No. 3 or CS3: Vanilla fields on non-forest soils that is mostly poor in nutrient resources and devoid of natural shade

Table 5. Description of cultivation systems and areas for improvement

Systems	Description	Environmental factors	Socioeconomic factors	Opportunities for improvement / best practices
CS1: Healthy and productive fields on humus soil in undergrowth areas under forest cover	**Share:** 30% (SAVA) **Soil:** rich, deep, humus-rich forest soil **Shade:** adequate and biodiverse, consisting of selected forest trees/shrubs **Atmosphere:** fresh, forest-like, stable humidity Organic matter: abundant humus **Plant inputs available:** cultivation substrate, mulch, humus supply.	**Residual forest cover**: <40% **Deforestation:** 60% **Reforestation**: N/A **Dependence on forest resources:** 100%	**Plot management:** difficult **Land availability:** low Access to wooded areas has been restricted for almost 10 years.	**Goal: Permanent CS1bis vanilla fields in forest undergrowth** **Limits:** Despite the potential of fields in the undergrowth, the illogical fertility and tree cover management of certain parameters makes these fields less and less suitable for growing vanilla. After 10 to 15 years, the system becomes exhausted and is converted to CS2. The CS1 plots in the forest are far from the villages, which increases insecurity. **Means of improvement:** The goal is to make this CS1 system sustainable for preserving existing plots in this category and prevent them from entering the burn-regrowth cycle (Figure 3). The objective is not to encourage its spread to new forest areas, which would cause more deforestation. **Farming practices to be adopted:** Practices should be adopted through a cultivation or technical system that makes production sustainable and profitable. Above all, this means a process to limit the expansion of vanilla cultivation in forest areas. This is based on optimizing productivity sustainably and ecologically. **Levers / constraints:** A change in behavior is necessary for a more sustained adoption of cultivation practices.
CS2 Degraded, senescent fields on degraded forest floor and under shrub cover	**Share:** 70% (SAVA) **Soil:** forest soil that is depleted and being degraded **Shade:** more or less adequate, mixed and composed of secondary shrubs and stakes	**Residual forest cover**: 0-10% **Deforestation:** >90% **Reforestation:** cultivation stakes **Dependence on forest resources:** 60%	**Plot management:** difficult: **Land availability:** high This represents all land in SAVA currently in a burn-regrowth cycle.	**Goal: Vanilla fields maintained and restored via CS2bis** **Limits:** **Means of improvement:** Implementation of a technical cultivation procedure allowing vanilla plots to be brought back into biological activity on former forest soils that have already been exhausted and/or degraded, very often abandoned by farmers due to their loss of productivity (regrowth) . The aim is not only to improve the productivity of this type of plot but above all to restore environmental added value to this cultivation system, thus making

Systems	Description	Environmental factors	Socioeconomic factors	Opportunities for improvement / best practices
	Atmosphere: variable humidity **Organic matter:** variable, depending on number of years of regrowth **Plant inputs available:** almost inexistent			it attractive to farmers. This would allow these plots to be removed from the burn-regrowth cycle. Farming practices to be adopted: Same practices as before. **Levers / constraints:** A change in behavior is necessary for a more sustained adoption of cultivation practices.
CS3: Semi-open/sparsely wooded fields that are not very productive and on poor soil without tree cover	**Share:** unobserved or little observed in cultivation; 90% on some eroded areas **Soil:** poor, leached, skeletal soil **Shading:** comprised of stakes **Atmosphere:** variable humidity **Organic matter:** almost inexistent **Plant inputs available:** almost inexistent	**Residual forest cover:** 0% (starting point) **Deforestation:** 0% **Reforestation:** cultivation stakes **Dependence on forest resources:** 0%	**Plot management:** difficult: **Land availability:** high There is increasing availability because it is the only system easily accessible and available for new farmers. These plots are cultivated due to a lack of wooded areas available, but the farmers do not understand the cultivation and environmental constraints.	**Goal: A CS3bis resilient, scalable and modular vanilla agro-forestry system** **Limits:** Access to land **Means of improvement:** Implementation of an innovative cultivation system to produce vanilla sustainably and ecologically on non-forest soils (without using forest resources as agricultural inputs). This is a sustainable, scalable and modular cultivation system that makes vanilla cultivation resilient. **This cultivation technique will be recommended for all future vanilla cultivation.** Farming practices to be adopted: Same practices as before. **Technical improvements:** By default, this improved system represents the future of sustainable vanilla cultivation associated with other cash or food crops. The proposed system does not represent a one-size-fits-all solution, although it could be viable thanks to the greater special care given by the farmers to their vanilla plants. **Levers / constraints:** The ease of colonizing and exploiting wooded areas via traditional practices does not encourage the adoption of these new practices. This improved system requires much more involvement, work and rigor, because its sustainable and profitable implementation must be complete before farmers see profits. The insecurity of forest plots far from villages could be an additional argument to convince farmers to adopt this system.

3.2. Choice of cultivation site

Although primarily linked to geographical constraints mainly due to the proximity of wilderness areas, this choice will necessarily take into account the information and data found in chapter 3 concerning the needs and resources of vanilla plants.

The requirements described in the previous paragraphs determine the criteria for choosing the implementation site. It is currently feasible to extend the vanilla growing areas to less rainy regions (down to 900 mm per year).

For each change of biotope, the cultivation parameters will be adapted so as to be able to provide vanilla plants with a microclimate favorable to its leafy development and flowering.

The perfect scenario for planting is a gently sloping area facing the rising sun and with a few tall trees to diffuse shade. The land would be slightly acidic (pH 6-7), with well drained, loose and light soil containing humus and thick litter. Companion plants for nutrient supply and mulching would be close by.

For these reasons, it is advisable to choose the implantation sites according to the following criteria:

3.2.1. Landscape and climate

Areas with high humidity and a forest atmosphere

Vanilla plants need 2,000-3,000 mm of water per year. Ideally, cultivation plots are located in areas where rainfall is well distributed throughout the year: 6 months of rain in the hot season with an average temperature above 26 °C, 3 months of light rain in the cool season with an average temperature below 26 °C and 3 months of dry season (in other words, the climate of the east coast of Madagascar).

Wind sheltered areas

The trade winds, a dry wind that impacts northeast Madagascar, disrupts the growth of vanilla plants and, if sufficiently strong, could weaken them by exposure to the aforementioned diseases. If possible, these exposed sites should be avoided, otherwise the establishment of windbreaks will be essential before planting.

Lowland areas

In the case of cultivation sites located in lowlands or in areas that are too confined, it is essential to provide effective techniques and methods for aerating the plot during the hot and humid season. Excess humidity followed by a rise in temperature will inevitably favor fungal diseases, especially phytophtora.

This may involve the establishment of soil drainage channels associated with a close cut of grasses and the reduction of shade in order to reduce the site's humidity.

3.2.2. Terrain topography

Vanilla plants have no particular terrain preference. It can adapt to lowlands, hillsides and peaks. On the other hand, given that agriculture has to generate income from production, adjustments should be considered in certain situations in order to be able to allow cultivation without an initial handicap.

Plot orientation

When possible, it is always recommended to orient the plot towards the rising sun (east) so that the vanilla plants receive much brighter light in the morning and more shade in the afternoon. This can be made possible in part by regular pruning of shade trees.

This strategy contributes to the health and productivity of the plot. In the morning, the temperature is still generally relatively low and the humidity generally higher. As such, vanilla plants may develop via increased photosynthesis efficiency or yield.

Slope and topography

If possible and where resources permit, the slope should be limited to 1-2% ideally to limit soil erosion and the leaching of nutrients in the field (for companion plants: stakes, green manure, grass).

For fields with a slight slope (2-5%), it is advisable to install anti-erosion lines consisting of stabilizing plants (grasses, vetiver) before planting the crop. It may also be wise to lay out the crop lines along the contour lines, but this may reduce the aeration of the field in certain situations (near lowlands).

For fields with a medium slope (4-8%), it is recommended to establish dedicated and favorable lines for the growing medium avoiding this erosion. To a lesser extent, it is also possible to set up platforms in the plot protected from the effects of rain over an area of approximately 2 m^2, i.e. 1-2 m in diameter around the base.

In the event that the slopes are too steep and/or uneven (>8-10%), it will first be necessary to set up contour terraces. These earthworks, which are very labor-intensive, have the advantage of being durable over the long-term.

- The contour terraces to be developed by excavation, stabilization and the installation of soil-maintaining plants (e.g. vetiver) will represent an expenditure of approximately 40 to 60 labor units, or 400-600,000 MGA, for 100 vanilla plants.
- Plots or platforms will cost around 20 labor units, or 200,000 MGA, for 100 plants, i.e. three times less.

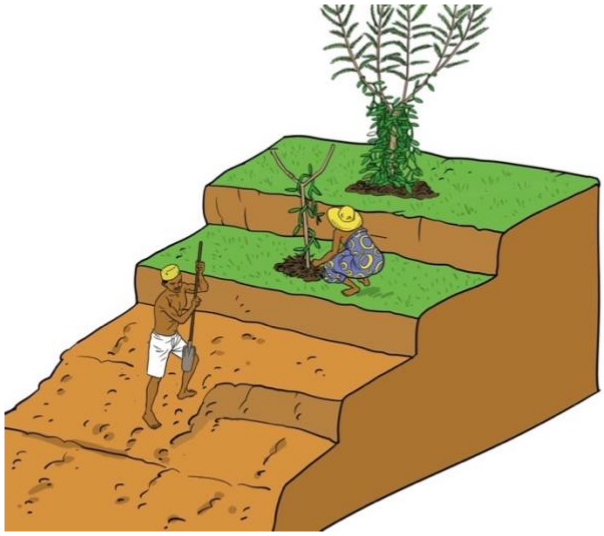


Figure 8. Terracing limits erosion and the leaching of nutrients by rain.

3.2.3. Soil type and texture

Black soils rich in biological activity are strongly recommended, otherwise a periodic supply of organic matter will be essential starting in the first year. This will have an economic impact.

In the event of cultivation in a sandy area, there is almost no capillary water rise. It is thus crucial to estimate the soil cover before implementing the cultivation. As the biomass production capacity of this type of soil is low, it is also necessary to provide for the supply of organic matter for the growing medium in the form of ''plots'' of approximately 2 m^2 (1-2 m in diameter) . This may prove to be insufficient, so the use of an irrigation system is irrelevant here.

On clay soil, a drainage system must be implemented to avoid water stagnation and/or flooding during the rainy season. It is also necessary to avoid the drying out of this type of soil to avoid **shrinkage cracks which cause irreversible damage to the root system of vanilla plants.** The development of plots with filter bed substrate also limits the risk of flooding.

This drainage network will require about 5 man-days for 100 vanilla plants.

3.2.4. Availability of plant material and inputs

Availability of companion plants (seeds, cuttings)

As described in previous paragraphs, the availability of organic matter near the cultivation site is also a key factor in the success of vanilla cultivation.

Thus, to optimize work and lower production costs, it is recommended to have companion plant seeds and/or cuttings nearby.

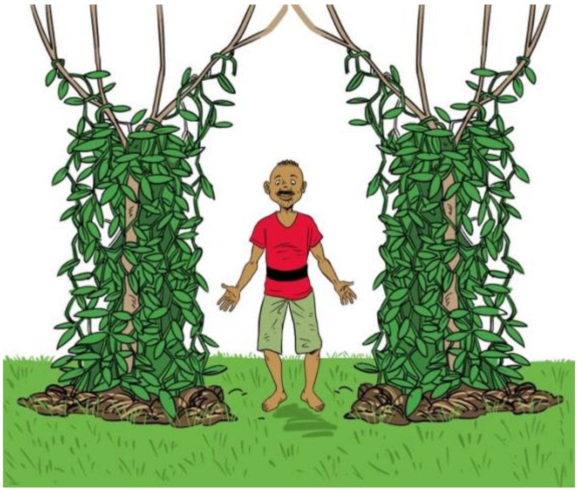
Availability of healthy vanilla vines

It is strongly recommended to use healthy vanilla vines from the same ecological zone or close ecological zones as cuttings because they have proven to work thanks to having been developed in that site.

3.2.5. Preparation of the land before planting: system-specific steps

Table 6. Pre-planting land preparation steps for each system

Steps	CS1	CS2	CS3
Delimitation: Physical definition (pen, windbreak) GPS delimitation in the case of referencing or certification	YES	YES	YES
Cleaning the plot of all weeds	YES	YES	YES
Clearing: Elimination of trees that are not used for shade or support.	YES	NO	NO
Staking for shade plants	NO	YES AND NO	YES
Staking	NO	YES	YES
Installation of shade	NO	YES AND NO	YES Banana tree
Installation of stakes	NO	YES	YES
Input of organic matter	YES only mulch	YES growing medium and/or mulch	YES growing medium and/or mulch
Crop density	1,600 to 1,800 plants/ha	1,600 to 1,800 plants/ha	1,600 to 1,800 plants/ha
Establishment of food crops inside the cultivation plot	NO	YES but only partially, where appropriate	YES Banana tree
Establishment of a biomass production field for the growing medium	NO	YES AND NO on a case-by-case basis	YES necessary to make the cultivation sustainable



Several activities are to be carried out simultaneously or even before the preparation of the cultivation plot, but this will be done off-site or nearby and will depend on:

- Selection and preparation of companion plants: shade trees, stakes, ground covers, food plants and cover plants
- Selection and preparation of vanilla vines

Figure 9. Adequate spacing of stakes ensures optimal aeration and facilitates maintenance in the field.

3.3. Selection, preparation and planting of companion plants

3.3.1. Shading: trees, shrubs and stakes

The optimal shade rate is 40-60%, except for during the production phase where it is gradually lowered to 20-30% to trigger flowering. The shading system must make it easy to respect the shading parameters according to the physiological needs of the plant (or for disease control) no matter the cultivation system.

Shade is provided by large trees and shrubs (high shade) and by the foliage of stakes (low shade). In non-wooded areas or in semi-intensive plantations, it is provided only by the stakes. Temporary shade allows earlier planting of vines in open areas.

Too much shade results in short, dark leaves, while too little shade results in smaller, yellowing leaves.

It seems that the high shade (tree or shrub layer) limits the intensity of the splashing on the ground which accelerates the spread of fusarium wilt. Tests of conditions under nets have given promising results.

For the CS1 cultivation system

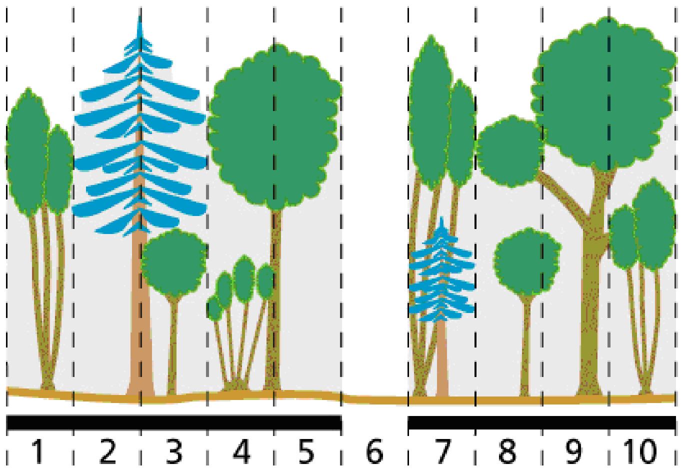
Monitoring is delicate and requires a great deal of care since regeneration or recovery is very often slow and difficult after cutting or pruning the forest species present. **The lack of knowledge of shading for this cultivation system can become a factor limiting its productivity.**

It is important to mention that, if no irrigation is practiced in the three cultivation systems, water stress (a trigger of flowering) is only indirectly controlled via shade reduction (cf. paragraph on flower induction). Water stress would be an advantage if it could naturally occur at the right time.

Box 3. Estimation of the plant cover of a plot

The **plant cover** represents the vertical projection of the crowns on the ground and gives the relative importance of tree species within a stand.

In the following figure, the absolute coverage rate is 90% (9/10)



Source: IGN forest inventory glossary

For CS2 and CS3 cultivation systems

The shading system is made up of plants chosen for their shade regulating ability. The banana tree seems the most appropriate given its availability, ease of propagation, adaptability to sunshine and its usefulness as a companion plant (ease of cutting, non-fermentable, compostable). Its foliage, which develops very quickly after planting, quickly ensures ample shade and is easy to maintain, reduce and eliminate in times of stress. It has a high recovery and regeneration rate after cutting. Banana trees make a perennial and durable population once cultivated. An adult banana tree dies but produces at least 4-5 shoots.

In summary, the following are general recommendations

For CS1, shading depends on the pre-existing forest species, while for CS2 and CS3, the banana tree is selected for its versatile and multi-purpose shade.

- Plant the banana trees in staggered rows 3 months before setting up the vines and plant a maximum density 500 to 625 vines per ha, i.e. a distance of 4-5 m between the plants. In the event of excessive shade, do not hesitate to eliminate some plants.
- Control the spread of young shoots.
- Cut adult banana trees before flowering. This operation avoids draining minerals essential for the flowering of vanilla plants.
- Cut adult banana trees if a cyclone is coming.

3.3.2. Support: stakes

The choice of stakes depends on the pedoclimate.

For less watered areas with relatively poor soils (CS2, CS3)

The selection should involve legume cuttings, including *gliricida* which is already widely distributed. Other indigenous legumes used by farmers seem to give good results. Cuttings are prepared as follows:

Choose well-lignified cuttings (very green new shoots) with a diameter of about 5-8 cm and 1.50 to 1.75 m long on average. After stripping them of leaves, cut the bottom of the cutting diagonally and the top of the cutting on a slant, then push the bottom of the cutting 30-40 cm into the ground. Ensure that the bark is not damaged or detached from the wood. Carry out suckering (removal of low or too numerous young shoots) starting at 30-45 days then prune main branches starting at 3 months after establishment.

Stakes are maintained according to their growth and the needs of the plant. However, the objective is to have several (8-12) main branches at the average optimal height of 2 m before the first year of cultivation to support the mass of the vanilla plant and to proceed with looping, pollination and other tasks.

It is crucial to maintain this optimal height (1.8-2.25 m). The shape and length of the stake must allow vanilla plants to comply with this standard.

Figure 10. A low main branch development height makes plant pruning more tiring.

For vanilla plants to be productive, their height must be 1.8-2.25 m. Also for vanilla plants to be productive, it is crucial to stay within this height range as **it is one of the key factors determining their productivity. A stake that is too low reduces the productivity of vanilla plants.** A short stake favors a short looping which in turn increases the frequency of feeder roots per linear meter of vine and causes an imbalance which decreases the potential for flower buds.

Wetter areas with relatively rich soil (CS1)

Jatropha curcas cuttings are preferred:

Same commentaries as in the previous case, but it is difficult to find 1.75 m *jatropha* cuttings without branching. Thus, the farmer have to use what is available even if they are initially a bit short. After 2-3 years the cutting is strong and structured enough to meet the structural needs of vanilla plants.

3.3.3. Ground cover, grass cover

Whether inert or alive, soil cover is essential to maintaining the freshness, fertility, stability and biological activity of the soil where vanilla is grown. It also promotes an environment conducive to the good development of the vanilla plant's root system.

The grass *stenotaphrum secundatum* offers an attractive biomass yield and above all is easily available. It multiplies easily from its stolon and colonizes the soil by promoting a 5 cm living laver which shelters the roots of vanilla plants. It is established in the plots at the start of the rainy season after the implementation of the shading system by plates integrated into the ground or via the runners removed.

For the (less recommended) inert cover, the choice is broader and depends on availability, but plants that harbor diseases or those that release phytotoxic molecules should be avoided. Examples of such plants include:

- Plants with leaves or needles rich in tannin such as the filao tree (*casuarina equisetifolia*), pink peppercorn (*shinus terebinthifolius*), etc.

- Cineol-rich plants like the myrtaceae family (all eucalyptus);
- Vetiver roots, even after distillation
- Rice straw which can release fungi responsible for vanilla fungal diseases

3.3.4. SUBSTRATE AND NUTRITIONAL INCORPORATION AT THE AERIAL ROOT: HUMUS, GREEN MANURES AND COMPOSTING

To ensure adequate growth for vanilla plants, it must be provided with an adequate substrate for rooting (substrate fiber, plant litter) and regular nutritional inputs of plant organic matter that can be incorporated (humus, compost).

Vanilla does not require a lot. The demand for minerals is modest, but to maintain the sustainability of the cultivation it is important to restore the minerals drained from the soil.

Humus is incorporated regularly (2-3 times/year) and more carefully during the dry and/or hot months. Substrate and mulch incorporation is essential when the new roots grow outside the pre-existing substrate. As soon as the flower buds appear, it is necessary to re-mulch abundantly. Care should be taken to avoid touching the vines or roots with (non-dried, non-composted) fresh mulch because the parts of the vines or roots it comes in contact with could be burned.

Figure 11. The lack of substrate and inputs quickly lead to the death of vanilla plants from below.

Whatever the cultivation system, the ideal is to have a service plant with multiple uses, such as the banana tree associated with *stenotaphrum* for the aforementioned reasons.

If this is not possible, it is strongly recommended to use composting. Composting requires more work in digging pits, transporting biomass and monitoring. In addition, vanilla farmers are not used to this work.

Waste from pruning stakes and pruning shade trees are good raw materials for compost. 1 ha of *gliricidia* used as a stake gives 150-200 m^3 of finished compost per year if pruning is done on a regular basis, i.e. around every 2-3 months at least.

Figure 12. A regular nutritional contribution in the form of mulch guarantees vigorous aerial roots and plant mass.

Important clarification

Vanilla is a perennial plant that can last for many years, but this will depend on the management of its cultivation. The lack of soil fertility management and vine maintenance are the main factors limiting its lifespan. Vanilla plants can in fact live longer than 12-15 years, and if it withers it is simply because its environment is exhausted and no longer able to meet its needs. Cultivated vanilla is a plant that renews itself continuously, hence the need to master fertility management of the cultivation soil.

A vine becomes senescent after about 3 years and a *bout-pendant* (vine removed from the plant mass and directed downwards) starts aging (and therefore becomes unproductive) after 2 successive flowerings. Farmers must eliminate these senescent portions to allow the young tissues to develop and express their potential. These eliminated portions will be composted outside the cultivation plot. In case of disease, controlled burning can be considered. Looping 3-4 times a year that will ensure vigorous production of vanilla plants over time.

3.3.5. ANTI-EROSION AND ANTI-DRYING SYSTEM

The implementation of this system is especially important for crops in sloped areas. All companion plants above the cultivation plot already play an anti-erosion role. But the steeper the slope, the more the installation of "green walls" mounted on the protective embankments upstream and on both sides of the plot is necessary. The vetiver plant gives a remarkable "green wall" effect apparently without hindering vanilla plants. Cut trunks and branches arranged perpendicular to the slope also help to limit erosion.

For plots too exposed to the trade winds during the dry season, windbreak hedges are also essential. However, due to the risk of shade and regular deposits of dead leaves, a distance from the vanilla plants must be maintained.

3.4. Propagation and planting of vanilla

3.4.1. THE DIFFERENT TYPES OF PROPAGATION BY CUTTINGS

Short or long cuttings

There are various vanilla propagation techniques, but the two types which are useful in the context of SAVA region are mentioned:

- Short cuttings (or small cuttings) have 2-3 nodes, are 20-30 cm in length and are cut at both ends. The first node (the basal node) will be used for rooting, while the second (and third) are for bud growth.
- Long cuttings are 1.5 m in length with about ten nodes. They can be cut on both ends or have an apical leafy end (with 2 leaves rolled up in a cone called **the heart**).

Table 7. Advantages and disadvantages of the two types of cuttings

	Short cuttings	Long cuttings
Propagation speed	High Facilitates and accelerates multiplication in case of insufficient cutting: 1.5 linear m of vine = 5-7 short cuttings	Low Limits multiplication in case of insufficient cutting: 1.5 linear m of vine gives 1 single cutting.
Timeliness of production	**Late** production: + 1 year ▪ 3.5 years in hot and dry areas ▪ 4.5 years in hot and humid areas ▪ 5.5 years in cool and humid areas	**Early** production ▪ 2.5 years in hot and dry areas ▪ 3.5 years in hot and humid areas ▪ 4.5 years in cool and humid areas
Disease tolerance	Relatively high	Relatively low
Tolerance to climatic events	Relatively high	Relatively low
Period	Wet season	Ideally in the wet season, but possible all year round, according to the farmers' calendar

3.4.2. PREPARATION OF VANILLA CUTTINGS

This is a crucial step Many farmers neglect this step, which affects the productivity and sustainability of an entire plot.

Choice of mother vines

For cutting cultivation, you need **vines or *bout-pendants* under a year old with high growth potential**, in other words healthy, vigorous vines (without diseases) that are not grooved and whose diameter is 10-14 mm and 12-15 cm between the nodes. It is better to have vines of three to four years old that have not yet produced.

Farmers in all regions have a bad habit of systematically using bad vines for propagation (vines with low growth potential or that are exhausted):

- Vines with low growth potential are those that have a small diameter (<10 mm) and short internodes (<8-10 cm). They are often otherwise healthy vines that have suffered climatic events or a lack of food which has caused poor growth.
- Depleted vines are by definition senescent. These are either vines that have already produced or vines exhausted by disease or other causes. **They are waste to be disposed of**, but farmers, often young or migrant, tend to use them incorrectly.

Materials and tools

The following are materials and tools needed **by 1 farmer** to take the cuttings:

- A single small container with cinnamon powder or one liter cup filled with disinfectant (bleach or a solution of diluted, crushed garlic)
- Two small sharp knives (or razor blades) used alternately (while the 1st knife is used to cut a single vine, the 2nd is immersed in the disinfectant product and so on).

3.4.3. Short cuttings

Short cuttings (or small cuttings) have two to three nodes, are 20-30 cm in length and are cut at both ends. The first node (basal) will be for rooting, while the second (and third) are for bud growth. It is too risky to make a cutting from a single node because the roots and the bud start from the same place.

Choice of mother vines

On the morning of the day preparation takes place, harvest the mother vine per the parameters mentioned.

Obtaining cuttings

The vine is cut in segments containing at most two to three nodes such that one third of the space between nodes on the lower part of the vine is on the base and two third of the space between nodes on the upper part is on the head.

The lower part of the cutting is cut perpendicular to the axis of the stem in order to produce the smallest wound possible. The upper part is cut at a slant.

It is important to point out that, for short cuttings, it is not necessary to go beyond three nodes per cutting because that represents a loss of plant material.

Preparation of cuttings

Removal of all holdfast roots and leaves from the first node. Removal of half-leaves from the two upper nodes.

Disinfection of cut wounds

Dip the wounds on both ends of the cutting in melted beeswax or cinnamon powder to protect them from possible microbial infection.

Scarification

Store in a cool, slightly humid environment for **at most** of 48-72 hours.

Potting

- **Option 1:** The cutting is placed in a 1-liter nursery container so that it is tilted at 45°. The lower end should stick out of the pot, and the lower node should remain in the growing medium. One or both of the upper nodes remain exposed to the air and the slanted face is placed in a vertical position during potting to facilitate drainage and thus avoid stagnation of excess water to limit infections. Classic nursery substrates (rich soil) excluding organic matter of animal origin are to be used.

- **Option 2:** The first node of the cutting is to be wrapped in a decomposed banana tree trunk or in crushed coconut husk. In this case, carefully monitor the humidity.

Rooting under shade

Keep the cuttings planted in a fairly shady environment until the bud emerges under optimal (temperature and humidity) conditions for plant growth.

Bud growth under shade

When the bud emerges, place in a small shade house under optimal conditions (temperature and humidity + conventional shade with coconut palm/raffia or whatever is available) for 45-60 days.

Transplanting

After 60-75 days in the nursery, the young plant is ready to be transferred to the field, provided that this is done under optimal (temperature and humidity) conditions for plant growth and on good growing substrates.

Short cuttings are ready to be planted in the field when they have more than 5 leaves (or are about 50-70 cm in length). Before transplanting in the field, **water one last time.**

Planting cuttings in the field

Planting should be done at the beginning of the rainy season. Just after watering, the short cuttings are taken to the field and **placed at the foot of each stake.** The plastic pot is gently torn and removed, then the young plant is placed on **recently wetted soil.** The young plant is carefully attached to the stake with a natural fiber (raffia, pineapple fiber, banana tree fiber, sisal, bark). Add growing medium and mulch above the aerial root of the young plant. If the shade is insufficient (for example in a new plot), cover the plants with banana leaves. With this, the planting is complete.

Managing cutting growth in the field

The vine grown from short cuttings measures 50-70 cm when transplanted in the field. At first it is thin (4-5 mm in diameter) and the more it grows, the more root surface it needs to feed itself at the beginning. It should be bent down after different stages of growth (at 50 cm, then 1 m, etc.) until it reaches the optimum height (1.8 - 2.25 m):

- 1st looping after 50 cm of growth (3-4 leaves), i.e. when it reaches 1.2 m
- 2nd looping after 1 m of growth (5-7 leaves), i.e. when it reaches 2.5 m
- 3rd looping after 2 m of growth (10-14 leaves), i.e. when it reaches 3.5 m
- Classic looping is done when the vine reaches 4-5 m. At this point the vine is cut back to the optimal height (1.8-2.2 m).

3.4.4. Long cuttings

Long cuttings are 1.5 m in length and have about twelve nodes (about 10-15 leaves). They can be cut on both ends or have an apical leafy end (with 2 leaves rolled up in a cone: called **the heart**).

Choice of mother vines

On the morning of the day preparation takes place, harvest the mother vine per the parameters mentioned.

Obtaining cuttings

Cut the vine in segments of at least 1.5 m each. If possible, **always favor the top vine**, taking care that it is well preserved until planting.

Preparation of cuttings

Remove the leaves and holdfast roots on the 5 nodes of the basal part intended for rooting.

Disinfection of cut wounds

Dip the wounds on both ends of the cutting in melted beeswax or cinnamon powder to protect them from possible microbial infection.

Drying

Bundles of 10 vines are arranged in a crown and suspended on a bamboo stem under a shelter for 10-20 or up to 30 days depending on climactic conditions. The pruning wounds heal and the vines soften then become supple.

The drying-out is finished when roots are observed to be sprouting from the 5 nodes stripped of leaves. If necessary, the cooling period will sort out undesirable vines.

Transplanting

After 1-2 weeks of drying out, the long cuttings are ready to be transplanted. But first it is necessary to prepare the mulch and water regrowth/cultivation substrate in the field.

Planting cuttings in the field

To guarantee optimal (temperature and humidity) conditions for plant growth**, it is recommended to plant at the start of the rainy season.** Long cuttings are transported to the field.

Long cuttings are planted as follows:

- Dig a small, 4-5 cm deep trench from the center to the outside of the plot
- Place the vine on the stake so that the 4 nodes stripped of leaves from the base are in the trench on the ground and the 5th node stripped of leaves is at the foot of the stake.
- Attach the vine with a natural fiber (raffia, pineapple fiber, banana tree fiber, sisal, bark) against the stake at the 5th node stripped of leaves. Then attach the vine in the middle and at the end near the second to last node.
- The "buried" end is covered with the regrowth/cultivation substrate, leaving the healed wound of the basal cut sticking out (to avoid infection).

If the soil is poor in organic matter, the "buried" end should be abundantly covered with mulch. If the shade is insufficient (for example in a new plot), cover the plants with banana leaves.

If the cutting does not have a vine head, the upper end should be tied in such a way that it can be **bent at one of the two second to last nodes with the axil facing outwards towards the curvature** to facilitate the growth of a bud at this location.

To do this successfully, you need to make sure that:

- The pressure of the bend is sufficient at the node but without breaking it.
- The lower end is exposed to the air to avoid rotting.
- This is carried out at the start of the rainy season.

3.4.5. Cutting propagation centers

This type of propagation center can be an artisanal, semi-artisanal (without a net and using a simple misting) or modern (with a shade net and automated misting) installation.

Artisanal cuttings propagation center (adapted for this situation)

This system is suitable for village communities with few vanilla vines.

It is a simple technical infrastructure made with locally sourced light materials with a shading rate of 40-60%. Since this system does not use irrigation, its productivity is low (12,000-15,000 cuttings of 1.5 m in length per ha per year), but it is feasible for farmers. It is easy to install and the operational costs are low.

Semi-artisanal cuttings propagation center

This is a semi-artisanal infrastructure made of locally sourced and light materials and is equipped with a non-automated irrigation system. It produces around 80,000 cuttings of 1.5 m in length per ha per year starting in the 30th month of system establishment. The drawback of this system is the need to invest in irrigation.

Modern cuttings propagation center (for informational purposes)

This consists of specialized technical infrastructure covered by a shade net with a 60% light interception rate and equipped with an automated misting irrigation system. Twenty years ago, technicians used this infrastructure to produce vanilla beans, but its practical application failed and most abandoned this system.

The vanilla bean production obtained does not warrant the investment required. For biomass production, on the other hand, this type of infrastructure is particularly attractive. If well managed, it is possible to produce the equivalent of 200,000-300,000 cuttings of 1.5 m in length per ha of shade house 2.5 years after its establishment. A drawback of this system is the need to invest in a shade net and irrigation system.

Modern *in vitro* cuttings production center

This is a specialized technical infrastructure, available to certain companies, which has the advantage of allowing for the multiplication of high-yield varieties (either in vanilla beans or vanillin) or varieties resistant to diseases.

3.5. Field management before production

After establishment, the growth of vines must be managed to obtain a biomass capable of flowering after 2 or 3 years.

3.5.1. Management of vines and configuration of vanilla plants

In addition to the climatic parameters, the vanilla plant's structure has a large impact on its health and vigor over time. The configuration of vanilla plants includes the maintenance that make it possible to give a healthy pre- and post-production structure via pruning and looping (*passe-cœur* or cutting the last bud of a vanilla plant to stimulate flower buds).

The configuration of the vines, and in particular the looping, must be mastered to ensure the vigor of vanilla plants throughout cultivation. Care should always be taken to maintain a sufficient distance between the plants to prevent the spread of diseases.

Facts about vanilla

For vanilla plants to be productive, their height must be 1.8-2.25 m.

A vanilla node only has:

- 2 holdfast roots (and 2 adventitious roots)
- 1 leaf (with 1 axillary bud in its axil)
- The unique axillary bud exclusively produces:
  - either 1 plant bud which produces 1 new vine
  - or 1 flower bud which produces 1 inflorescence (and 1 future bunch of vanilla beans)
- An axillary bud that already produced a flower bud can no longer produce a plant bud and vice versa.

Vine pruning

The elimination of senescent vines is also important for the productivity of the cultivation plot. Senescent vines include old vines and shoots that have already exhausted their productive potential.

A vine becomes senescent after about 3 years and a *bout-pendant* (vine removed from the plant mass and directed downwards) starts aging (and therefore becomes unproductive) after 2 successive flowerings. Farmers must eliminate these senescent portions to allow the young tissues to develop and express their potential. These eliminated portions will be burned outside the cultivation plot.

Vines parts infected with fusarium wilt (or any other fungal disease) should be cut (3 nodes below and 3 nodes above the affected part) and burned.

Vine looping

An independent vanilla vine (root and leaf system) exhausts its resources and dies after about 36 months. **Looping (*provignage*)** makes it possible to renew the growth capacity of vanilla plants. During this process, a contribution of organic matter is recommended because the growth of roots, buds and new vines require more of it.

Looping consists of bringing part of the vine back to the ground by making a loop which causes the following:

- on the bottom portion: the lower loop (i.e. the apical portion of the layered vine) buried into the substrate towards the stake will develop:
  - roots to increase the nutritional capacity of vanilla plants (provided that the substrate is extended accordingly and humus is incorporated)
  - a new vine will possibly be generated on the stake
- on the top portion: the axillary bud of the node just below the upper loop will develop a new head which will then become a mature vine after a few months, thus ensuring the development of biomass; this new vine will be:
  - either layered to increase the plant mass and the growth capacity of vanilla plants,
  - either removed from the plant mass (*passe-cœur*) to become a *bout-pendant* intended for production

Precautions to take before looping:

- The part to be put back in the substrate must be mature enough to avoid any rot and disease (segments that are at least 3-4 weeks of age).
- Strip the leaves and remove the already exhausted roots from the part to be put back in the substrate.
- The vine must be allowed to heal for a week before returning it to the substrate. To avoid waiting, you can apply cinnamon powder and put the vine directly in the substrate.

The optimal lengths of a vine to layer depending on the leafy growth stage:

- First looping of a small cutting: 1.20 m,
- Second looping of a small cutting: 2.40 m
- Looping for an adult aerial root in production: 4.5 m to 5 m

What the success of looping depends on

For vanilla plans to be productive, it is crucial to stay within optimal height (1.8-2.25 m) **as it is one of the key factors determining their productivity.** Shoots to be layered must measure 4.5-5 m from the ground where the roots of the last loop are located. A stake that is too low reduces the productivity of vanilla plants because it favors a short looping which in turn increases the frequency of feeder roots per linear meter of vine and causes an imbalance which decreases the potential for flower buds. Looping ensures that vanilla plants are well nourished, but when it is done too much, it limits flowering. Through too much looping the vine is so well fed that it is difficult to stress it. Insufficient looping also weakens the vine and makes it vulnerable to diseases due to lack of food.

Practiced 3-4 times a year, looping must be mastered

- The absence of looping weakens the vine starting in the first year of cultivation.
- Too much looping greatly reduces its productivity.

Looping is not a natural phenomenon of vanilla plants. Rather, it is an agricultural activity to encourage them to live longer and be more productive. **Mastering this operation is therefore one of the keys to the success of vanilla cultivation.**

Vanilla vine configuration can be used to extend the planted area:

- **In the narrowest definition, looping** makes it possible to maintain the plant mass at the height of a man by lowering and bending up the high vines on the same stake or on an overhead support between stakes **without necessarily putting the apical end back into the substrate.**

- *Provignage*, in the strict sense of the word, also makes it possible to reinforce the root's nutritive capacities by lowering the high vines and placing **the apical end in the substrate.** ***Provignage*** can also make it possible to extend the vanilla trees to other planted or natural stakes, in order to avoid the need for cuttings.

3.5.2. Shade management: shade trees and stakes

The high shade (shade trees) helps to maintain a semi-forest atmosphere which maintains humidity levels favorable to vanilla plants and naturally controls weeds. Shade trees are pruned annually at the start of the cool and dry season to trigger flowering. Shade trees do not require any maintenance other than removing dead branches (which could fall on the vanilla trees).

The low shade offered by the stakes limits the vines' sun exposure. If the shade of the stakes is too close or too dense, it can cause humidity in the dense portion of the plant mass and promote the spread of disease. Thus, regular thinning of the stakes is necessary. During the implementation phase, temporary shade can be provided by banana trees and *cajanus cajan*.

The optimal shade rate is 40-60%, except for the production stage where it is gradually lowered to 20-30% to trigger flowering. Too much shading results in short, dark leaves.

3.5.3. Ground cover management and weeding

For maintenance reasons, a living ground cover is preferred over mulch which must be renewed regularly. Planting ground cover on the plot helps to maintain the humidity of the field and the soil while avoiding the uncontrolled development of weeds. The appearance of weeds in the grass cover means there is too much shade. **A homogeneous and dense grass cover is an important element of a well-maintained field which guarantees good production.**

Mowing is done 2-3 times a year, depending on the growth of the grass. The mown plant matter can be left on the spot or used as mulch AROUND the aerial root. Do not put the waste in direct contact with the vines or the roots:

- During the dry season, grass cover must be maintained and mowing is not practiced.
- After very wet periods, mowing is necessary to promote evaporation, especially on clay soil and in lowlands on alluvial soil.

3.5.4. Fertility and growing medium management

Fertility management and improvement is practiced on a regular basis during the leafy growth periods. **Ideally, contributions are made at the same time as looping activities, in other words approximately every 3 months.** Fertility is improved by incorporation of organic matter (only of plant origin, meaning compost, litter and humus) in the soil and substrate and, if necessary, by the addition of more solid elements (loose, fragmented wood) as a rooting substrate.

During the period of stress, it is advisable not to add organic matter. At the beginning of flowering, a supply of organic matter is beneficial for the successful growth of the vanilla beans because, in this moment, they have more nutritional needs.

The productivity of a field does not only depend on the fertility of the soil/cultivation substrate, but also on the configuration of the vanilla plants via looping.

3.6. Field management for production: induction, flowering and pollination

3.6.1. Vanilla plant configuration: using *passe-cœur* for shoot production

This consists in choosing the best vines of the year and making them climb to the highest part of the stake and then taking them out of the plant mass in order to make them descend while keeping the head always pointed down, but without touching the ground so that they receive more light.

These vines, called ***bout-pendants***, are the ones that will give flowers and then vanilla beans. Vines inside the plant mass that receive little or no light will not produce much. Choosing these vines takes place 4-7 months before flower induction. For this to succeed, the *bout-pendant* must have a total length of approximately 4.5 m from the last loop.

Figure 13. Too many bout-pendants leads to more work without guaranteeing sustainable production.

3.6.2. FLOWER INDUCTION: REDUCTION OF SHADE AND NUTRITIONAL INTAKE

The first year of production occurs 2-4 years after the implementing the cultivation, depending on the type of cuttings (short vs. long) and the plantation's vigor. The leafy growth of vanilla plants must be limited before entering the first year of production. To trigger flowering (a process called **flower induction**), the plant is subjected to intentional stress by reducing shade and limiting humus.

Extent of thinning

The reduction in the shading rate is carried out with substantial thinning This artificial stress coincides with the natural stress produced by the southern hemisphere winter (bringing cold and dry conditions) which limits photosynthesis. The seasonal drop in temperature and humidity usually occurs in mid-May in the DIANA region and in mid-June in the SAVA region, but this varies from year to year.

About 15 days beforehand, the shade trees are pruned. The stakes are then gradually thinned. Clear-cut pruning is not always recommended. During this period, it is advisable not to add humus.

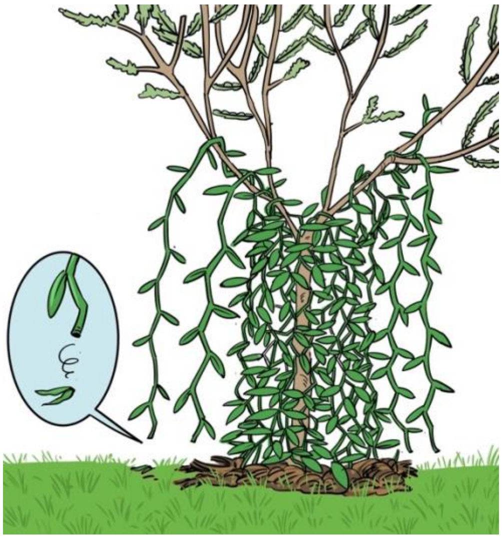
About 45 days later, i.e. at the beginning of July in DIANA and the beginning of August in SAVA, the heads of the *bout-pendants* become necrotic, dry and fall off: **this is like a natural heart failure.** This is a sign of the beginning of flower induction.-At this time, the shading rate is allowed to rise to 40-60% (no stake cutting) as before. 2-4 weeks later, the flower buds begin to appear. This is the beginning of flowering.

Reduction of carbon input

The main factor that determines flower induction is the reduction of the carbon supply (by photosynthesis) which will result from:

- The drop in temperature at the beginning of winter
- The drop in humidity after the rainy season
- The simultaneous increase in sunshine during the dry season

Farmers cannot act on temperature alone, but it is possible to react to humidity and sunshine by generating additional water stress. Reducing the shade rate by thinning (clear pruning can be done on healthy stakes with high regeneration potential) causes an increase in sunshine and a decrease in humidity (increase in evapotranspiration).



If the pruning is well executed, it is not necessary to carry out forced "heart attacks" via pinching (topping) the end of the vine. This procedure has not proven its efficacy when the other parameters are controlled for.

Before this, or at the same time, the nutrient supply is stopped (to add more stress to the vanilla plant), but care must be taken to mulch the vines to protect them from future sun exposure. For vanilla plants in production, a supply of nutrients is beneficial at the start of flowering for the proper growth of the vanilla beans because they have more nutritional needs at this time

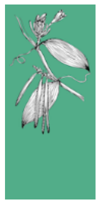
Figure 14. Proper induction pruning naturally leads to "plant heart failure" which ensures flowering.

Artificial "heart failure": Topping of *bout-pendants*

This activity has not been proven and is not recommended.

3.6.3. Optimization of pollination and adjustment of bunches

Failure to manage the pollination of all the flowers will lower the quality of the vanilla beans and the sustainability of the cultivation. This excess pollination favors small beans and weakens the aerial roots of vanilla plants. Overloading the vine with pollinated flowers makes vanilla plants vulnerable to disease because they will tend to weaken to provide for the excessive nutrition demanded by these flowers.



A standardized pollination, guaranteeing a high-quality and sustainable production, must respect a certain rule. In the best of cases, a *bout-pendant* with a diameter of 10-12 mm and a total length of 6 m (the maximum recommended) holds 15 bunches which potentially represent a mass of 200-250 g regardless of the number of pollinated flowers, i.e. about 16-18 large or 50 small vanilla beans. It is not the mass of vanilla beans that causes problems but rather the number of pollinated flowers. This mass of vanilla beans remains fairly stable regardless of the number of flowers pollinated on a *bout-pendant*. Pollinating 50 flowers on a *bout-pendant* may yield this potential mass of beans, but pollinating 16-18 flowers/*bout-pendant* will have a better chance of achieving this mass. In the first case, the vanilla beans will be smaller and have poor processing properties as well as lower vanillin rates, and in the second case, the vanilla beans will be larger, of high quality and thus will fetch a higher sale price.

Selection of *bout-pendants*, inflorescences and flowers:

- Only the *bout-pendants* on the outside of the plant mass are productive
- A *bout-pendant* only produces for two successive years, alternating production from one productive node to the other from one year to another.
- A node gives only gives one bunch (inflorescence).
- Inflorescences can be single or multiple.
- One inflorescence bears several flowers.
- A flower gives a vanilla bean after hand pollination.

Which flowers need to be pollinated?

- The flowers that appear first (those that are closest to the roots) are the highest priority.
- The flowers in the bunches closest to the roots
- Flowers on a *bout-pendant* farther away from the root are not high priority.
- If you see that the last flower pollinated has a vanilla bean that grows slower than the others, stop pollinating the associated inflorescence. This phenomenon is visible after 2 days of pollination.
- Stop pollination as soon as a streak appears at the last node that has an inflorescence with pollinated flowers (does this indicate weakening as fluted spaces between nodes does?)
- On a multiple inflorescence, **up to 16 flowers** can be pollinated and drop the other remaining flowers.
- **Do NOT remove unpollinated/unfertilized flowers.** It is useless work because the resulting wound is a vector for disease.

Figure 15. Adjusting bunches makes it possible to reduce the coupling without impacting production.

3.6.4. Health management after pollination

After pollination, farmers should manage bean health and growth as follows:

- Unfertilized pollination based on the aforementioned quantity control must be carried out if other flowers appear.
- During the vanilla bean growth phase, vanilla plants must enjoy optimal growth conditions by providing substrate and humus.
- **The drop of vanilla beans appears when there is insufficient mineral supply**, either due to a lack of organic matter, insufficient humidity in the growing medium, or a cessation of feeding caused by a disease.
- Vanilla bean rot due to phytophtora (mildew) appears in the summer because excess humidity and heat are generated in plots that are too confined.

3.6.5. From flower to mature vanilla bean: stages of development

The vanilla bean is technically the fruit of the vanilla plant. It is a cultivation that cannot be mechanized, so human intervention throughout the cultivation stages is essential.

Monitoring correct vanilla bean growth

- Pollination is carried out by hand one flower at a time and can be completed at a rate of 500 to 800 fertilized flowers per person per day.
- Fertilization occurs 18-20 hours after pollination.
- Starting in the first hours after fertilization, the ovary swells and grows in length.
- The vanilla bean reaches its final length and diameter 45-60 days after fertilization, (the growth period of the vanilla bean), beyond which it does not grow anymore.
- The physiological maturation process begins at the end of the vanilla bean lengthening period.
- After fertilization, vanilla takes 8 months to grow and mature in arid zones and 9 months in humid zones, depending on the year.

Vanilla stamping

This consists in “branding” the vanilla bean via scarification. Stamping plays a fundamental role in the traceability and security of vanilla production. Technicians abandoned this practice about 12 years ago after illnesses caused by viruses appeared. According to plant pathologists, it appears that the rate of transmission of viral diseases with disinfected sharp tools is very low and does not pose a threat to the crop. 2 punch stampers are required and they must be used alternately after disinfection.

3.6.6. Harvest management

Like pollination, harvesting should ideally be applied bean by bean and be done selectively based on maturity. A vanilla bean is mature when it reaches 8-9 months of age and when the yellow dehiscence fibers have appeared on both sides of the vanilla bean. When the vanilla is ready to harvest, the vanilla bean loses its shine and its lower end turns yellow. Like with pollination, the harvest must be spread out. However, due to the risk of theft and constraints during the day, harvest is finished in only a week or less.

3.7. Management of post-harvest activities

Not all farmers prepare their vanilla and not all master the many stages of the process. Some do it systematically in whole or in part with full knowledge of the facts and according to their immediate cash needs (sale of green vanilla) or while waiting for better prices in the bulk market (sale of processed vanilla prepared according to agreements with buyers, or lack thereof).

Operations related to harvesting, scalding, parboiling, drying and other forms of processing and classification are not considered in general or specific vanilla cultivation recommendations.

This document will not address the many steps and specificities of the preparation cycle, as they ultimately have little environmental impact and are too complex to detail. Below the activities that are not part of the planting process are mentioned.

Scalding

Green vanilla needs to be scalded shortly after harvesting otherwise its quality could be impacted or its green or black exportable yield could be reduced.

Scalding is one of the two wood-consuming post-harvest stages. It consists of bringing 150 liters of water to around 63-65 °C in order to “soak” a mass of around 35 kg of green vanilla for 3 minutes. To do this, every year the preparers take wood from the forest or accessible areas. If an average production of 60-90 kg of green vanilla, this requires 2-3 scaldings that will use approximately 200 kg of firewood, i.e. 3–5-year-old *acacia*.

Parboiling

Immediately after scalding, hot, green vanilla is placed in an oven with several layers of covering and then stored in boxes for a minimum of 1-2 days, depending on various parameters.

Storing vanillas on grates and in wood boxes

Following scalding and parboiling, the browned vanilla beans are placed in the sun during a few mornings in order to prepare them for drying on grates with a wooden frame. They are then stored in ripening boxes mostly made from wood harvested at renewable pine plantations in Madagascar. Formerly these boxes were made from forest wood. These two stages consume wood harvested locally. Today (pine) wood is also imported from producing regions.

Other input use

Raffia is used to tie the vanilla beans together for temporary classification and storage until export. Raffia production is domestic but the lack of replanting makes it ever rarer and more expensive. A few projects have started to regrow raffia in southeast Madagascar

The **wax paper** that is essential for the development of vanilla bean flavors and which is a byproduct of the petroleum industry can be locally discarded or left abandoned in nature after several uses. However, to date this has not been reported as a source of pollution.

Permethrin impregnated **mosquito nets** present in many huts in the country impact vanilla quality and price. In fact, batches where permethrin is detected are systematically downgraded to conventional vanilla due to the presence of pesticides.

Wood consumption, mainly of local species for fuel and pine for other uses, is the only notable negative impact. This impact can be controlled through the systematic replanting of at least 1 tree for every tree felled for firewood, but this could also apply to locally purchased pine.

3.8. Need for record keeping and documentation

After describing the current situation and the proposals and recommendations in this document, it is relevant to anticipate a development of professional skills (starting with farmers). This goal has become necessary and must be combined with documentary requirements first to facilitate farmers' work but also to ensure traceability and transparency for an overall sustainable benefit. Internal documentation is even an obligation in certification programs.

To better manage a plot and specially to ensure traceability of these products, farmers must keep a minimum of records showing costs and activities. These documents would also help technicians supervise farmers. This represents a tool that also makes it possible for the government and technical and financial partners to have reliable statistical data from the get-go. Record keeping represents a major challenge that has never been met to date, despite numerous public and private initiatives.

Apart from the fact that some farmers cannot read and write, there are two reasons for this. First, there is a lack of willingness because it is considered a constraint without benefits or a return on investment (including for certifications linked to weight bonuses), and second, this requires **collectors** to do the same thing and prevents them from price speculating as they normally do when they are involved.

These necessary registers are:

- **Cultivation notebooks** that record all activities on the plot;
- A **pollination notebook** which records the numbers of flowers pollinated daily and allows the technician to fill out the phenological sheets;
- **A harvest notebook** that records the daily harvest;
- A **farmer's I.D. card** which plays a major role for statistical data collection, security and product traceability.

4. SUPPORTING THE TRANSITION TO SUSTAINABLE VANILLA CULTIVATION

Sustainability in agriculture is generally defined in terms of 3 pillars: social sustainability, environmental sustainability and economic sustainability. Applied to vanilla, these criteria could include the following aspects:

- ***Social sustainability***: ensuring all stakeholders in the value chain a decent standard of living (living income: FairTrade International, 2019) and respect for human rights.
- ***Environmental sustainability***: improving biodiversity and the natural capital of soils or at least maintaining impacts through sustainable practices. Organizing the sector to reduce deforestation. Mitigating climate change.
- ***Economic sustainability:*** ensuring significant and sustainable revenue to finance the goals of the first 2 pillars. Economic needs must be satisfied by the compensation and supervision of farmers to encourage them to abandon traditional systems (*tavy*) in the short-term and by sustainable practices allowing high and controlled productivity in the long-term.

4.1. Socio-cultural analysis

The analysis is based on a survey of 1,800 households in the SAVA region done in 2017 (Diversity Turn Baseline Study: DTBS - Hänke et al., 2018). From this, the different percentages given in this subsection are derived. This survey highlights that agriculture is the main activity in the region (involving 92% of heads of households). Also, the same households grow a wide variety of crops (rice, vanilla, banana, coffee, cloves, etc.).

4.1.1. ROLE OF VANILLA IN AGRICULTURE IN THE SAVA REGION

Vanilla is an extremely attractive cash crop in the SAVA region. In fact, 83% of households surveyed (DBTS) grow it. It is thus grown much more than other cash crops (involving up to 20% of households that grow cloves and coffee). It is a labor-intensive crop, and the majority of this labor is carried out directly by household members (unlike the case of rice farming) due to a great need for monitoring and care and a fear of theft (Herimanga, 2016).

Despite the attractive selling prices of vanilla today, rice as a food crop remains immensely popular in this region. In fact, 90% of the households surveyed (DBTS) grow rice as a food crop, and 26% of households grow a *tavy* rice crop. There are several reasons for the persistence of food crops (especially *tavy* rice which causes deforestation) despite the possibility of replacing them with cash crops.

Recent research on the subject suggests that the main culprit is **internal**: social property relations (Laney and Turner, 2015). This concept is defined by the fact that money can be lost through a large number of social expenditures (gifts, irrational purchases, agricultural expenditures) but harvested and stored rice cannot. This gives it a greater value relative to the money earned.

Other more **external** reasons can be suggested:

- The insecurity of owning vanilla: 40% of households growing vanilla surveyed (DBTS) suffered theft in 2016. This can even cause vanilla to be harvested before it matures.
- The complexity of hiring non-family labor for vanilla farming (Herimanga, 2016).
- The poor organization and informality of the sector (see 4.1.2).
- Fear of the risk of fully committing to a cash crop due to price variability (Minten, 2006).

4.1.2. Status of the sector

The vanilla-producing population in the SAVA region is socially extremely poor and suffers from a lack of education (see Box 4). There is also a young population which has a hard time obtaining land to cultivate.

The vanilla sector in SAVA is still little or poorly structured. Only 15% of farmers surveyed (DBTS) had contracts with buyers (however, today this percentage is increasing sharply: Ton et al., 2018). In addition, a significant portion of vanilla is sold as green vanilla beans before the markets open (due to farmers' need for cash and fear of theft: Hermanga, 2016). The vanilla sector's lack of organization is regularly criticized due to this. Thus, 63% of the farmers surveyed said they sold their vanilla to collectors in the informal market, adding intermediaries in the value chain.

Box 4. Socio-economic conditions in SAVA

SAVA is a poor region (source: CNV International & Fairfood International, 2018):

- 66-78% of the population lives below the poverty line (1.90 USD/day).
- 81% of the population consumes less than the minimum acceptable diet (2,133 kcal/day).
- 4 out of 10 households say they are unable to save.
- The average agricultural income is lower than that of Madagascar as a whole.

SAVA suffers from a lack of education (source: Hänke et al., 2018):

- The literacy rate varies from 81% (for women over 22) to 86% (for men over 22); the majority of the population can read French but less than 25% can speak it.
- Female heads of household have completed 4.5 years of education on average and male heads of household 5.6 years.

The vanilla sector suffers from inequality. This can be seen through the accessibility or lack thereof of contracts which make it possible to have more stable sales and economic guarantees (Hänke et al., 2018). The DBTS study determined that these contracts are more accessible to wealthy farmers. This analysis can be extended to labeling, which requires investments, particularly in traceability. Similarly, contracts are not very accessible to households headed by women, which are also the least educated households and those that suffer the poorest harvests.

4.1.3. Priorities for a traditional and sustainable transition

The last 2 sub-sections show that vanilla cultivation is part of a complex socio-cultural fabric. The implementation of a new sustainable vanilla sector must be carried out with knowledge of these priorities in order to be effective. 3 priorities can be discussed for the concrete application of this guide:

- The lack of organization and widespread informality of the sector can reduce the effectiveness of legislation and sustainable vanilla cultivation programs.
- Social relations, particularly access to land, can frustrate attempts to dissuade farmers from producing *tavy* rice. For example, a "zero deforestation" label on all a household's farming practices intended to encourage them to produce only vanilla can have unintended consequences. If households still want to keep rice as a food crop, then only families with both vanilla and irrigated rice (usually the wealthiest families: Herimanga, 2016) will be able to take advantage of this label. The label will then become a symbol of social inequalities and will not succeed in converting poor *tavy* rice farmers.
- New practices may be difficult for farmers to accept. On one hand, vanilla cultivation using said practices requires more care, and there is a lack of reliable and qualified labor (labor by family members is mainly used). On the other hand, *tavy* practices are strongly rooted in rural Malagasy society, relegating vanilla cultivation to a secondary cash crop.

4.2. Environmental analysis

4.2.1. Carbon footprint comparison of cultivation systems

To get an idea of the carbon storage in vanilla cultivation systems, the figures from the Diversity Turn project (Soazafy et al., 2021), which identified average values of stored carbon as summarized in Table 8, have been analyzed.

Table 8. Carbon storage comparison by cultivation system (Soazafy et al., 2021)

Soils	Number of plots measured	Average aboveground carbon stocks (TC/ha)	Average soil carbon stocks (mmol/g of dry soil)
Slash and burn rice cultivation	(10) 25 m radius plots	0	1.9
Forest-derived vanilla cultivation (CS1)	(10) 25 m radius plots	51	2.0
Vanilla cultivation from regrowth (CS2)	(20) 25 m radius plots	16	2.7

This comparison makes it possible to suggest an approach focusing on aboveground carbon stocks and to assign a carbon storage value:

- to the sustainability of CS1 cultivation systems by preventing the destocking of 51 TC/ha when farmers resort to the burn-regrowth cycle.
- to the implementation of a new CS2 cultivation system by making it possible to store 16 TC/ha thanks to the removal of land from the burn-regrowth cycle.

4.2.2. Natural capital of cultivation systems

Calculation of current natural capital

Natural capital is defined as the resources made available to humans by biodiversity. To analyze this, two parameters will be used: biodiversity (diversity of species) and functionality (functions and services provided by the ecosystem).

The most comprehensive analysis of the current natural capital of lands associated with vanilla and traditional systems was conducted by the Diversity Turn project (Martin, 2021). This was carried out in 10 villages in the SAVA region and in 1 protected forest where 80 plots with a radius of 25 m each were selected (including 10 plots of each type of soil from the procedure explained in 1.4 and 20 plots corresponding to CS2) .

On these plots, 3 aggregate indices were calculated:

- *Total multi-diversity*: the diversity of species obtained via censuses and statistical analyses (ANOVA) of 7 taxa: trees, herbaceous plants, birds, amphibians, reptiles, butterflies and ants (data from the study: Dröge et al., 2021; Fulgence et al., 2021; Martin et al., 2021; Raveloaritiana et al., 2021).
- Endemic *multi-diversity*: diversity of species endemic to Madagascar measured in the same taxa.
- *Multi-functionality*: this is measured with the associated method according to the 5 criteria listed below:
  - *Aboveground carbon storage*: tree counts and diameter breast height measurements (Soazafy et al., 2021).
  - *Terrestrial carbon storage*: soil analyses (Soazafy et al., 2021).
  - *Predation rate*: measurement of attack rate on decoy prey (sentinel prey method: Schwab et al., 2021).
  - Sourcing of natural products: requests to 322 households in the 10 villages participating in the experiment to list the benefits they obtain from the different types of soils (Raveloaritiana et al., 2021). The main benefits identified were heating, construction, and weaving materials, fodder, wild food and medicinal plants.
  - Water regulation: the same procedure used for sourcing of natural products was used, and 3 benefits were identified: water retention, water infiltration and precipitation interception.

Box 5. The calculation of multi-functionality indices

The value of these aggregate indices was determined using a 50% threshold approach (Manning et al., 2018). This consists of:

- Defining the diversity measured in the plots for a particular function or species.
- Selecting the 5 most diverse plots and calculating the average of said diversity.
- Determining the proportion of plots where the diversity of the species or function exceeds a certain threshold (50% in this case) of this average for each type of soil.
- Calculating this proportion of plots exceeding the threshold for each function or species making up the aggregate indices (5 functions for multi-functionality, 7 species for multi-diversity) using the same method.
- Obtaining the 3 aggregate indices by averaging the proportions of these indices (each index thus has the same weight in the final calculation).

The result of this aggregate analysis is summarized in Table 9. For more readability, the results of this study are given in relative terms by defining the diversity and functionality of natural forests as a reference.

Table 9. Soil diversity (at 50% threshold) in the vanilla land use itinerary

Soil type	Total multi-diversity	Endemic multi-diversity	Multi-functionality
Natural forest	100%	100%	100%
Degraded forest	64%	51%	42%
Forest-derived vanilla cultivation (CS1)	68%	50%	33%
Slash and burn rice cultivation	42%	3%	11%
Tree regrowth	48%	18%	33%
Vanilla cultivation from regrowth (CS2)	56%	23%	28%

Thanks to this study, it has been possible to produce a table of biodiversity and functionality gains and losses associated with the implementation of different traditional vanilla cultivation systems (Table 10).

Table 10. Impact of the implementation of vanilla cultivation systems on the natural capital of soils

Soil modification process (Figure 3)	Farmer actions	Impact on total multi-diversity	Impact on endemic multi-diversity	Impact on multi-functionality
Natural forest to CS1 vanilla cultivation	Forest thinning Vanilla cultivation	- 30%	- 50%	- 70%
Regrowth areas to CS2 vanilla cultivation	Stake planting Vanilla cultivation	+ 20%	+ 20%	- 20%
Depleted/grassy regrowth areas to CS3 vanilla cultivation	Fertility restoration Stake planting Vanilla cultivation	Not measured, increase expected		

From a biodiversity perspective, traditional vanilla cultivation has an attractive impact on conservation since it plays host to more biodiversity than the degraded forest used for CS1 vanilla cultivation. Above all, it enables an increase in the biodiversity of the regrowth trees during the implementation of CS2 vanilla cultivation.

There is a significant drop in functionality following the implementation of vanilla cultivation. This is due to the fact that, even though the implementation of vanilla cultivation makes it possible to increase carbon storage, it nevertheless leads to an increase in the predation rate, a reduction in the use of natural products and a disappearance of the water regulation benefits inherent to natural and degraded forests. This point highlights the significant room for improvement in the way sustainable cultivation practices impact natural capital. However, this drop in functionality should be taken with a grain of salt because it does not take into account the long-term benefits of conserving soil fertility by stabilizing its use rather than letting the soil enter a burn-regrowth cycle which impoverishes it.

Since the CS3 is still an experimental system, no biodiversity or functionality study has been carried out on it. However, CS3 cultivation is implemented on infertile soils that have been impoverished by several burn-regrowth cycles and involves soil fertility restoration work. The impact of its implementation should therefore be positive for biodiversity and functionality.

4.2.3. Prospects for a traditional and sustainable transition

The practices proposed in section 3 make it possible to increase the natural capital of vanilla, in particular by offering better management of weeds and of the choice of stakes (see 3.3).

In addition to this increase, the main objective of these practices is the sustainability of crops by stabilizing and optimizing yields and limiting the spread of diseases. Making vanilla crops sustainable helps stabilize land use in the cultivation procedure discussed in 1.4 (see Figure 3). This stabilization is crucial because, as seen before, the burn-regrowth cycle and rice cultivation are now frequent uses of the land associated with vanilla cultivation and the main drivers of deforestation. 3 principal related conservation opportunities can be identified:

- The sustainability of CS1 systems (via disease mitigation) which prevents soils from entering the burn-regrowth cycle after slash-and-burn. The opportunity to apply sustainable practices is thus particularly important for biodiversity conservation because applying slash and burn to these soils leads to a loss of half of the total biodiversity and almost all of the endemic biodiversity.
- The implementation of CS1 systems in forests that have already been degraded (for example by logging) but have not been subject to slash and burn would prevent this and by extension the loss of biodiversity and associated functionality.
- The sustainability of the CS2 system allows regrowth to be removed from the slash and burn cycle. This thus prevents the depletion of soils and the biodiversity associated with these cycles (Randrianarison et al, 2016b), transforms these soils into CO_2 sinks (Eaton and Lawrence, 2009) and reduces the pressure on land use by implementing a cultivation system that uses less soil (Michellon, 2006).

Finally, the implementation of the CS3 system would enable the recovery of land not used for agriculture and thus again reduce the use of the burn-regrowth cycle.

4.3. Economic cost-benefit analysis

In this section, a cost-benefit analysis of the transition to sustainable vanilla cultivation practices for vanilla farms is conducted.

4.3.1. Source of costs

The different costs have been studied in detail for each transition and cultivation step. Summaries and averages of these estimates are provided in the tables and figures in this section. These figures come from the various interviews and focus groups held as part of this study (see the individuals contacted in Annex 1), reading reports and technical manuals and our knowledge of farming practices.

These estimates have been broken into different summarized categories in Table 11 and added a list of the main sources of our costs.

Table 11. Types of costs accounted for in the cost-benefit analysis

Cost category		Description	Source of costs
Operations/Labor		Human resource costs on the plot expressed in man-days.	Technical manuals, interviews, expertise in farming practices. 1 man-day is worth 10,000 malagasy ariary (MGA) in our calculations. This is a realistic choice, above the market price and the minimum wage recommended by the State but lower than the 19,000 MGA living wage mentioned in the FairTrade study, 2019.
Inputs	Equipment	Materials needed to grow vanilla. Possibly consumable material (stamps) or new equipment for sustainable cultivation.	Costs of current material in SAVA farms.
	Plant material	Stakes and plans procured as part of a new crop.	
External costs	Benefits	Costs of services to be provided by transition initiatives to support farmers: supervision, assistance with certification (implementation of traceability by geolocation of orchards), diagnostics.	Data provided by experts. Supervision ratio of 1 agent per 160 farmers. This rate is intended to be a realistic approximation of the operations of a committed company and higher than those of a framework aimed solely at certification, but lower than the operations of NGOs.
	Compensations	Compensation provided to farmers to make the transition sustainable: • In cash: land security, compensation for the conversion of plots. • In kind: emergency aid (e.g. rice during the hungry gap season).	Documentation on compensation values (INSTAT, 2014), amounts of compensation observed in ongoing initiatives to help change practices.

All the costs given in this section are annual and calculated per ha of crop. They are calculated for a vanilla crop with a density of 2,000 vines per ha for crops using current practices and 1,800 vines per ha for sustainable crops (see section 3 for density studies).

The adoption of practices has a fixed transition cost to sustain the plots and train farmers and an additional annual operating cost.

4.3.2. Transition costs

Transition as is from current systems to sustainable systems

This first study corresponds to a transition as is from existing traditional cultivation (CS1 and CS2). It therefore mainly corresponds to reorganizing the plot and learning new practices. 2 years of transition are necessary during which time farmers benefit from regular supervision:

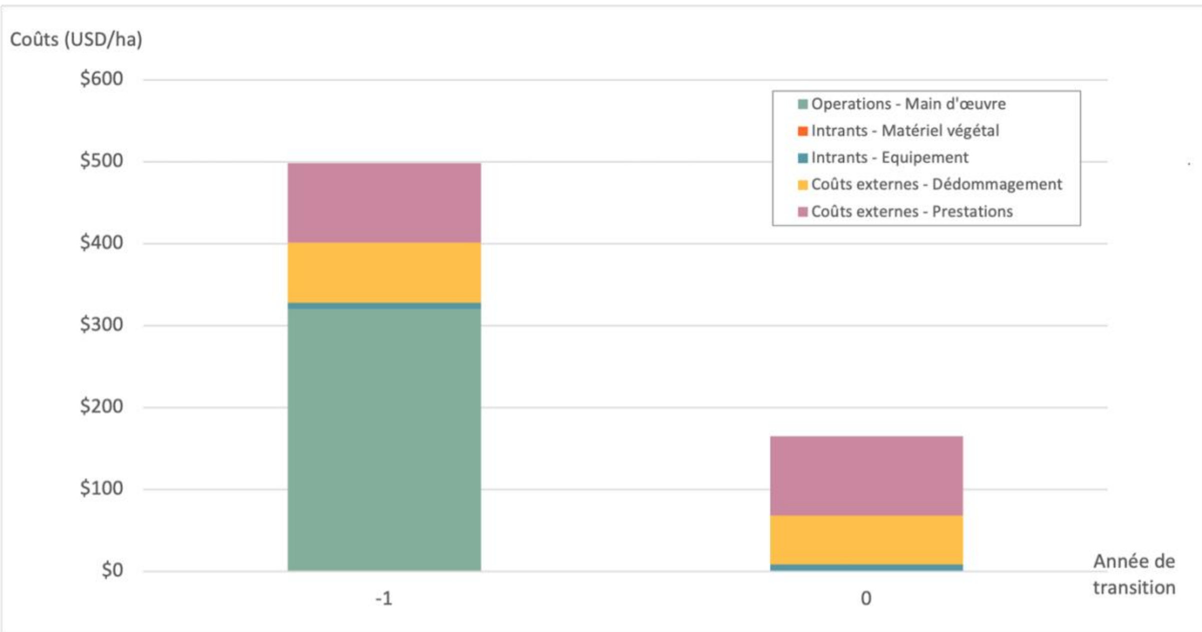
- The first year (year -1) consists of reorganizing the plot: installation of anti-erosion lines, water management and de-densification of the vanilla trees.
- The second year (year 0) involves support for the first year of sustainable cultivation and certification.

The effects on yield are discussed in section 4.3.4, Figure 18 and Figure 19.

During these two years of transition, there is still vanilla cultivation but it will not yet be certified and cultivation may be lower due to the transition efforts made by the farmer.

These transition costs are calculated at USD $660 (≈2,500,000 MGA) and are detailed in Figure 16. They mainly comprise labor costs to reorganize the plot (which can be avoided if it is already well developed) and service costs to train farmers and certify the plots. The compensation cost is mainly comprised of the emergency aid provided to guarantee the transition in the event of problems. There are no plant material costs since this transition is carried out as is on plots already planted.

Figure 16. Costs of transitioning current CS1/2 cultivations to sustainable practices



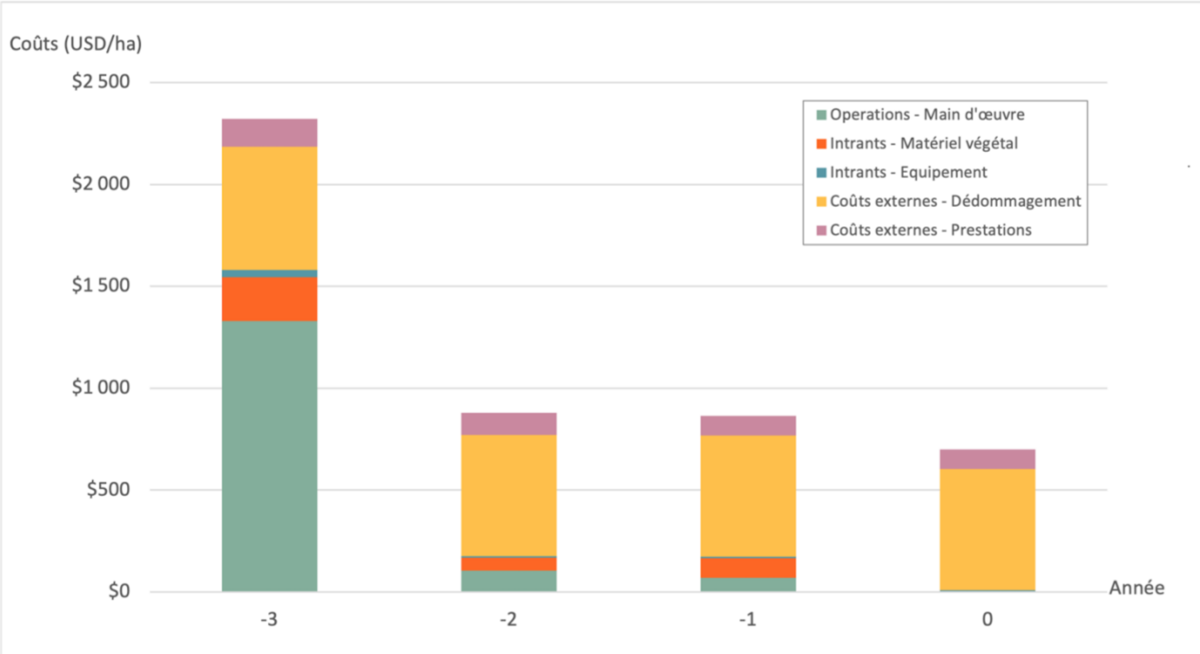
Implementing a CS3 cultivation on impoverished land

This deals with transforming soil poor in nutrients that is not being used for agricultural cultivation (or being used for the cultivation of plants requiring few nutrients) to CS3. Such an endeavor involves investing in plot development, fertilization and planting (stakes and seedlings). 4 years of transition are suggested during which time farmers benefit from regular supervision:

- Three years (year -3 to -1) of plot implementation during which time there is no cultivation.
- Support during the first year (year 0) of sustainable cultivation.

These transition costs are calculated at USD $4,750 (≈18,000,000 MGA) and are summarized in Figure 17. They are mainly comprised of labor costs to organize the plot as well as a significant compensation cost. Indeed, farmers will have to work on one of their plots without seeing any cultivation during this transition period. It will therefore be necessary to pay them an annual compensation for the conversion of plots corresponding to the value of 1 year of lost agricultural cultivation. The costs of services are the same as before (training, certification). Finally, there is a cost in plant material which will also require possible village nurseries to supply.

Figure 17. CS3 System implementation costs



4.3.3. Operating costs during the full cultivation phase

Operating costs are almost entirely made up of labor costs (with the exception of stamping to reduce theft. This is a system tested in DIANA which should be made publicly available). We have classified these costs into 2 categories:

- The maintenance costs which correspond to the different activities involving the vines and the plots that contribute to the proper functioning of the plot.
- The cultivation costs which correspond to all the costs linked to the cultivation of vanilla beans (flower induction, pollination, security, harvest).

The operating costs of the different cultivation systems are detailed in Table 12. There is an additional cost of more than 60% for the cultivation of sustainable crops. Indeed, sustainable practices are more labor intensive than current practices with twice as much work required for most maintenance and cultivation activities.

Table 12. Estimated annual operating costs of different cultivation systems

Costs and crop systems	Current practices	Sustainable practices
Plot maintenance costs		
Maintenance of vanilla trees	18 MD/ha	36 MD/ha
Shading maintenance	21 MD/ha	36 MD/ha
Field maintenance	6 MD/ha	12 MD/ha
Cultivation costs		
Flower induction	5 MD/ha	18 MD/ha
Pollination	48 MD/ha	74 MD/ha
Security	29 MD/ha	29 MD/ha
Harvest	6 MD/ha	12 MD/ha
Total labor time	**133 MD/ha**	**217 HJ/ha**
Total costs (labor + equipment)	USD $370 (≈1,390,000 MGA)	USD $600 (≈2,230,000 MGA)

4.3.4. Benefits of the transition

Qualitative analysis

The main benefit of implementing sustainable practices is the **productivity sustainability**. Current vanilla crops are very dense and have remarkably high yields in the first years before experiencing a gradual drop in yields due to the spread of disease and soil depletion. On the contrary, sustainable crops are by definition "endless" since they enjoy regular inputs that maintain soil fertility and significant disease control.

Sustainable practices also allow for **quality** cultivation. Thanks to the limitation of pollination in particular, the vanilla beans produced with these practices are longer and have a higher vanillin rate. This quality gives an advantage to farmers who can sell their vanilla beans for a higher price.

During the transition, **certification** will also increase the selling price of vanilla beans and stimulate quality improvement.

Finally, the adoption of these practices via farmer training gives them **professional skills**. 2 important benefits of these professional skills should be mentioned:

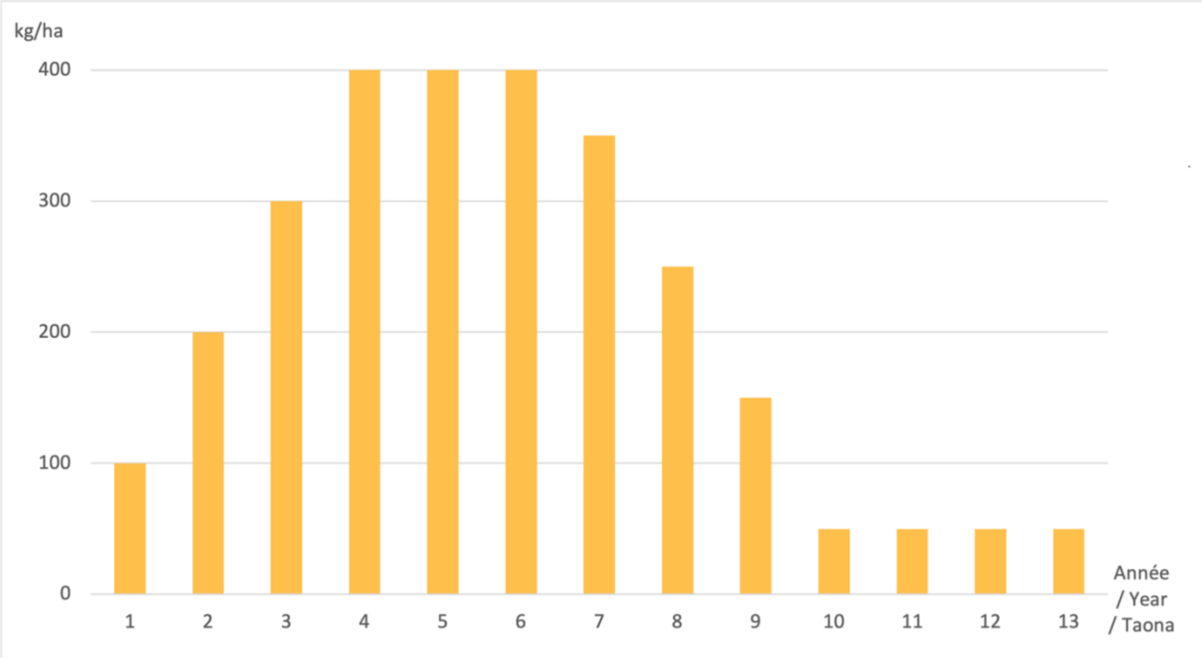
- The ability to manage a long-term operation (investments in sustainable vanilla cultivation on a plot) that allows farmers to not fall back on *tavy*.
- A possible diversification of agro-forestry systems (densification of vanilla or addition of nurse trees) when sustainable techniques are mastered.

Quantitative data

Yields

To obtain quantitative data on yields, we conducted a broad literature review of different reports and interviewed many stakeholders in the field (see Annex 1). It is quite clear that the yields of vanilla fields vary widely: from yields of less than 100 kg/ha of green vanilla per year (Herimanga, 2016) to yields of more than 1 ton/ha observed by our field study. This large difference comes from the variable fertility of the soil, the diseases present in the crops, the different cultivation practices used or even from the climate of the plot which varies depending on the geographical area it is located in. To conduct a cost-benefit analysis and illustrate the key stages of the two current and sustainable crops, we have proposed average yield profiles (Figure 18 and Figure 19). These profiles represent a rough tendency rather than the reality on the ground.

Figure 18. Average yield profile of a current crop (year 1 = 1st year of cultivation)

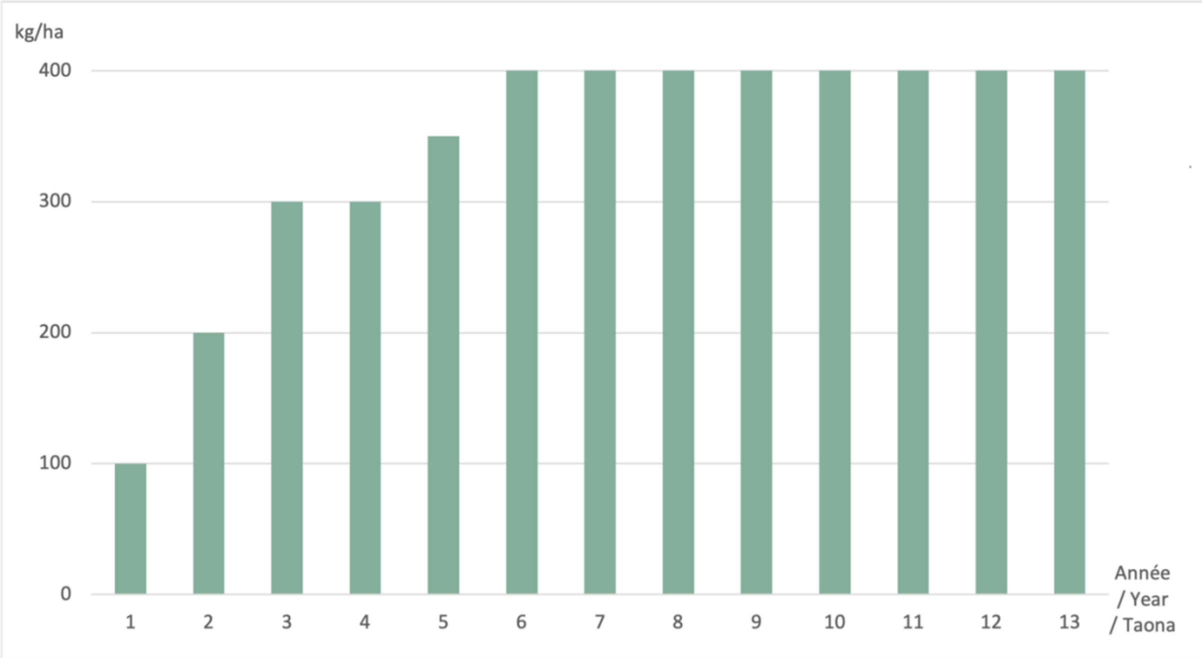


For **crops using current practices**, Figure 18, the profile proposed starting in year 1 of cultivation, makes it possible to identify 3 key stages in the change of their yield:

- A **rise in yield** then a **stabilization** of these yields towards 400 kg/ha starting in year 4 onwards. The rapid rise in yield corresponds to the aim of current practices to produce a maximum crop on a short time scale (planting of dense vanilla trees). The proposed stabilization at a yield value of 400 kg/ha is a conservative estimate relative to the maximum values observed.
- A **drop in yield,** observed after 7 years of cultivation on average. This fall can be slow as shown on Figure 18, due to a drop in soil fertility, for example, or it can even be very sudden with the rapid spread of fungi or diseases throughout the crop.
- After this fall, a **low yield** is maintained starting in year 11 of cultivation. This corresponds to the strategy of the farmers to preserve their sick vanilla stocks as an additional resource. This preservation of sick vanilla can change according to the food resource needs of households. It is generally during this period that a farmer can decide to slash and burn their vanilla farm to reestablish a *tavy* cultivation.

The average yield assessed on these crops over 10 years is close to 300 kg/ha, which corresponds to an average value given in several recent reports (Salva Terra, 2018; FairTrade International, 2019; MAEP, 2019; Marinot, 2020).

Figure 19. Average yield profile of a sustainable crop (year 1 = 1st year of cultivation)



For **sustainable crops**, Figure 19, the profile proposed starting in year 1 of cultivation, makes it possible to identify 2 key stages in the change of their yield:

- A **rise in performance** until year 6. The rise in yield is slower than for crops using current practices because we assume that progressive professional skills acquisition by sustainable farmers allows them to reach maximum productivity by year 6 despite a lower density of plants.
- A **sustainability** of high yields (400 kg/ha) starting in year 6 which corresponds to the fact that a sustainable vanilla crop is by definition "endless". This full cultivation yield is a conservative estimate compared to the yields up to 3 times higher observed when farmers have a good mastery of vanilla cultivation practices. This partly explains the choice of the authors to focus on the quality of the vanilla produced and the importance of disease management rather than optimizing productivity.

Quality

An increase in the selling price of vanilla thanks to the increase in its quality has been debated in the exchanges that we have had with the stakeholders in the field and is seen on a case-by-case basis.. Although the increase in quality is clear in the case of processed vanilla (black), it is more difficult to measure for unprocessed vanilla (green) which represents the majority of vanilla sold by small farmers. This increase in quality of the green vanilla is thus measured by the appearance (size of the vanilla beans) or the vanillin rate after preparation. However, in general, vanilla collectors buy vanilla in bulk from farmers without quality control. Here we encounter the obstacle of the lack of formalization of the sector mentioned in 4.1.3. Aid programs to improve the quality of vanilla (ex: Vanilla for Change, see 4.4.1) with this approach thus deal directly with farmers without going through these collectors and can then offer quality bonuses either directly for the appearance, or retroactively after measuring the vanillin rate.. Appearance quality control could also be considered for the sale of production in regulated markets offering a more formal framework than that of direct sale to collectors. If quality control is carried out, a **10% increase in the price of green vanilla** seems a reasonable value for the stakeholders we were able to interview.

Certification

An increase in income derived from vanilla thanks to **certification** is estimated **to be 10% of the price of green vanilla** by calculating the average increases derived from different certifications (BIO, FairTrade, RFA). For this certification premium to be available on a large scale, however, an increase in demand for certified vanilla is necessary, as several exporters have told us that they can easily meet the demand for certified vanilla.

4.3.5. COST-BENEFIT ANALYSIS OF A TRANSITION

To perform this analysis, two additional assumptions are needed:

- The definition of annual **losses** related mainly to theft and bad weather: estimated at **15% of production per year.** This amount, confirmed by vanilla technical experts, is rather optimistic and takes into account the theft-reduction advances made in recent years (introduction of stamping).
- The definition of the **price of green vanilla.** This amount is critical in this analysis because vanilla prices vary greatly from year to year. These price variations make our cost-benefit analysis more academic than factual because we will consider a constant price (quite different from reality). In addition, these prices have a strong socio-cultural influence. For example, the vanilla quality is observed to decline when prices increase (due to over-pollination and increased theft) or when they are exceptionally low (again due to over-pollination). For this analysis, we will use a low estimate of green vanilla prices during the 2019-2020 season: **50,000 MGA/kg green vanilla.**

Analysis of the transition from current systems in place to sustainable systems

We will conduct a cost-benefit analysis for the transition of practices on the CS1/2 systems already in place (transition costs corresponding to Figure 16). This analysis represents the main challenge for the vanilla sector identified by this guide: the reform of current practices.

The cost-benefit analysis depends on when a farmer's transition to sustainable practices is achieved. 3 transition scenarios can be considered.

Scenario 1

This scenario corresponds to a transition to sustainability with the implementation of a new CS2 plot. We assumed that the two years of transition to sustainability of the plot proposed in 4.3.1 would take place in years 1 and 2 of Figure 19. This scenario assumes that the farmer has made the investment in planting the plot himself and that the support for training and certification in sustainable cultivation comes after.

The profile of the cost-benefit analysis in scenario 1 is presented in Figure 20. It compares the total differences in cost and revenue between sustainable crops and crops using current practices. We observe how this total changes over 2 phases:

- From year 1 to year 6, costs and revenues between sustainable crops and crops using current practices are similar. This trend is due to the fact that the additional transition and operating costs as well as the slightly lower yields of sustainable crops compared to the crops using current practices over this period are compensated by the increase in the sale price of sustainable cultivation thanks to its quality and certification (obtained at the end of the transition starting in year 3).
- Starting in year 7, income from sustainable crops is much higher due to the sustainability of yields compared to the drop in yields from current practices at this time.

This scenario shows the immediate benefit of the sustainability of crops which enables a consistent return on investment starting in year 1 while crops using current practices see lower yields. It also makes it possible to demonstrate the benefit of sale price increases due to certification and the increase in quality in making sustainable cultivation competitive despite a faster rise in yield of crops using current practices.

Scenario 2

This scenario corresponds to a transition to sustainability when the first drop in yields is observed by the farmer (year 7 in Figure 18). It then assumes that years 8 and 9 will be the 2 transition years for farmers. During this time, the fall in productivity continues and is then halted due to learning and subsequently applying sustainable practices which will make it possible to gradually regain full cultivation for the new sustainable operations (see the proposed transition yield profile in Figure 21).

The cost-benefit analysis profile is given in Figure 21. Here, the return on investment is more direct and is obtained once the 2-year transition period ends, in other words, in year 3, thanks to the fertilization of the soil and the management of diseases which enables renewed good yields.

Scenario 2 thus seems to be the simplest to finance and benefits the farmer. It seems to be a good way to start introducing sustainable practices.

Scenario 3

This scenario corresponds to a transition to sustainability when the yields of the plot are very low. This scenario is more uncertain in terms of the costs incurred since it depends on the condition of the plot. If the diseases are too prevalent or the soil too poor, for example, the plot will have to be reorganized (replacement of vines, fertilization) and the transition cost would correspond to the implementation of the CS3 considered in 4.3.2. Given this uncertainty, we have not proposed a cost-benefit profile for this scenario.

Figure 20. Comparative cost-benefit analysis if the transition to sustainability takes place starting in year 1

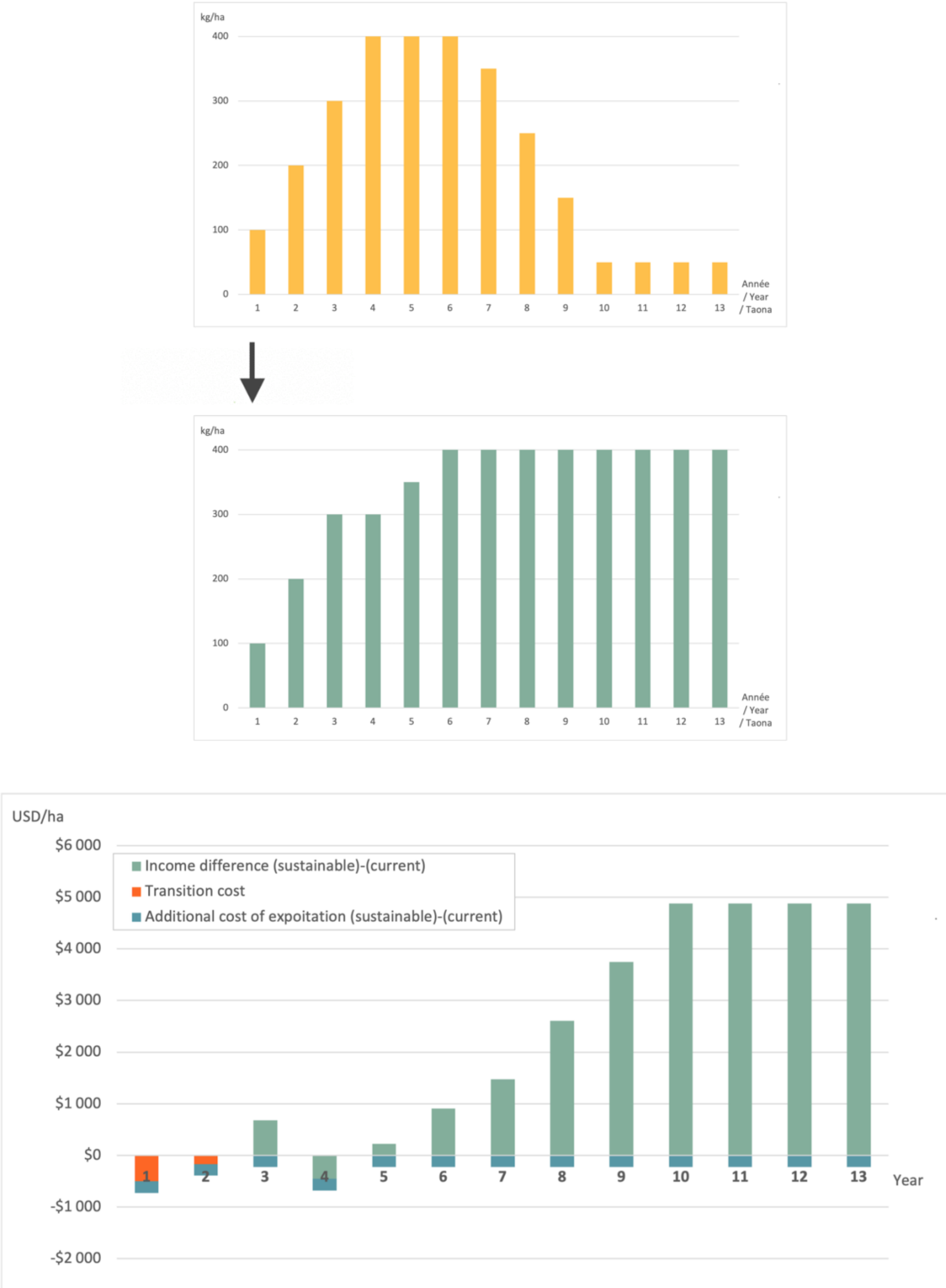


Figure 21. Comparative cost-benefit analysis if the transition to sustainability takes place starting in year 8

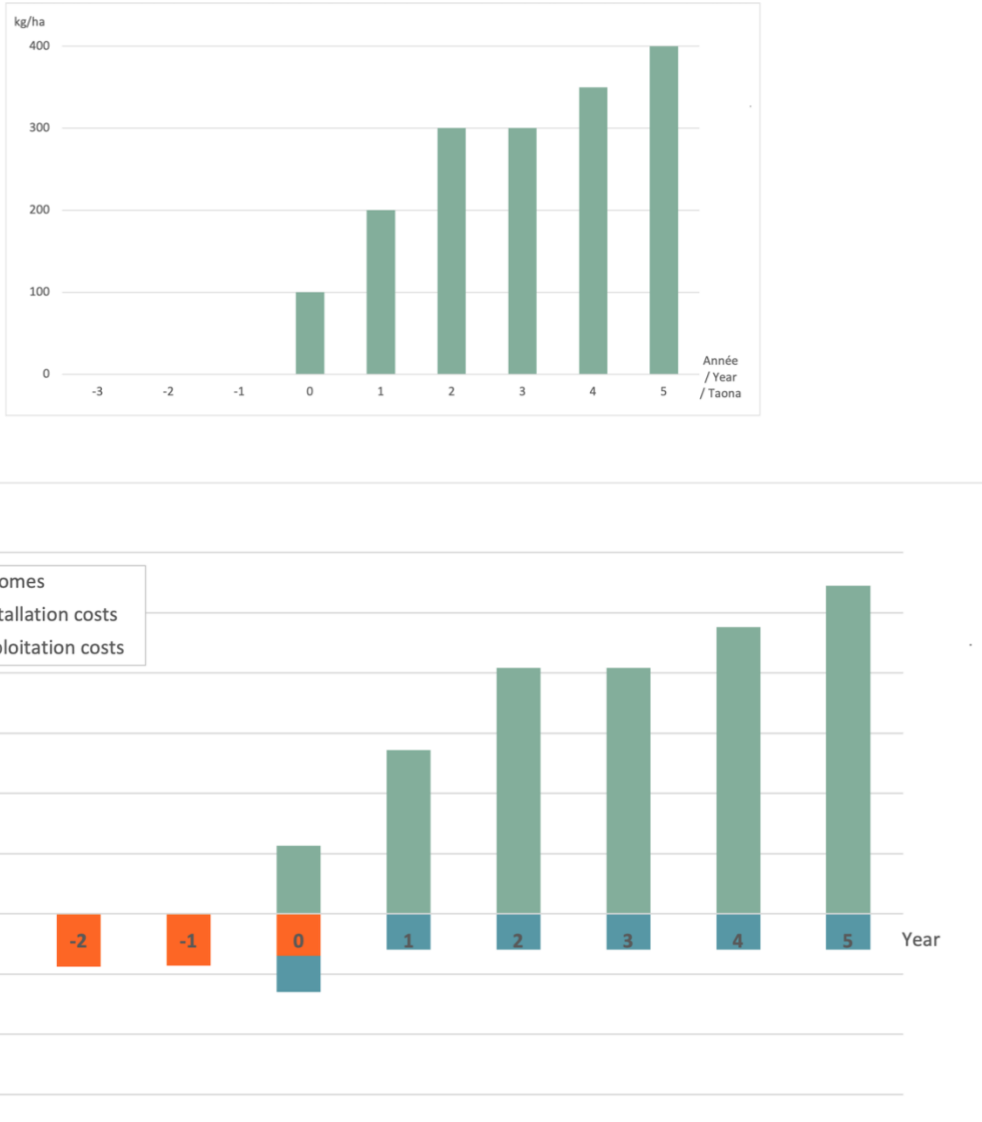
Analysis of implementing a CS3 cultivation on impoverished land

We conducted the cost-benefit analysis (Figure 22) of implementing this system on impoverished land. This represents the scenario favored by the guide for future extensions of the area under vanilla cultivation because it does not occupy areas associated with deforestation.

The costs given come from those given in sections 4.3.2 and 4.3.3 and the benefits are calculated in the same way as before by following the return on investment profile given in Figure 22. It is important to note that, as explained in 4.3.2, the implementation of these plots is accompanied by their full development (earth-moving, anti-erosion lines) and the cultivation of vanilla and companion plants. This is why there is no vanilla cultivation during the 3 years of plot development (year -3 to -1).

On this figure, we can see that the return on investment of the implementation of a CS3 cultivation starts in year 2, i.e. 6 years after the start of the implementation of the plot.

Figure 22. Cost-benefit analysis of implementing a CS3 cultivation (ROI after 6 years, at year 2)



4.4. Possible alliances and innovative financing

4.4.1. FINANCING RISKS AND OPPORTUNITIES

We will discuss the key risks and opportunities of sustainable vanilla financing issues.

Risks

First, there is an **environmental risk**. This is associated with the importance of ensuring that the sustainable vanilla cultivation systems financed are not linked to deforestation. This risk is also associated with the difficulty of access to land, which is particularly acute among young people and which can encourage the implementation of new systems in natural forests. For example, CS1 systems sustained by a mechanism for transitioning to sustainable vanilla cultivation practices must not result from recent deforestation.

The major risk facing the vanilla sector is **social** in nature. Already mentioned in 4.1.3, this is linked to complex dynamics mentioned on several occasions in this report. Indeed, the sustainable vanilla cultivation practices proposed are more labor intensive and transform the care of the vanilla field into one of the farmer's main activities. This risk is long-standing and has already represented an obstacle for other initiatives to improve vanilla cultivation practices such as the STABEX Madagascar project in the late 1990s. Below we have listed the obstacles associated with this risk for a financing project:

- **Difficulty of appraising quality:** price volatility, and its rapid rise in particular, encourage theft and over-pollination which lead to an overall decline in the vanilla quality. The informality of the sector and the lack of professionalism of collectors and preparers hinders the appraisal of the quality of green vanilla due to the absence of a price difference between, for example, mature and immature vanilla beans.
- **Lack of trust in the sector:** vanilla is seen as a side crop by farmers mostly due to price volatility.
- **Poverty and lack of financial management:** for vanilla to transform from a side income into a main crop, farmers need to be able to support themselves all year round. However, vanilla revenues are mostly seen at the time of sale. There are thus regular financial shortfalls outside periods where vanilla generates income (hungry gap season, children attending school). The primary origin of this obstacle are the social relationships of current properties (see 4.1.1 and Table 13) which leads to poor financial management and in particular very little savings among families.
- **Loss of know-how:** due to vanilla's status as a side crop and price pressures, the more sustainable traditional vanilla cultivation skills are being lost. Also, there is a weak market for skilled labor due to the mistrust of farmers and the heavy use of family labor. Finally, the number of competent technicians is also an obstacle to rapid large-scale deployment. As such, the training of additional technicians is necessary.
- **Social acceptability:** all of the previous points explain that current practices are not labor intensive and that the social structure lends itself better to food crops. The implementation of sustainable practices that go against these dynamics risks coming up against a lack of social acceptability.

Finally, there is an **economic risk**, namely, the instability of sustainable vanilla prices which complicates long-term predictions of how the sector is changing. This economic risk comes mainly from the fluctuation in demand for natural vanilla and its possible substitution by synthetic vanillin.

Opportunities

As vanilla is grown in a setting where **agroforestry** is practiced, the sustainability of these fields offers an opportunity to **diversify the crops** inherent to these systems. This would make farmers more resilient.

Today, natural vanilla is an **attractive sector.** In particular, we observe an increase in the amount of natural vanilla sold in 2020. It attracts both farmers and investors thanks to its high prices, offering an attractive environment for the launch of initiatives to finance new practices. Several farmers, companies and NGOs have already launched interesting initiatives that can be renewed or scaled up. The attractiveness of the sector is also an opportunity to mitigate the economic risk and guarantee the demand for natural vanilla by ensuring or even increasing the amount of natural vanillin required in the designations of "vanilla flavor" products.

Section 4.2 sketched out the different **ecosystem services** and the maintenance of biodiversity obtained by choosing to grow vanilla rather than a *tavy* crop. This can give rise to payments for ecosystem services, in particular to finance carbon storage, which has potential in these agroforestry plots.

4.4.2. What to fund? Analysis of existing initiatives

Two funding mechanisms are being considered to fund the transition to sustainable vanilla cultivation:

- A **global mechanism** aiming at systemic change in the sector.
- A **local mechanism** aimed at changing the practices of partner farmers.

All the mechanisms that exist today are local. These correspond to initiatives between exporters and importers generally carried out by partnerships which can then be financed by public bodies such as development agencies.

Funding needs of initiatives

The feedback from the promoters of various initiatives for financing vanilla best practices shows that to mitigate the risks mentioned in 4.4.1, significant monitoring of partner farmers is necessary. The analysis of all identified financing needs is discussed in Table 13. Such needs are identified by monitoring farmers daily. This comprehensive approach identifies all the needs of farmers for implementing long-term dynamics. Thus, because of this monitoring requirement, existing initiatives are limited to groups of 1,000 farmers.

Table 13. Identification of project needs for financing sustainable practices

Current barriers to changing practices	Needs of a financing project
Lack of technical know-how	• Training sessions. • Monitoring. • Quality-based incentive mechanisms.
Poverty, fear of risk Need for guarantees for farmers	• Direct, regular and long-term monitoring • Comprehensive approach: guarantees meeting living needs: health insurance, rice during the hungry gap season, improving access to education.
Cultural barriers Lack of financial education (lack of savings), vanilla seen as a side crop	• Financial education and creation of savings systems. • Pilot projects to demonstrate the benefits of labor-intensive vanilla
Access to land	• Clarify and divulge land use laws. • Support for farmers to legalize their land situation.
Role of young people	• Aiding and training young people: transmission of practices and credibility with elders. • Facilitating access to land

Strategies for redistribution to farmers

To implement the needs listed in Table 13, it is recommended to develop funding initiatives centered on 2 components:

- A **technical transformation component** which assumes the training and infrastructure needs detailed in 4.1.1 by contributing a sector structuring initiative through the creation of cooperatives. This is generally provided directly by the exporters.
- A **social component** to provide broader support to households affected by the project and to mitigate the social risk mentioned in 4.4.1. This takes the form of a wide range of initiatives: creation of savings and credit associations, health insurance, emergency aid, aid for education and a strengthening of institutions. These initiatives are often carried out by exporting companies or partner NGOs.

This second point constitutes a best practice implemented by several private stakeholders and NGOs consulted during the study and makes it possible to address the problems of agricultural operations more broadly than by just addressing prices.

4.4.3. Prospectus on a national cost of the transition to sustainable vanilla cultivation

Here we attempt to assess what it would cost to transition vanilla cultivation in the SAVA region to sustainable practices as proposed in this report. To achieve this we make the following assumptions:

- There are possibly 100,000 ha of plantations in Madagascar, including 65,000 ha in the SAVA region. These figures need to be confirmed by further studies.
- 30% of plantations are in CS1 and 70% in CS2. CS3s do not yet exist.
- The cultivated areas increase by 3% per year. As a conservative estimate, this figure (which also needs to be refined) corresponds to half of the average growth of areas as provided by FAOSTAT from 1961 to 2017. Some experts suggest that annual growth in demand in a "normal" year, i.e. not during price spikes, is also 3%.
- All area growth will now be based on a CS3 model, i.e. 19,810 ha over a 10-year period (65,000 ha of plantations in 2021 + 3% per year).

We recommend that the following costs be strategically borne by public authorities:

- 100% of the plant material needed to ensure quality;
- 100% of external costs aimed at full traceability (different from certification linked to labels). In fact, geolocation of plots and development of documentation constitute the highest costs when it comes to traceability, a fundamental element to assess and confirm the zero-deforestation performance of the vanilla sector. The sector can hardly meet this cost without confirmed demand for certified vanilla.
- 50% compensation for loss of earnings;
- 50% of labor costs (useful for incentivizing the implementation of CS3)

Table 14. Budget proposal for the pilot phase

	CS1	CS2	CS3	**Total**
Project assumptions				
Reference condition (ha)	19,500	45,500	0	65,000
Remarks	30% of plantations are in forests according to the Diversity Turn project	70% of plantations are located in brownfield according to the Diversity Turn project		According to an expert opinion cross-checking communications from private and vanilla development stakeholders.
Annual plantation growth			3%	**3%**
Target values in sustainable vanilla cultivation at 10 years (ha)	19,500	45,500	**19,810**	**84,810**
Remarks	Maintaining current cultivated areas	Maintaining current cultivated areas	Growth of 3%/year is only achieved in CS3 cultivation	
Cost assumptions				
Transition duration (years)	2	2	4	
Net transition cost USD/ha	**664**	**664**	**4,762**	
Operations/labor	*320*	*320*	*1,503*	
Inputs - plant material	*0*	*0*	*374*	
Inputs - equipment	*16*	*16*	*59*	
External costs - compensation	*134*	*134*	*2,390*	
External costs - services	*194*	*194*	*437*	
Distribution proposal				
Public sector (USD/ha)	*421*	*421*	*2,757*	
Remarks	100% of plant material, 100% of external costs contributing to full traceability, 50% of compensation for loss of income, 50% of labor costs (CS3 implementation effort)			
Other costs (USD/ha)	243	243	2,005	
Remarks	50% of compensation for loss of income, 50% of labor costs (as part of the implementation of CS3 cultivation)			
Co-financing scenario				
Pilot cost (millions)	**12,952,270**	**30,221,963**	**94,343,373**	**137,517,606**
Public sector cost	8,213,952	19,165,888	54,617,064	**81,996,903**
Other costs	4,738,318	11,056,075	39,726,310	**55,520,702**

4.4.4. Funding mechanisms for existing initiatives

Initiative bearers

Most of the initiatives in place to change practices are driven by a **partnership between exporters and importers.** These partnerships are often strengthened by associations with local businesses and NGOs. We can thus mention the following partnerships with exporters and importers aimed at improving vanilla cultivation practices: Estee Lauder Companies and IFF; Firmenich and Authentic Products; Givaudan and SOMAVA; Unilever and Symrise. These initiatives are often self-financed by companies who see an interest in them both for their corporate social responsibility (CSR) policy and for changing their value chain.

There are also **initiatives carried out by NGOs** (Livelihood-vanilla, *Revenues pour la protection de la nature*): these require funding to be completed. These initiatives can thus promote the ecosystem services rendered and provide aid for the development of private interests for changing the vanilla sector value chain.

Source of funding

Some of the initiatives may seek **public funding**. In this case, 2 mechanisms are used:

- **Grants**, given directly to a dedicated project by a development agency, such as the financing provided by the USAID project managed by McCormick & Company: Sustainable Vanilla for People and Nature.
- Matching grants. This mechanism consists of a financing offer by a development bank for initiatives concerning a given specification that is proposed by companies which must also commit a minimum capital. This was the case for the Vanilla for change project (a Unilever-Symrise partnership) which was funded by the develoPPP matching grants program led by GIZ. This program finances up to 50% of a project led by one or more companies if it specifically meets sustainability requirements.

Other initiatives may seek funding support through **private funds**. 2 attractive mechanisms can thus be identified:

- An access to the capital of an exporter to finance a project to renew practices: the capital can come from a fund or directly from exporters.
- A loan: for example made by a private fund dedicated to financing sustainable agricultural practices (examples of funds given in Table 16).

In both cases, these private funds will require a financial return on investment. This may include improvements in the vanilla value chain (e.g. financing of the Livelihood-vanilla project by Livelihood 3F), price increases due to increased quality and certification or even increases in yields due to the mastery of sustainable practices.

Finally, initiatives can also seek funding through **donations** from civil society (Income for Nature). To summarize the various points discussed in 4.4.2 and 4.4.3, we have analyzed 4 existing initiatives to improve the vanilla sector.

Table 15. Analysis of 4 existing vanilla sector improvement initiatives

Project description	Source of funding	Capital and funding method	Target audience	Objective	Redistribution strategy
Vanilla for Change Financing launched in 2014, a project supported by a partnership between an exporter and an importer (Symrise-Unilever)	Symrise, Unilever and GIZ (2014-2017)	Public funds in matching grants (developPPP program - GIZ). Private funding by Unilever and Symrise since 2017.	50,000 people affected Farmers and population in the SAVA region	Improved practices Fight against poverty : • Improved education • Crop diversification for farmers.	Technical objectives: Practical improvements provided by Symrise • Training in sustainable practices and farm management. • Creation of cooperatives. • Food aid during the hungry gap season. Social objectives: Mainly managed by NGOs funded by the program (Save the children, ME to WE): • Financial education: Creation of savings and credit associations. • Improved education: construction of schools and colleges, financing of teachers. • Health insurance.
Livelihoods-vanilla Financing launched in 2017 with a 10-year duration. Project led by NGOs (Fanamaby and the Missouri Botanical Garden)	Livelihood 3F (Danone, Firmenich, Mars, Veolia), FFEM (since 2019)	Public subsidies €800,000 by the FFEM in 2019 (up to €4 million over 5 years) Private funds: €2 million endowed by Livelihood 3F. The fund will be gradually reimbursed via a royalty based on the results of the project for the 4 companies that buy the vanilla and benefit from the project.	3,000 households outside the SAVA region (Soanierana), 3,000 ha of cultivation	Improved practices • Yield control Fight against poverty • Teaching farmers about the transformation • Reduction of food insecurity (promotion of crop diversification). Biodiversity conservation	Technical objectives: • Creation and management of cooperatives. • Training Social objectives: • Payments • Institutional support for COBAs (local communities) and strengthening of governance to reduce land use conflicts.

Project description	Source of funding	Capital and funding method	Target audience	Objective	Redistribution strategy
Revenus pour la Protection de la Nature project Financing launched in 2017, duration 4 years. Project led by NGOs (WWF, Helvetas, OSDRM)	WWF and SDC	**Public subsidies** SDC funding **Funding by donations** Mainly from WWF	23,000 people affected (9 villages in Andapa)	**Improved practices** • Quality improvement **Protection of natural forests** • Commitment of grassroots communities that are signatories of natural resource management transfers **Fight against poverty:** • Improved vanilla revenues. • Reduction of food insecurity (promotion of crop diversification: ginger).	**Technical objectives:** • Creation and management of cooperatives. • Training **Social objectives:** • Financial education: creation of community savings groups (GECs) • Help with forest management: support for COBAs and support for sustainable clearing.
Sustainable Vanilla for People and Nature Financing launched in 2020, with a 3-year duration Project led by an import-export company and an association (McCormick & Cie and NCBA CLUSA)	McCormick & Company and USAID	**Public subsidies** USAID funding. **Capital:** USD $3 million	3,000 farmers in the SAVA region	Improvement and certification of practices.	**Technical objectives:** • Certification assistance. • Support for the creation and structuring of cooperatives
Financial support for vanilla exporters[1]	Ramanandraibe Export, Biovanilla and IFC	**Short term loan:** USD $26 million	6,500 small farmers	Triple the volume of certified vanilla	**Technical objectives:** • Structuring sustainable supply chains • Technical assistance for compliance

[1] *https://www.newsmada.com/2020/12/18/secteur-de-la-vanille-les-societes-dexport-recoivent-des-aides-financieres/*

4.4.5. Funding outlook

Although substantial, the current funding initiatives remain local, affecting groups of 1000 farmers. Creation and expansion of similar initiatives as well as new funding mechanisms can be considered.

Mobilizable funds

To expand the offer of transition to more sustainable practices, other sources of funding could be mobilized. In Table 16 we have listed the existing private funds that may be interested in financing a transition project for sustainable vanilla cultivation.

Table 16. Private funds that can be mobilized to finance a transition project for sustainable vanilla cultivation

Possible funds	Investment area	Possible partnership
Mirova Natural Capital	Sustainable agriculture.	Investment in a project similar to the one managed by Livelihood-Vanilla (Table 15).
Moringa	Sustainable agroforestry.	More targeted investment with the participation of one well-identified company.
12Tree	Sustainable agroforestry.	More targeted investment with the participation of one well-identified company.
Miarakap	Entrepreneurship in general with a strong social impact	More targeted investment with the participation of one well-identified company.

In addition to these private funds, many development agencies have already invested funds in changing practices (such as GIZ, AFD, SDC, USAID) or are already present in Madagascar (for example The World Bank). These public funds can complement and coordinate with the Malagasy State, as The World Bank does for PIC projects (corporate financing with the matching grant mechanism).

Funding expansion

All funding for current changes is local. Since these initiatives are mainly driven by private organizations, there is no exchange of experiences between them.

To expand sustainable vanilla financing from where it is now, 2 mechanisms can be considered:

- a reinforcement of the current mechanisms by the addition of new public and private funds or
- the creation of a unifying initiative to drive systemic change

Strengthening current mechanisms

This may involve procuring funds for the initiatives mentioned in 4.4.2 and 4.4.3 to broaden their scope.

Private funds can be mobilized based on, for example, the prospects for returns on investment presented in 4.3.

Public funds are the most appropriate resource for seeking large-scale change. For this, the **matching grant** mechanism seems very promising for both strengthening existing initiatives and attracting new private capital. Among them, the Malagasy government's PIC 2.2 (Integrated Growth Poles and Corridors) project with World Bank financing provides grants of up to $700,000 in return for private sector investment in agribusiness projects benefiting small farmers. The share provided by the PIC supports investments in the commons and general interest investments (inclusion of cooperatives and small farmers in the supply chain, for example). Mostly present in other regions of Madagascar (Anosy, DIANA, Atsimo Andrefana, Sainte-Marie), today these projects are experiencing good investment incentive results and could be reproduced in SAVA. The government could condition the use of this mechanism on sharing knowledge with other existing initiatives to facilitate scaling up of operations and compensate for the lack of coordination of the many parallel initiatives listed in 4.4.2 and 4.4.3.

4.4.6. CREATING A UNIFYING INITIATIVE

Given the need for systemic change in practices in the vanilla sector, a more global mechanism can be imagined.

This mechanism can take inspiration in the **Renovation and Rehabilitation (R&R)** programs (World Cocoa Foundation, 2016a and b; Root Capital, 2016). These programs finance the rehabilitation of diseased or aging plots in a given agricultural sector by providing financial resources and training. They are generally used in sectors composed mainly of small farmers of crops such as cocoa and coffee because of their risk aversion and limited finances which prevent them from embarking on such projects. These programs are financed through major partnerships between public entities (states, development agencies), private entities (companies in the sector's value chain) and impact foundations. Said partnerships mainly seek to bring together as many private stakeholders as possible in a given sector. They are generally coordinated by the public sector and in particular the local governments which provide a large part of the funds and ensure part of the repayments of the loans granted.

A program piloted by the Malagasy government bringing together the investment banks already present in the vanilla sector (AFD, GIZ, USAID) and the private sector (composed of the many companies already invested today) could thus be established using this model as inspiration. Such an initiative will have to clearly define the axes to target to drive overall change. 3 axes are thus proposed (see Table 17).

As for the scale of financing necessary for such a program, this study estimated the area of vanilla cultivation at around 100,000 ha, including 65,000 ha in SAVA (see 1.3). A transition of these areas under cultivation to sustainable practices by simply financing the costs mentioned in Figure 16 would therefore cost approximately USD 70 million and USD 45 million for the SAVA region. This value is certainly low compared to other overall additional support costs for this sector beyond the 2-year horizon proposed in 4.3.

Box 6. Description of the revolving fund mechanism for farmer self-financing

Revolving funds are a self-financing mechanism for farmers to transition to sustainable practices driven by microfinance organizations (Horus, 2018). These funds consist of loans or repayable advances to beneficiaries (these loans can be in cash or in kind). The repayments of these must allow for the granting of new loans to other beneficiaries. This "revolving" function encourages strong monitoring of loans to maintain the fund. The provision of these funds could thus be accompanied by technical monitoring (guides, for example) allowing farmers to self-train. This use of micro-credits would thus make it possible to familiarize farmers with money management while being able to make financial investments for sustainable practices (labor, certification, etc.).

Table 17. Axes for a unified financing fund for sustainable vanilla cultivation in Madagascar

Axis	Purpose of funding	Sector transformation mechanism
Existing initiatives	Reinforcement of the capacity of existing initiatives: • Funding and training the staff that provides day-to-day monitoring of farmers. • Financing guarantees to farmers to enable the transition (emergency aid, health insurance, etc.)	Enable scaling up of existing initiatives by providing all participants with means for achieving certain aspects of the project (compensation or service costs). The objective is to allow exporters to source the majority of their vanilla from producers who are partners to these initiatives. This funding could also stimulate knowledge sharing between said initiatives.
Phytophthora and fusarium wilt epidemics	Donations of healthy plant material to farmers in exchange for monitoring and training for sustainably managing it.	Implement a **renovation and rehabilitation (R&R) mechanism**: this means taking advantage of the increasingly widespread contamination of vanilla plants to offer healthy plant material, grown in nurseries financed by the fund (material resistant to fusarium wilt is being analyzed by CIRAD on Reunion Island). The recovery of this material by farmers, who are impeded by diseases in their fields, would provide them with training in sustainable practices.
Beneficial aid to voluntary farmers	Offer training and loans to farmers. The revolving fund model could be used (see Box 6) Loans could be partly guaranteed by the transition financing fund to lighten the burden on farmers, just as was done in the R&R project in the Colombian coffee sector (from 2009 to 2014: Root Capital, 2016).	Scaling up practices in a "spillover" model: the early-adopter interested farmers demonstrate the effectiveness of their practices and attract new farmers.

4.5. *Certifying sustainable vanilla*

4.5.1. Analysis of current certifications

We can analyze 4 certification standards used for vanilla today (BIO, Equitable, RFA, UEBT). In Table 18, we measured the compatibility of existing standards with best practices for the cultivation of sustainable vanilla.

Table 18. Differences between selected standards and the recommendations of the guide

		Labels BIO	Fairtrade - Fair for life	Rainforest Alliance	UEBT
Environmental and agricultural criteria					
Sustainable implementation of the plot	Choice of cultivation site	3	1	3	3
	Field management before cultivation	3	0	2	2
	Choice, preparation and planting of companion plants	3	0	3	3
	Propagation and planting of vanilla	3	1	1	1
	Absence of *tavy* in cultivation practices	1	1	3	1
	Subtotal	**13/15**	**3/15**	**12/15**	**10/15**
Sustainable use of the plot	Better management and improved site efficiency	1	0	1	0
	Induction, flowering, pollination	0	0	0	0
	Mitigating the effects of climate change.	2	0	0	2
	Protection of water and natural resources	0	1	1	1
	Protection of flora, fauna and nature reserves	0	1	3	3
	Reduction of pollution	3	1	1	1
	Optimization and reduction of the use of inputs	3	1	1	1
	Increase in yield and quality	1	0	2	0
	Need for record keeping and documentation	3	3	3	3
	Subtotal	**13/27**	**7/27**	**12/27**	**11/27**
Social criteria					
	Working conditions	0	3	2	2
	Improved means of subsistence	2	3	0	0
	Empowerment of farmers and agricultural workers	0	3	0	0
	Hygiene, safety and dignity in the workplace	0	2	2	2
	No child labor, forced labor or discrimination	0	3	3	3
	Subtotal	**2/15**	**15/15**	**7/15**	**7/15**
Economic criteria					
	Cost reduction	0	0	2	0
	Price stability	1	3	1	1
	Certification premium	0	3	0	2
	Contract stability	1	3	2	2
	Subtotal	**2/12**	**9/12**	**5/12**	**5/12**

We can observe that these different certifications provide little incentive to apply the best operating practices recommended by this guide. Additionally, they are still a means by which a farmer adopting sustainable practices can receive a certification bonus (4.3.4).

For this certification to benefit a large number of farmers, action is needed to encourage an increase in demand. This requires an investment by all stakeholders to conduct lobbying with buyers to promote interest in certified vanilla, all the while relying on the growing interest of importing countries for “zero imported deforestation” commodities.

4.5.2. The opportunity for specifications specific to Madagascar

For vanilla, the myriad certifications that exist today are thus limited. They appear too general as they stem from international frameworks that do not address the challenges of the vanilla sector in Madagascar detailed in this guide.

Indeed, most of the practical points necessary for a sustainable vanilla farm that optimizes quality without the spread of disease are not considered in these labels (Table 18). Also, with these general labels, it is exceedingly difficult to address the specific risks hindering a sustainable conversion of the sector (listed in 4.4.1) and thus to address the more general issues of poverty, deforestation and loss of natural capital in SAVA.

By reviewing and reporting on agricultural activities and approaches, this document constitutes a complete analysis of this sector. The technical reorientation of the sector in response to the economic and agricultural conditions of the region can significantly impact the income of the local population and its resilience to the impacts of global warming.

Due to the specific nature of the sector, it is recommended that all the stakeholders in Madagascar rigorously create their own vision of it by publishing ambitious and specific long-term specifications to be implemented via a consciously and concertedly planned strategy that involves end users and possibly private and institutional donors. This would be the best sign of commitment from the state to foreign stakeholders all the while relying on a specific and therefore non-competitive domestic label made possible by the influence Madagascar enjoys today. The usual "customers" of this product would be forced to work in line with the country's requirements and not on gaining a meaningless certification that generates no positive impact. Is a link to current environmental dynamics, namely the approval of the "territories with organic agricultural vocation" law possible or would alliances with other initiatives be undertaken?

The state could manage all future actions associated with this and thereby send a strong, positive signal that is demanding for foreign stakeholders.

- Establishment of technical and environmental specifications for the sector at the federal level based on the document
- Expansion to other producing areas during the global program
- Drafting of a framework before establishing specifications
- Establishment of specific specifications for the environmental impact of cultivated vanilla by providing parameters and control points.
- Drafting of the MRV reference framework
- Implementation of guidelines and objectives for preparing trainers associated with farmers and stakeholders in the sector
- Drafting of documents and educational materials intended for trainers and stakeholders in the sector
- Designing a training course leading to a diploma that is adapted to all stakeholders in the sector
- Establish protocols, tools and operational and documentary means of control that include all domestic and foreign stakeholders in the sector, similar to the most proactive certifications.

5. GENERAL CONCLUSION

The vanilla price variations experienced in the 21st century have had financial consequences that have been both terribly negative for farmers when demand drops, but also positive in light of recent seasons. The fall in prices in the early 2000s led to a reduction in volumes in several vanilla producing countries, except Madagascar.

Madagascar initially maintained cultivation at pre-crisis levels. The price increase apart from 2013 has consolidated cultivation capacity, positioning the country as the long-term market leader. Demand from manufacturers has been forced to adapt to expensive products despite their lower quality, especially during the 2015-2017 seasons. This lack of quality of a significant portion of Malagasy vanilla coupled with high prices and harmful environmental practices are all threats to the future of the sector in the SAVA region. Nobody knows for the moment what consequences the significant drop in prices starting in 2020 could have in Madagascar.

The change in vanilla cultivation techniques in this new situation should therefore make it possible to generate more income through sustainably increased yields and better-quality management.

In this study, with the help of various stakeholders (researchers, technical service providers, the private sector, NGOs), we were able to demonstrate that it is very possible to produce sustainable vanilla which would be both profitable for the small farmers and respectful of the natural capital of the region. However, the consultations also revealed that only a comprehensive approach will support the transition to these sustainable practices. The private sector in particular made the working group aware of the limits of demand for certified vanilla. Demand for conventional vanilla remains strong. In this context, it is perfectly legitimate to consider public sector participation or national projects to manage certain difficult tasks such as mapping vanilla plantations nationally or drafting a vanilla plantation registry. Despite not being a part of the certification process, this pre-certification traceability is extremely expensive for the private sector and for cooperatives in the sustainability process. However, this is one of the best ways to manage the risk of deforestation or damage to habitats.

In this study, we also attempted to quantify the cost of the transition of vanilla cultivation to sustainable practices in the SAVA region as well as a possible cost-sharing scheme between the public sector and other sectors (private sector and development operators). Thus, to make the current area of land under vanilla cultivation (65,000 ha) sustainable and to assure that any new vanilla cultivation (estimated at 3% per year) is implemented solely on non-forested plots (approximately 19,000 ha for the next 10 years) would require an investment of USD 137 million. Public authorities would provide USD 82 million to finance:

- 100% of the plant material needed to ensure quality;
- 100% of external costs aimed at full traceability (different from certification linked to labels). In fact, geolocation of plots and development of documentation constitute the highest costs when it comes to traceability, a fundamental element to assess and confirm the zero-deforestation performance of the vanilla sector. The sector can hardly meet this cost without confirmed demand for certified vanilla.
- 50% compensation for loss of earnings;
- 50% of labor costs (useful for incentivizing the implementation of CS3)

In Table 19, we try to summarize the possible actions for different sector stakeholders.

Table 19. Possible actions of sector stakeholders to enable the transition to sustainable vanilla

Stakeholder	Component	Action
Research and technical centers	Research objectives	Pursue research on sustainable vanilla-based cultivation systems Our study remains theoretical in some respects because today there is truly little hindsight concerning the proposed cultivation systems. A sample of plots located in the different agro-ecological areas (coastal zone, intermediate zone, mountainous zone, northern and southern Madagascar) should be monitored long-term. This monitoring would study both the technical, economic and environmental variables and even the quality of the vanilla resulting from these practices in the above areas.
Technical services NGO	Technical objectives	Develop a farmer training program based on the elements of the guide and sustainable practices. Train farmers in: • best practices such as plot choice and regulations on the clearing and cleaning of plots, • the introduction of additional forest species in vanilla plots to increase biodiversity (encourage nurseries and tree planting) • monitoring and eradication of invasive species in plots • identification of habitats worth preserving • exchange visits to farms carrying out agricultural innovations (agro-forestry with the promotion of native species) or protecting intact landscapes in said farms
Government Donors	Financing objectives	Pursue the development of PPPs in cultivation areas. • In Madagascar, several funds have successfully experimented with matching grants in different sectors and an earmarking of public funds to small private sector farmers. However, the number of vanilla farmers involved in such initiatives remains too low.
	Traceability goals	Continue mapping the vanilla cultivation area • Acquire better knowledge of the location of plantations in order to identify the risks and potential negative impacts associated with vanilla supply chains. • Set up and regularly update a map superimposing vanilla cultivation areas and protected areas. This will make it possible to monitor farms located near protected forests more closely. • Set up a registry of farms describing cultivation systems adopted (CS1, CS2, CS3). This is a less urgent priority.

GLOSSARY

Adulteration: Falsifying a product. This can happen with vanilla beans, whose origin can be falsified with a consequent loss of quality. For example, vacuum packing before stabilizing the vanilla beans, etc.

Sustainable agriculture (environmental dictionary): The application of the principles of sustainable development to agriculture. It therefore deals with ensuring the cultivation of food, wood and fibers while respecting the ecological, economic and social limits, ensuring the sustainability of this cultivation over time. This does not affect the integrity of people and living things. Sustainable agriculture limits the use of pesticides that can harm the health of farmers and consumers while aiming to protect biodiversity.

Axil: Acute angle formed by an axis with a leaf's petiole. (Here the roots, apical buds and floral buds sprout.)

Biotope: A geographically delimited living environment in which the ecological conditions (temperature, humidity, etc.) are homogeneous, well defined and sufficient for the development of living beings residing there (called biocenosis), and with which they form an ecosystem. A mangrove forest, a pond, a dune, a hedge and a beach are all biotopes.

Apical bud: Found at the end of the stems and which ensures the lengthening of said stems

Flower bud: Outgrowth giving rise to flowers or inflorescences

Main branch: Trunk bifurcations selected and used as support

Eucalyptol: Natural terpene organic compound of plants which can be toxic to the root systems of other plants

Compost: Compost is produced through a biological process of converting and upgrading organic matter into a stabilized, hygienic and soil-like product which is rich in humus and minerals useful to plants.

Crop management: Successive actions during a crop's cultivation cycles aimed at improving and optimizing its development and agricultural cultivation

Cut: A piece of a vanilla bean that is accidentally broken or intentionally cut in order to remove damaged or moldy parts.

Dehiscence: The organ of a plant which opens spontaneously to give way to some content.

Thinning: Reducing the number of trees by harvesting excess saplings to modify the climate parameters.

Suckering: Removing buds or shoots from a main stem for the purpose of agricultural optimization

Internode: Part of a plant axis (stem, branch, etc.) located between two nodes

Forest species: This usually designates a species of tree, or a subspecies or variety which is of interest in forestry and which has biological requirements or associated particular uses in agriculture, for example

Topping: Cutting the end or top of a plant in order to encourage growth in another part

Ferralitic soil: So-called "red" soil mainly composed of ferric and aluminum oxides without different soil horizons and which is not very fertile

Humus: Upper layer of soil created and maintained by the decomposition of organic matter, essentially by the combined action of animals, bacteria and soil fungi which are very fertile and particularly abundant in forest areas

Hygrometry: Measurement of the humidity of the atmosphere in a particular location and at a given temperature

Flower induction: Preliminary and fundamental stage before flowering which depends on different plant-specific parameters that enable it. It can sometimes also be influenced by certain agricultural practices.

Erosion control: Set of strategies using different techniques to limit erosion or improve the erosion situation locally or generally with a specific purpose in mind

Mulch: Ground straw cover intended to preserve and improve humidity and soil retention and possibly conserve elements useful to a plant or crop

Phytotoxic: A substance whose presence or effects have toxic effects on other living organisms, either plants or animals

Soil profile: Characteristic sequence of the different layers of a vertical cross-section of soil from its surface to a determined depth

Prophylaxis: Active or passive process aimed at preventing the spread of diseases

Holdfast root: Aerial root of a climbing plant used to cling and having little or no nutritional role

Regrowth: Spontaneous woody vegetation colonizing a formerly cultivated space.

Resilience (ecology): Ability of a specific environment or living system (ecosystem, etc.) to regain its original or reference nature via its original structures and functions following a disturbance

Renewable resources: Natural resources that can be renewed or regenerated within at least human life cycle or within the life cycle of a cultivation, for example.

Drying: Activity intended to dry to a certain point

Senescence: Natural process of biological aging resulting in an irreversible cessation of the cell cycle resulting in the death of tissues. This is useful in promoting the spread or protection of living organisms.

Black or brown soils: Soils developed with a surface horizon particularly rich in organic matter

Undergrowth: Area comprising organisms that live between the soil and the canopy in a forest.

Stolon: Creeping aerial stem that takes root producing adventitious roots

Water stress: Periods during which demand exceeds the quantity of water available. It can be sudden or regulated for agricultural purposes

Substrate: Support or element in which a plant attaches itself and draws the nutrients it needs. Soil in a field is a type of substrate

Texture: *Texture* refers to the distribution of minerals in *soil* according to their characteristics and quantity

UMO: Labor unit

Green vanilla: vanilla beans after harvest but before preparation

Processed vanilla: Processed vanilla comes in the form of shiny brown sticks obtained by scalding and drying green vanilla beans. The yield is 15-20%, i.e. it takes around 6 kg of green vanilla to produce 1 kg of processed vanilla.

Red vanilla: lower quality vanilla bean after preparation

Black vanilla: premium quality vanilla bean after preparation

Bulk vanilla: Commercialized processed vanilla

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ANNEXES

Annex 1. Interviews conducted

Stakeholder category	Organization	Contact	Role	Location	Interview type
Research objectives		Eric Marinot	Consultant	Tamatave	Face-to-face interview
		Fleuron Nany	Retired vanilla specialist (Ex-director of FOFIFA-East)	Tamatave	Face-to-face interview
	Diversity Turn	Dominic Martin	Ex-PhD student		Visio
NGO	Nitidæ-Agrisud, TALAKY project	Jessica Fournier	Technical and agricultural assistant	Tolagnaro	Visio
	Helvetas	Julia Randimbisoa Rija Razakamampionona	Country representative and technical advisor	Antananarivo	Visio
Private group	Madagascar vanilla exporters	Georges Geeraerts	Chairman of GEVM, CEO of Sopral	Tamatave	Face-to-face interview
Private enterprise	SAHANALA	Serge Rajaobelina	President	Antananarivo	Face-to-face interview
	SYMRISE	Mimie Ravaroson	Communication & partnership	Sambava Antananarivo	Face-to-face interview
	SYMRISE	Alain Bourdon	Director	Antananarivo	Face-to-face interview
	Agri Resources Madagascar SA	Hadrien Charvet	Farm director	Antalaha	Face-to-face interview
Public sector	National Vanilla Council	Sylvain Velomora	Technical assistant	Antananarivo	Face-to-face interview
	OSDRM	Christiane Randrianarisoa	Independant consultant	Antananarivo	Phone interview
	MAEP (DFAPP)	Andriamahefa Rakotondrazaka (and Ms. Manjaka, department head - HayTao collaboration)	Director of agricultural training and of farmer/fishermen training and professional skills	Antananarivo	Visio
	Integrated Growth Poles Project	Haingo Razafimbelo	Head of the agribusiness component	Antananarivo	Visio

Annex 2. Attempt to analyze the impact of the COVID-19 pandemic on the sector

To better understand the impacts of COVID-19 on the vanilla sector, it is necessary to take into account the entire ecosystem of this complex sector. Indeed, in the SAVA region, vanilla cultivation represents more than 50% of the agricultural income of farming households, ahead of rice (which represents a third of agricultural income), coffee and beans. It also represents 80% of household cash income (rice and beans are mostly used for food self-sufficiency).

No specific study on the impacts of COVID-19 on the vanilla sector in particular has been published. The studies published to date[1] deal with the socio-economic impacts on the country in general, with vanilla being mentioned as a sector that was relatively spared like the other agricultural sectors. Since the other income-generating sectors such as tourism, textiles, fishing or mining have been strongly impacted by COVID-19, vanilla has occupied a prominent place in the country's balance of trade. Nevertheless, all the studies and interviews carried out report on difficulty and a slowdown in exports due to the period of confinement and the restrictions placed on movement between the different regions, in particular towards the port of Toamasina which is the point of departure for the majority of the country's exports. Finally, the limitation of the number of employees that can be present in the administrative offices slowed down the processing of files and the export procedures.

In terms of job impact, the vanilla sector did not suffer any layoffs due to the cessation of activities. Indeed, after the declaration of the first COVID-19 cases in the country, the start of confinement coincided with the last months of exports which took place from late March to late May 2020, thus having had no effect on orders already signed. Also, despite the fear of stakeholders, world demand has not fallen due to the pandemic. On the contrary, the customs exports statistics from March to June 2020 are significantly higher than the year of before during the same period[2].

Another effect contributing to the stabilization of demand is the excitement of a new vanilla bean market in the USA. Although the American market is more oriented towards extraction, the long periods of confinement have changed the habits of families who have started to use more natural ingredients since they have had more time to cook at home and have become more aware of their health. An increase in sales of vanilla beans in large retailers in Europe has also been observed, thus making it possible to compensate for the losses caused by the closure of hotels, cafes and restaurants, even if this is a localized phenomenon. As a result, like other sectors that deal with natural products such as spices and essential oils, farmers in the vanilla sector have not felt the market impact of COVID-19.

Serious concern was nevertheless felt among farmers before the start of the 2020/2021 season, due in part to the setting of an FOB price floor at the start of 2020. Indeed, a price floor associated with the impact of COVID-19 that was considered too high compared to what the market could bear raised uncertainties as to the position of importers who initially predicted a drop in prices for the 2020/2021 season[3]. Procurement contracts as well as the financing of advances on seasonal yield were thus delayed with repercussions for the entire supply chain, including the various intermediaries such as collectors who could not be bullish in all green vanilla markets. As a spillover effect, the price of green vanilla fell by more than 50% compared to the previous season. Also, it was feared that villages in remote areas could not organize markets stretched to the limit by the pandemic. The slowdown in the spread of COVID-19 as well as awareness of compliance with protective measures have allowed the green vanilla markets to run smoothly. In addition, international organizations and exporters have rallied to provide the villages with masks, buckets and soap in order to enforce protective measures at the markets.

Since the price of green vanilla has been far below farmers' expectations, they hypothesize COVID-19 as the source of this market phenomenon. Farmers interviewed said they hoped the situation would improve once the pandemic was over. In order to compensate for the fall in prices and to mitigate its effects on their standard of living, many farmers have decided to keep their green vanilla to prepare it themselves in

[1] INSTAT "Impacts of COVID-19 on household living conditions", Swiss Confederation "Economic Report Madagascar 2020"

[2] 455 MT in 2019, 573 MT in 2020 for the period from March to June

[3] Source MINTEC global analysis https://www.mintecglobal.com

order to resell at a higher price at bulk markets. However, bulk prices remained relatively low compared to farmers' expectations.

Despite the fact that the SAVA region has not been greatly affected by the pandemic, more than 50% of adult respondents in rural areas say they have felt the health effects of COVID-19. However, the impact is mainly on the smooth conduction of activities. For example, it is impossible to freely venture to the crop fields or sell crops (other than vanilla) during periods of confinement. Products intended for household consumption, such as bananas and other fruits could not be harvested and rotted. The collectors of cash crops such as coffee, cloves and pepper were unable to reach all the villages, thus provoking a drop in the prices of these products in the market since the farmers were forced to sell at low prices. These parameters have increased the cost of living, especially the prices of basic necessities such as rice, oil and sugar, due to the isolation of the SAVA region from large cities, on one hand, and the speculation of certain unscrupulous distributors who took advantage of the situation. Livestock farmers say they have been the most impacted, as people no longer prioritize meat when buying food.

COVID-19 has also impacted the social stability of families. Following school closures, parents have been forced to manage the time of school-age children and adolescents. Often, parents preferred to take their children to the crop fields since the youngest are not independent enough to prepare their meals and take care of themselves. Parents also report concern about the behavior of teenagers which has been affected by the long months of inactivity. Juvenile delinquency, alcohol abuse and teenage pregnancies are among the reported incidents that have contributed to parents’ concerns, thus making them reluctant to leave their children alone in the villages without supervision.

In conclusion, the impacts of COVID-19 on the vanilla sector are less compared to those on other sectors such as tourism, mining or textiles. The socio-economic impacts felt, i.e. the increase in the cost of living and the reduction in purchasing power, are the same as in the rest of the country since Madagascar is highly dependent on imported products. Studies show that confined urban areas have been much more impacted in their living conditions than remote rural areas. In rural areas the primary impact has been on the social stability of families since parents do not have the means to occupy their children during the long days spent working in the fields.

In addition, the behavior of the vanilla market strongly linked to supply and demand and the impact of the FOB price floor were interpreted by the farmers as an impact of the pandemic. Thus, farmers who saw a sharp drop in their income over the previous season are betting heavily on the 2021/2022 season scheduled to start in May in the DIANA region. They expect prices to increase, and therefore social pressure for an early opening could occur. If this scenario comes to pass, this could coincide with a second wave of COVID-19 that becomes more widespread in the largest vanilla-producing region, and if all this occurs while an artificial FOB price is maintained, there will be an impact on the quality of the next harvest due to the immaturity of the beans, which could lead to the collapse of the market and thus become one of the most negative impacts of COVID-19 on the sector.

Annex 3. Risks of biodiversity loss in northeastern Madagascar

HIGH DENSITY OF PROTECTED AREAS IN NORTHEASTERN MADAGASCAR

Northeastern Madagascar is covered with many protected areas. The importance of Madagascar's biodiversity is widely recognized globally. The diversity and endemicity are superior to many other ecosystems, especially at higher taxonomic levels (family and genus). Considering only vascular plants and vertebrates, the country is home to 23 endemic families and more than 470 endemic genera, including a quarter of all primate species in the world.

Before 2003, the biological inventories carried out showed that a significant proportion of endemic species were not protected in reserves. Thus, in September 2003, the Government of Madagascar launched an ambitious program aimed at tripling the area of its network of protected areas from 1.7 to 6 million ha, covering at least 10% of the national territory, in accordance with IUCN recommendations. With respect to northeast Madagascar (the subject of this study), preserving biodiversity and the ecological functions of forests meant decrees for the creation of the following new protected areas in 2015:

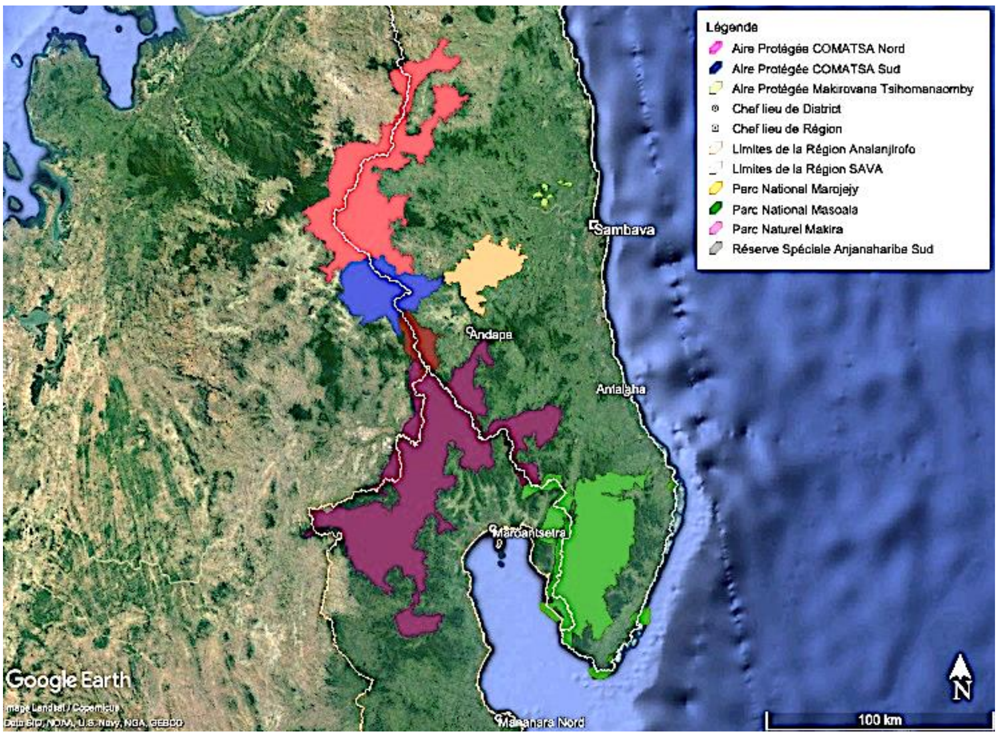
- COMATSA North (IUCN category IV), managed by WWF – 238,177 ha;
- COMATSA North (IUCN category IV), managed by WWF – 82,234 ha;
- Makira Natural Park (IUCN Category II), managed by WCS – 372,179 ha;
- Makirovana Tsihomanaomby (IUCN category IV), managed by MBG – 3,386 ha.

Three protected areas under the management of Madagascar National Parks existed in the area before 2003:

- Masoala National Park (IUCN Category II), created in 1997 - 222,070 ha;
- Marojejy National Park (IUCN Category II), created in 1998 - 55,560 ha;
- Anjanaharibe Special Reserve (IUCN Category IV) created in 1958 - 26,908 ha.

In summary, we can say that the largest vanilla-producing region is also a region with a high density of protected areas (Figure 23).

Figure 23. Protected areas in the vanilla cultivation area (Source: SAPM, February 2017 / Kinomé 2020)

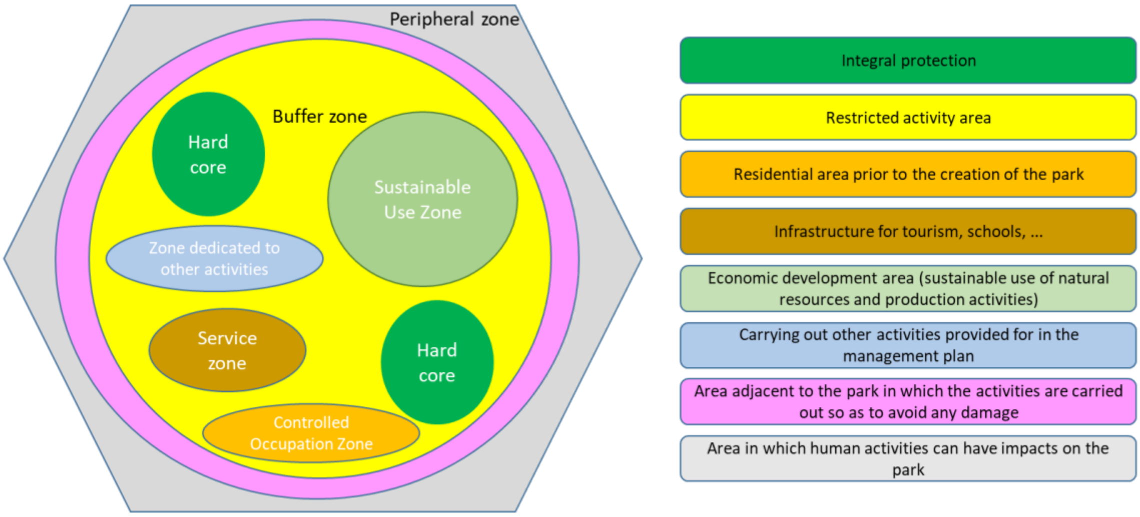


The ecosystems of the area are composed of dense low and medium altitude moist forests. They are part of the "dense moist forests" ecoregion. A few remains of natural forests that are not integrated into protected areas are observed in the area concerned. Outside these protected areas and residual forests, habitats modified following past natural forest clearing for the establishment of rainfed rice cultivation are visible as secondary forests (*savoka*) and grassy and/or tree meadows.

Protected areas in the northeast provide a wide range of ecosystem products and services to the people living around them: irrigation for perimeter cultivation, water purification, climate regulation, pollination as well as recreation and tourism. The importance of protected areas lies primarily in the multitude of micro-habitats and an extremely rich biodiversity with exceptional fauna and flora associated with high local endemicity and the presence of many rare and threatened species. Makira Natural Park is home to the largest tract of low and medium altitude dense humid forests still intact on the big island of Madagascar.

Agriculture is tolerated in certain areas of certain protected areas under certain conditions. Each protected area management plan includes zoning and each area has specific objectives. For category V (protected landscapes) protected areas, agriculture is authorized in the sustainable use area, but prohibited in all other categories of protected areas (Figure 24).

Figure 24. Diagram of the organization of a Category V protected area (source: Kinomé, Gret and ECR, 2016)



The main threats to biodiversity and habitats are clearings for rice cultivation, forest fires, illegal logging, illegal squatting, mining, wandering livestock and the hunting of lemurs. The forests of the northeast have been the main targets of illegal logging for years, reaching a peak during the crisis of 2009-2014.

Current risks and opportunities. All the studies carried out in Madagascar show that there is a close relationship between environmental degradation and poverty. At least 50% of the income of the Malagasy economy comes directly from natural resources and 90% of jobs are in sectors directly dependent on natural resources.

Most of the rural communities around the protected areas of the region live on agriculture and livestock. They are heavily dependent on access to natural resources and ecological services provided by protected areas. Protected areas also contribute to water regulation in agricultural fields. The household economy is mainly based on subsistence farming, especially irrigated or slash and burn rice cultivation. Annual rice cultivation is mostly insufficient for self-consumption and must be combined with cash crops such as vanilla, cloves or coffee. Vanilla cultivation in particular is a significant source of income.

Over the past ten years, managers of protected areas have quickly realized that a new paradigm is required for the successful management of these spaces. Without a doubt, the harmonization of local development goals and effective biodiversity conservation presents a significant challenge that a majority of stakeholders are willing to address. As protected areas have the dual role of conserving biodiversity and promoting economic development, there is a growing perception that they are a means of breaking the persistent link between rural poverty and subsistence agriculture. Subsistence results in the conversion of natural habitats when searching for land or other resources, thus causing continuous loss or degradation. The transfer of responsibility for the management of natural resources has already encouraged communities to conserve and use these resources wisely, but it is now considered the right moment to promote innovative approaches that will stimulate more entrepreneurial-oriented activities, fostering rural economic growth as a way to break the cycle of poverty/subsistence.

National policy requires that protected areas should contribute to poverty reduction and sustainable development. The desire to create protected areas to help the poor meant that new categories of protected areas in which local people took responsibility for managing their own natural resources were needed. Current management arrangements for protected areas facilitate direct management by local communities and the private sector. These also more fully integrate development while conserving biodiversity.

To this end, a connection between managers of protected areas with the private sector is emerging in order to ensure an improvement in the living conditions of local communities which are dependent on natural resources and the sustainability of management. Various experiments already exist:

- The partnership between the NGO Fanamby and the company Sahanala
- The "Income for Nature" project involving the WWF, Helvetas and vanilla buyers
- The MIKAJY project (USAID)

More generally, the environment is one of the intersectional issues that is increasingly taken into account in the formulation, implementation and monitoring and evaluation of projects and programs.

BIODIVERSITY AND PROTECTED AREA REGULATIONS TO CONSIDER IN VANILLA AREAS

As we have seen, the vanilla cultivation area is close to many other protected areas under different IUCN categories. Category 5, protected landscapes, is a bit special because it concerns a mosaic of agricultural lands existing before the creation of the protected area and hotbeds of biodiversity protected at the time of creation. Northeast Madagascar also includes areas of transfer of natural resource management to local communities (COBA). These transfers are in keeping with a strategy of increasing community participation in the preservation of the environment and environmentally-conscious development. Finally, there are still intact forest areas that are neither classified as protected areas nor integrated into TGRNs.

In the table below, we present the different texts that govern these three types of land.

Finally, it can be assumed that a large majority of vanilla plantations are located in rural land where farmers are authorized to grow vanilla on their private property and “untitled private property”. Regarding this, it should be noted that framework law No. 2005-019 dated October 17, 2005, on the status of land led to:

(i) Establishing the legal basis of untitled private property (Law No. 2006-031),
(ii) Establishing the legal basis of the public domain (Law No. 2008-013),
(iii) Defining the scope of the services in management areas of private property belonging to the state, decentralized communities and legal persons under public law (Law No. 2008-014)

Thanks to these texts, farmers who have been has been developing untitled ancestral land for several years can in theory easily obtain a certificate and then a deed.

Table 20. The legal texts that govern land and their implications for vanilla cultivation

Scope	Reference texts	Provisions and implications for agriculture (including vanilla)
Protected areas	Articles 52 and 53 of Law No. 2015-005 dated February 26, 2015, on the code of protected areas (COAP). The implementing decree was signed on May 30, 2017.	Each development and management plan (PAG) for a protected area must include complete zoning indicating: • The core protected area in one or more blocks • The buffer zone and its potential subdivisions which are: ▪ the controlled occupation zone (ZOC) which designates an area inhabited by populations located inside the protected area since before its creation ▪ the service zone (ZS) which is a space intended for the establishment of tourist, educational or functional infrastructures. ▪ the sustainable use zone (ZUD) which is an area of economic development where the use of resources and cultivation activities are regulated and controlled. This is a type of category 5 protected area (landscape) **Agriculture (and therefore vanilla) is therefore permitted in the ZUD (sustainable use zone) and in the ZP (peripheral zone)** (Figure 24) A protected area can be surrounded by a protection zone and a peripheral zone: • The protection zone is the zone adjacent to the protected area in which agricultural, pastoral and fishing activities or other types of activities are carried out in such a way as to avoid causing irreparable damage to the protected area. • The peripheral zone is the zone contiguous to the protection zone in which human activities are still likely to have direct effects on the protected zone. Economic activities compatible with the management objectives of the protected area and which are prohibited in other categories, such as agricultural or pastoral activities, collection or processing activities and tourism, a**re encouraged in the peripheral zone of category 5 protected areas.**
TGRN Natural resource management transfers	Law No. 96-025 dated September 30, 1996, relating to the local management of renewable natural resources, (Gelose); • Decree No. 2000-027 relating to local communities (COBA) in charge of the local management of renewable natural resources; • Decree No. 2001-122 establishing the conditions for the implementation of forest management	Many protected areas are surrounded by TGRN areas. These areas are managed by local communities (COBA) who sign a contract with the Ministry of the Environment. The COBA must generate a management plan and zoning that specifies where they can and cannot farm. Communities are allowed to practice agriculture (including vanilla or fallow rice cultivation. It is up to the local representative of the Ministry of the Environment ("Chef de cantonnement") to assess whether a given plot is fallow land or primary forest and give his or her approval if it is indeed recent fallow land. **Vanilla cultivation is allowed in areas identified as wasteland (savoka) or agricultural land by the authorities.**
Forest land	Law No. 97-017 dated August 8, 1997, revising forestry legislation and its implementing texts. A draft revision of the forest law is being prepared (FAO funding).	Forest land is made up of: ▪ Protected forest areas; ▪ Scheduled forests; ▪ State forests; ▪ Forest reserves; ▪ Reforestation reserves; ▪ Reforestation areas; ▪ Soil restoration perimeters; ▪ Forest stations; ▪ Sustainable forest management sites or ("koloala"); ▪ Hunting reserves; ▪ Sites where the public forest service is delegated to local populations. Agriculture is not authorized and the clearing of forest land cannot be considered an occupation per law 2005-019. Farmers will not be able to claim such cleared land as untitled private property.

Annex 4. Review of some sustainable vanilla projects in Madagascar

THE "INCOME FOR NATURE" (RPN) PROGRAM

The "Income for Nature" (RPN) program aims for improved management of natural resources and the climate change resilience of communities in the northern highlands through the active involvement of local communities (COBA) in sustainably managing the conservation of their ecosystems.

The RPN project is implemented by WWF, Helvetas and OSDRM. There is a WWF lead for a period of *(sic)* in Andapa district (using a research-action approach with involvement in 3 difficult to access areas). The distribution of areas of involvement between the 3 institutions is as follows:

- WWF reinforces the ability of local communities (COBA) involved to manage natural resources and improves part of said management
- Helvetas works to improve value chains (vanilla, ginger, coffee), particularly between farmer organizations and market stakeholders, implement a robust traceability system for obtaining certification (UEBT, Fairtrade, etc.) and support the municipalities for better recovery of local taxes ("rebates") on the supported sectors
- OSDRM disseminates improved agricultural practices with the aim of improving community resilience in the event of a drop in vanilla prices and access to a balanced diet (including sufficient protein intake). OSDRM also supports the establishment of community savings groups as well as individual household training in budget/savings management (the objective is to limit flower contracts which maintain vanilla farmers in great economic precariousness)

Highlights :

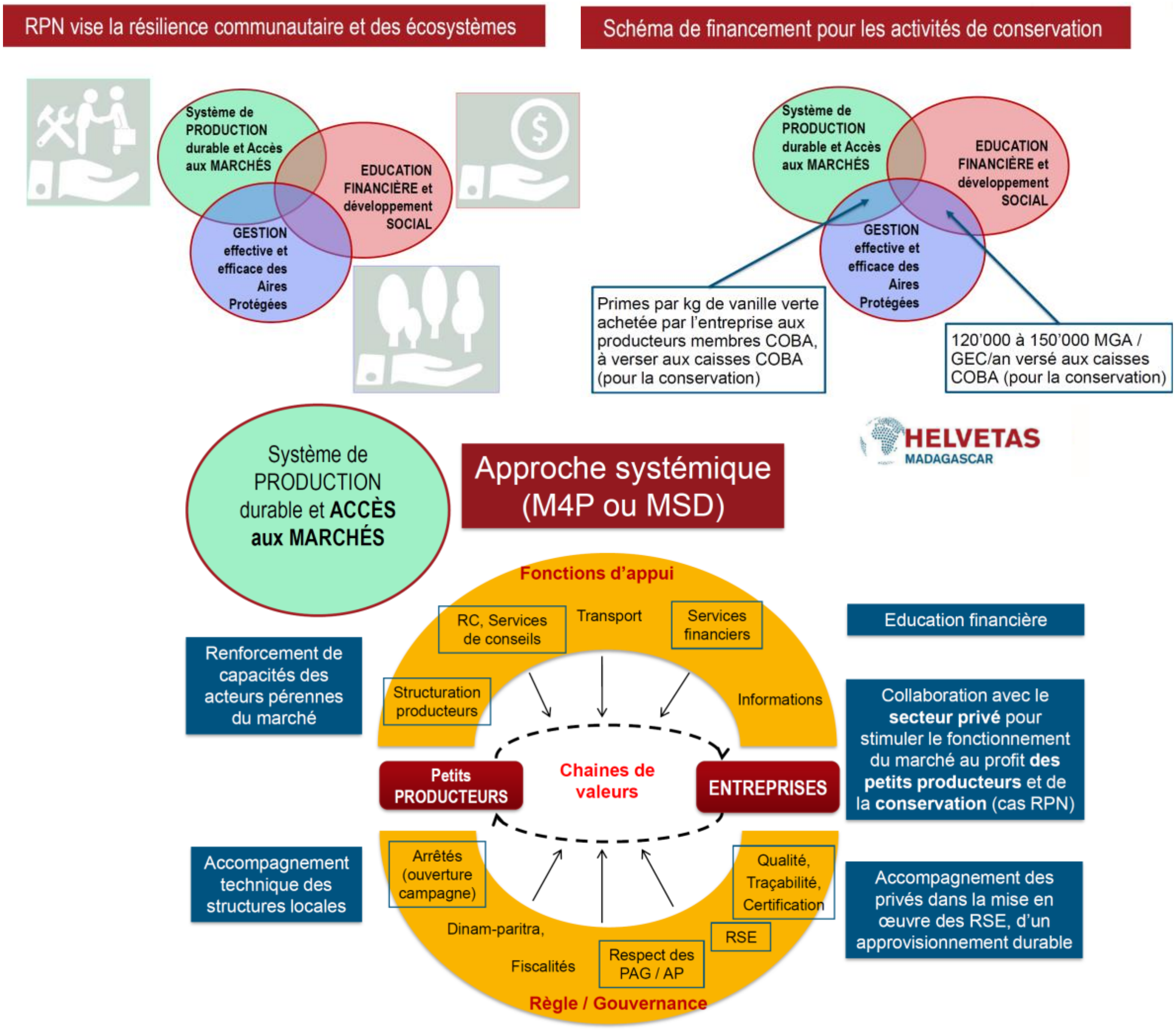
COBAs are financially reinforced through different mechanisms: vanilla buyers pay a premium (per kg of green vanilla). Each CSG contributes to financing the reforestation carried out by the COBAs (at the rate of 100 MGA/CSG member/week). Certain municipalities (1 out of 3 so far) finance the COBA's reforestation actions (thanks to additional refunds collected on vanilla). For informational purposes, operational needs of COBAs have been estimated at 10-12 million MGA/year. One of the COBAs supported succeeded in meeting this budget thanks to the various mechanisms put in place. Others have partially achieved this goal.

- COBAs are strengthening in their notoriety/legitimacy as most vanilla farmers are COBA members. Most CSG members are COBA members as well
- The COBAs are strengthened in their efficiency and transparent management because the contributing CSGs and the municipality financially monitor the proper use of the funds.
- Vanilla sector: strong collaboration between the supporting NGO (Helvetas), the buyer (Symrise and RAMEX): sharing of tasks and costs
- Vanilla sector: a contract is established between buyers and each farmer. Purchase price = market price + certification premium + COBA premium. In addition, Symrise covers 80% of farmers' medical expenses, pays the salaries of the FRAM teachers, etc.

The traceability system is very efficient (census of farmers and plots including GPS coordinates, photos of the plots), with specifications linked to extremely strict certifications. The main aspects analyzed were the complete lack of exposure to chemicals, respect for the environment (no clearing) and respect for human rights (no child labor). Some certifications even require every farmer to have a "standard" toilet. In the event of a violation, the farmers have a period of time to comply with the standards or are directly excluded (depending on the seriousness of the incident). There are two levels of control: village controllers and a Symrise organizer. The expected cultivation is evaluated for each plot. If a farmer delivers less than 70% of the estimated quantity without providing solid justification (fokontany chief support or village controller) he or she will not benefit from the social advantages offered by Symrise.

CSG: these are 15-25 people grouping together by similarity (people choose their own groups). Everyone pays a weekly contribution (the amount is established by the group, varying between 1,000 and 20,000 ar/week/person). Members can then either borrow to develop a business (3-month loans at a 10% monthly interest rate) or borrow without interest in the event of a personal or social problem (e.g. death of kin). At the end of a cycle (which lasts either 9 or 12 months), the money is redistributed to the members. The basic idea was to end the cycles during the lean period to help members get through said period. Members are encouraged to take out loans. At the same time, they receive training in budget management, savings, etc.

- A relay farmer was trained in each area. He is responsible for providing technical support to farmers (improved agricultural techniques) and improving the savings and budget management abilities of households. Relay farmers receive a small financial compensation from the CSGs during the redistribution of interest at the end of the cycle.
- To increase the resilience of farmers, diversification is underway via coffee and ginger cultivation.
- COBAs and CSGs form their own unions to further strengthen themselves.



Partnership enterprise Sahanala and the Fanamby NGO

The SAHANALA GIE (economic interest group), an economic, social and environmental alternative for rural households, was set up by the NGO FANAMBY in 2009. This is an alternative for rural households that live or work inside or on the outskirts of ecological zones threatened with degradation, particularly in the 4 protected areas managed by the FANAMBY NGO. This GIE brings together farmers engaged in organic farming, private stakeholders concerned about the environment and fair distribution and associations committed to a participatory conservation approach in the same platform.

Committed farm households are thus encouraged not to abuse natural resources and to cultivate outside protected areas. They unite in cooperatives and associations, and members of the SAHANALA GIE join them, which provides farming techniques and international markets. This NGO generally targets promising products in its focus areas, supports their certification and the development of a unique label. Its associated label is part of a preservation approach that revolves around the following points:

- a better economic appraisal of agricultural work through fair trade,

- agricultural practices that respect the environment and the health of consumers,
- the commercial organization of farmers,
- a relationship between sustainable tourism and local agriculture,
- guidance for sustainable management of conservation activities and protection of the environment thanks to the financial contributions of consumers,
- a strong understanding between farmers, distributors, consumers and environmental protection stakeholders.

Part of the revenue from the sale of vanilla is deposited in an environmental fund, a social fund and an investment fund to finance the activities of the COBA and other monitoring committees (KMT, CLP), of which the farmers are members and, in particular, to finance the monitoring of the lands whose management has been transferred to them. Management decisions for the environmental fund are taken by the association, which receives advice from Fanamby. The GIE ensures the transactions downstream with the buyer by seeking the best possible economic appraisal (which means certification). On the gross margin (selling price – cost price), a percentage goes to Fanamby, which integrates it into its business plan (not necessarily destined for PAs, but rather shared among all NAPs). As a bonus to the community, the rest goes to the net income of the GIE. Sahanala supervises farmers to guarantee the quality and traceability of vanilla and to meet the requirements of the certificate.

However, increased revenue streams for local people have encouraged a voluntary levy of a certain percentage that is used for recurrent PA costs. Household income from ginger, red rice and vanilla, for example, has increased significantly.

Feedback: Case of vanilla in Loky Manambato

The Loky Manambato area is not in the vanilla cultivation area. However, since 2007, farmers grouped together in the Bio-Vanille association, which became the BioVanille cooperative (CoBioVA) in 2009 and have benefited from the technical and organizational support of the Sahanala GIE.

The farmers of the association are supported through the GIE which carries out:

- A census of farmers and existing structures
- Information-collecting from the communities on the actions undertaken to promote vanilla cultivation.
- Supervision of association members regarding preparation techniques and quality criteria
- Identification of exporters ready to start on the path of fair-trade organic certification
- The reorganization of the sector and the terms of sale

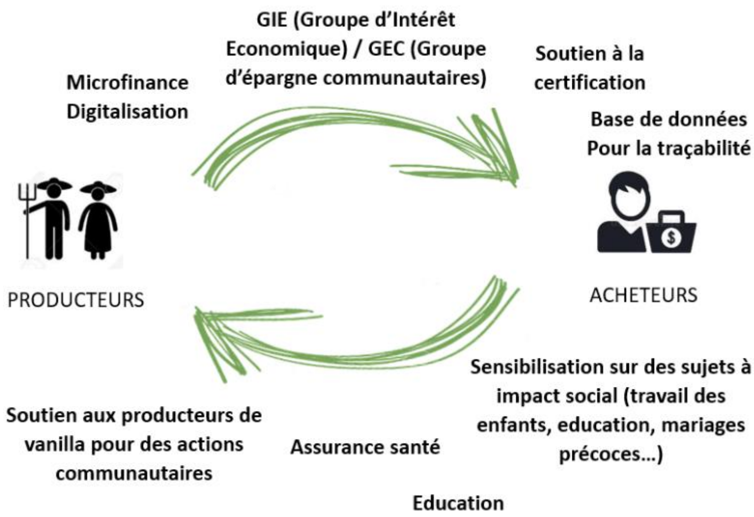
In the case of Loky-Manambato, the impacts of this equitable approach on vanilla production are numerous:

- ECOCERT certification under the Bio-ESR label (Fair, Solidary, Responsible);
- The launching of the partnership with a private stakeholder (the only manager to have done so out of the three in the SAVA Region);
- Improved income for vanilla-producing households;
- Traceability (referenced plots);
- The mastery of preparation and packaging techniques by members of the Bio-Vanille Association;
- Renewed participation in bushfire combatting activities.

Mikajy (USAID)

Mikajy, which means "to take care" in Malagasy, is a local conservation effort to reduce threats to targeted PAs and high biodiversity ecosystems through better management, better economic opportunities, better access to social services and support for natural resource ownership and property rights. This project is undertaken by Tetra Tech ARD and supported by its partners the Wildlife Conservation Society (WCS), the National Cooperative Business Association CLUSA (NCBA-CLUSA), the Inter Church Organization for Development Cooperation, the Multi-Sector Information Service (MSIS) and Viamo .

Mikajy is part of USAID Madagascar's Conservation and Communities Project (CCP), a larger project which aims to support the protection of Madagascar's natural capital, an essential element of the country's sustainable development, through better conservation of the country's unique biodiversity (nature), the promotion of resilient livelihoods that will provide an alternative to unsustainable natural resource management practices and concrete measures to ensure effective local management and ownership of natural resources. Launched in 2018, the Mikajy project ends in 2023. Its objective is to work with 2,300 farmers on improving management and governance on 5,165 ha to improve their living standards.



STRATEGIC ALLIANCE (SYMRISE[1]-UNILEVER[2]-GIZ[3])

With the support of GIZ and the participation of Save the Children, the partners Symrise and Unilever bring together organization-specific skills to ensure the sustainable development of the sector, as well as a willingness to work in maintaining supply quality natural vanilla.

As part of this alliance, vanilla farmers benefit from numerous supports aimed at improving resilience to economic shocks, improving community service infrastructure, reducing the intergenerational transfer of poverty and learning about the vanilla sector. Through this support, the farmer groups, with whom Symrise maintains a close commercial relationship, implement sustainable agricultural practices that do not negatively impact the environment but rather contribute to the improvement of farmers' social conditions.

This partnership made it possible to support 500 vanilla farmers between 2010 and 2012 in the Diana region in northern Madagascar. The results were promising: 500 farmers were trained in sustainable farming practices, fair trade standards and certification and marketing principles and saw their income increase by 24%.[4]

From November 2016 to October 2019, this alliance extended to supporting vanilla producing communities and included at least 10,000 households in northeast Madagascar, ensuring that good sustainable practices are scaled up as part of the process of improving the living conditions of vanilla farmers. The alliance aimed to improve the economic self-sufficiency and resilience of vanilla farmers, their families and communities.

Following this analysis of the different practices, we can conclude that the different facets of the vanilla quality, poverty and deforestation problems should be addressed through a global approach bringing together different skillsets in the same project.

[1] *Symrise is a global supplier of fragrances, flavors, cosmetic active ingredients and raw materials as well as functional ingredients. Its customers include manufacturers of perfumes, cosmetics, food and beverages, the pharmaceutical industry and farmers of dietary supplements.*

[2] *Unilever is one of the world's leading providers of food, homecare and personal care products with sales in over 190 countries.*

[3] *GIZ is a federal company with operations worldwide. It supports the German government in the areas of international cooperation for sustainable development and international education.*

[4] *https://www.symrise.com/newsroom/article/unilever-symrise-and-giz-join-forces-to-support-vanilla-farmers/*