

Report on the Mozambican Macadamia Value Chain

*Assessment of the potential of the macadamia sector
and recommendations to the IAM, IP*

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F. Montfort – 2021 / 2022





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Nitidae

Nitidae is a French non-governmental organization, which aims to develop projects that combine the preservation of the environment and reinforces local economies. With a team of 150 employees, Nitidae develops projects in Madagascar, Burkina Faso, Mozambique and Ivory Coast.

It also provides technical expertise to agri-food companies and public institutions to improve the performance of agricultural value chains, decrease environmental impact and stimulate local economic development together with the organization of producers and local communities.

Nitidae has been in Mozambique since 2013, developing value chain projects such as ACAMAZ (Apoio a Cadeia de Valor do Caju em Moçambique), biodiversity conservation programs with the Legado Namuli project for the preservation of Mount Namuli in Gurue, payments for ecosystems services schemes (REDD+), or project such as LUCCIA (Land Use and Climate Change Impact Assessment in Mozambique).

More information can be found on the website www.nitidae.org

Instituto de Amêndoas de Moçambique, IP (IAM, IP)

The Instituto de Amêndoas de Moçambique, IP (IAM, IP), previously the Instituto de Fomento do Caju (INCAJU), is an institution governed by public law, created in December 1997 and reporting to the Ministry of Agriculture and Rural Development. In 2020 its attributions, powers, organization and functioning have been redefined and INCAJU have even been renamed the IAM. Its institutional objectives regarding the promotion of cashew sector were maintained with the addition of a new mission: the development of the macadamia value chain in Mozambique.

The mission of the institution is “to promote, in a sustainable way, the increase in the production and quality of nuts, the organization of marketing and the structuring of the processing industry, in coordination with all interested entities, with a goal of transforming the comparative advantages of the Country in competitive advantages, increase the income of rural families, create jobs and contribute to the improvement of the balance of payments.”

Its attributions include the definition of policies and strategies, the coordination of the stakeholder's cashew value chain, as well as those of others kernels under their tutelage. Its competencies include the support to the cashew production, the internal and external promotion of the cashew nut industry and other kernel. It is also responsible for elaborating and implementing, in coordination with specialized national and international institutions, the research, the transfer of technologies for the production, trade and processing of cashew nuts, the cashew apple included.

More information can be found on the website <https://iam.gov.mz/>



Acknowledgments

This study was realized as part of the ACAMAZ project, we therefore would like to thank our main partners, the IAM, IP from the Ministry of Agriculture and Rural Development and the French Development Agency (AFD), for their confidence, support and collaboration with us in this project.

We would also like to show our gratitude to all of the macadamia value chain actors that helped us create this report through field visits, interviews and reviews, in particular the macadamia producers of Mozambique, the AMM, the macadamia traders and experts from various countries.

Finally, we thank our colleagues from Nitidæ in Mozambique who allow us to implement promising projects, demonstrating and paving the way of the recommendations we propose in our reports.



Foreword

It is an honor and privilege for me to write the foreword for this very well researched, accurate and concise report on the global macadamia nut industry with the focus on the orderly development of the fledgling yet dynamic macadamia industry in Mozambique.

I firmly believe that the modern horticultural management systems exist and are readily available (from the correct sources) to build a prosperous macadamia industry in Mozambique that would be fully inclusive of both large commercial producers AND smallholder farmers, working together in an essentially free market structure without any of the fears or prejudices in terms of theft and/or poor quality as outlined in the report.

Of critical importance for the success of smallholder macadamia farmers is the correct funding model, which should NOT be based on handouts, but rather development/production loans that are fully repayable by the beneficiaries over time, whether funded by the public or private sector. Such smallholder developments will also never succeed unless supported by strong technical/horticultural advisory support, preferably driven and managed by private sector players rather than government (although funding of these developments could be made available from public sources).

Reference in the report to the chaotic situation in the Kenya macadamia industry illustrates the dire consequences of government involvement in a horticultural crop which requires intensive management, which indeed operates with great success in the rest of the world in a free market. In conclusion, as the report highlights, formation of an effective and appropriately funded macadamia growers' association (like the AMS in Australia and SAMAC in South Africa) will be the critical driver to realize the potential for Mozambique to become a significant producer of top-quality macadamia nuts for people around the world to enjoy.

By Philip Lee, Macadamia Consultant,
Former Executive Director of SAMAC.



1. Executive summary

- The Mozambican macadamia value chain is promising but still nascent, which means that there are a lot of needs, and opportunities of improvement all along the chain.
- There are, at the time of the redaction of this report (June 2022), 45 companies involved in macadamia, of which only 7 are known to produce commercial volumes of macadamia. There is currently no smallholder production of macadamia in the country. There is no processing factory yet neither. Some of the macadamia producers are gathered into the Association of Macadamia of Mozambique (AMM).
- The national production was evaluated between 1'500 and 2'500 tons of Nut-In-Shell in 2021, mainly exported to South African factories for processing into kernels, or directly exported in-shell to China.
- The macadamia market is divided into two sub-markets: the Nut-In-Shell market which the only consumer is China, and the kernel market, which needs processing into the cracking factories, mainly located in South Africa and Australia. For macadamia producers it is important to be able to sell on those two markets with flexibility.
- To provide this flexibility to the Mozambican macadamia producers, it would be very positive to obtain the official certificate needed to directly export to China. For now, Mozambican producers need to go through intermediaries in order to export in China, losing added value and also the chance of promoting Mozambique's reputation as a quality origin for nuts in this big consumer country.
- The first priority of the Mozambican macadamia sector should be to increase primary production, focusing well on quality since macadamia is a niche delicacy market that is ruled mostly by reputation. To achieve this objective, three short-term recommendations are proposed:
 1. Support the development and installation of commercial plantations;
 2. Foster the creation of smallholder production basis through pilot partnership with commercial farmers;
 3. Promote agronomical research, experimentations and knowledge transfer.
- In the long-term other objectives should be achieved such as the promotion of national processing factories.
- Mozambique has the chance to be a neighbor of Malawi which is a very good example of well-structured and inclusive macadamia value chain. Trips, projects and events should be organized to foster transfer of knowledge and lessons learnt from this country.



2. Introduction

Following the consuming trend of tree nuts, macadamia nut is in the spotlight, and seems to be an agricultural value chain with good potential for Mozambique. Entrepreneurs originating from neighboring countries such as South Africa or Malawi have been developing macadamia in their estates for more than 10 years now. However, due to the long growth cycle of the macadamia tree, and the time it needs to reach the first consistent harvests, the Mozambican macadamia sector can still be described as nascent.

Mozambique hosts today around 45 macadamia estates projects, with some leaders now reaching full production, providing them with a solid market presence. These pioneers have a good understanding of the macadamia market, and a careful vision of how it is going to evolve. The Mozambican macadamia sector is reaching today a tipping point, with established companies that could lead the way to its expansion and consolidation. However, the sector is still young and exposed to a very volatile international market. That is why this value chain needs to be carefully analyzed to identify the best ways to improve it, especially with relevant public support and regulations. The IAM, IP will have a key role in this development, and this report aims to bring them a comprehensive analysis of the macadamia value chain to help them in this task.

3. Context of the assessment

3.1. Objectives

This report has been produced as part of the ACAMAZ project. Nitidae works in collaboration with the IAM for the development of the ACAMAZ project, which objectives are:

- Contribute to the consolidation of the cashew value chain, with the aim to improve smallholders' livelihoods;
- Promote national processing of cashew nuts and its integration into the international market;
- Improve the economic, social and environmental sustainability of the cashew production;
- Support a reinforced and transparent institutional framework, led by the IAM.

The ACAMAZ project aims also to support the IAM in its new mission of developing the macadamia value chain. With this in mind, Nitidae undertook an analysis of the Mozambican macadamia sector, to identify its opportunities and challenges, with a focus on the possibility of integrating smallholders in this value chain. The present report is a restitution of this analysis.

3.2. Methodology and agenda

This value chain analysis was first realized at the international level, with a study of the world macadamia market, its fluxes (volumes and prices), and its main stakeholders (producing / consuming countries). The objective was to comprehend well the rules and trends of this market.

The second phase was an analysis of the national sector of the macadamia, with a consultation of its actors. The objectives were to collect macadamia production and commercialization data, understand the strengths and weaknesses of this value chain, and identify the most relevant actions to consolidate it.



This work has been realized during the last quarter of 2021 and the first of 2022. Here below are described the main activities undertook:

Tableau 1: Work agenda

DATE	ACTIVITIES
SEPTEMBER / OCTOBER 2021	Analysis of the international macadamia market Review of the literature about macadamia main stakeholders
NOVEMBER 2021	1 Call with Phillip Lee - CompleteLee Nuts - macadamia consultant 12 Call with Guillaume Maillard - Pamoja Impact - Investor in macadamia projects 13 Meeting with Kobus Botha (New Forest) and Izak Holtzhausen (Niassa Macadamia) 19 Call with Kim Wilson - Eureka Macadamia - macadamia consultant 24 Meeting with New Forest – Macadamia producer in Niassa 25 Meeting with DD Farming & Niassa macadamia – Macadamia producers in Niassa 26 Meeting with For Puma 1 – Macadamia producer in Niassa 29 Meeting with Murrimo Macadamia – Macadamia producer in Zambezia / Gurué Meeting with G&F Macadamia - Macadamia producer in Zambezia / Gurué
DECEMBER 2021	2 First preliminary restitution to IAM Meeting with LanBob – Maputo macadamia producer
JANUARY 2022	Call with macadamia actors in Malawi Call with Macs in Moz – Macadamia producer in Manica
FEBRUARY-JUNE 2022	Production of the report, round of review and comments on the report by the Mozambican macadamia stakeholders and IAM, IP Portuguese translation of the report and delivery to the IAM

4. International market of the macadamia

The macadamia market is peculiar: it depends on international exchanges, and its trade is well documented and dynamic, with a lot of market analysis, which makes it similar to agricultural commodities such as cocoa or cashew. However, at the same time, it is a very specialized niche market, with low production and trade volumes, and high prices. Hence, the profile of this market is unusual, and its rules very specific.

4.1. Place of the macadamia in the world tree nuts market

As said in the introduction, the macadamia nut is a very tiny market, weighing only 1% in the world tree nuts market¹ in terms of kernel production (**Image 1**). Its global kernel production was around 60'000 tons in 2020, representing a Nut-In-Shell (NIS) or Dry-In-Shell (DIS), production of approximately 200'000 tons (the standard ratio between NIS and kernel is 33%). As a comparison, cashew nuts global kernel production is around 840'000 tons, so 14 times bigger. Cashew can be described as a rather small agricultural commodity market compared to cocoa (near 5 million tons global production).

¹ International Nut Council. Nuts and Dried Fruits—Statistical Yearbook 2020–2021



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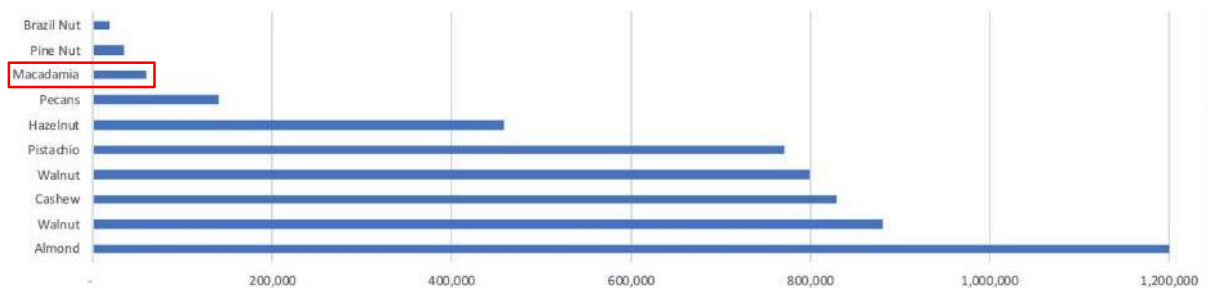


Image 1: Share of the macadamia in the world tree nuts market

Macadamia nut's production has been increasing at an average +5,6% annual for 10 years now (Image 2). It is a rather dynamic growth for an agricultural production, even compared to the other tree nuts that all display solid growth over the same period of time: +3,5% for cashew, almonds and hazelnuts, and +5% for a niche nut such as pecan.

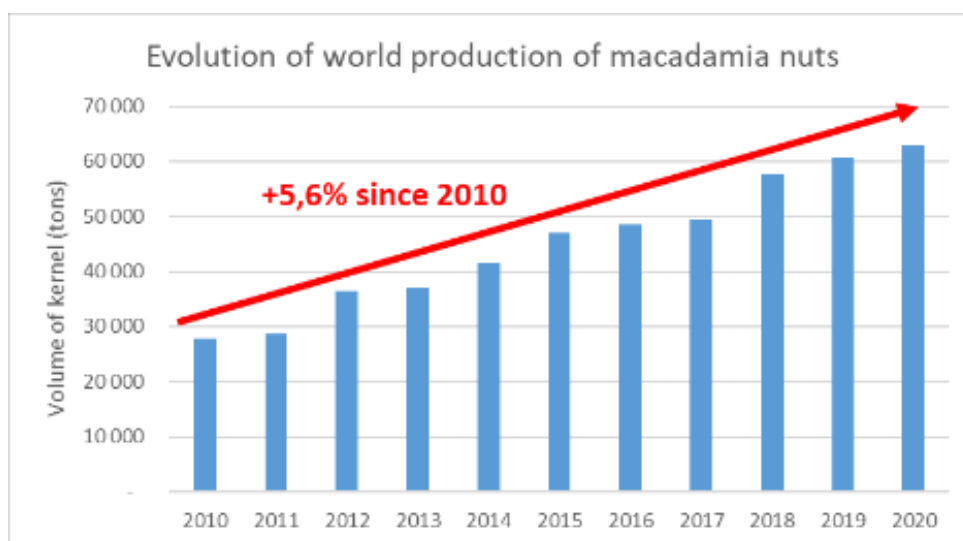


Image 2: Macadamia kernel production evolution

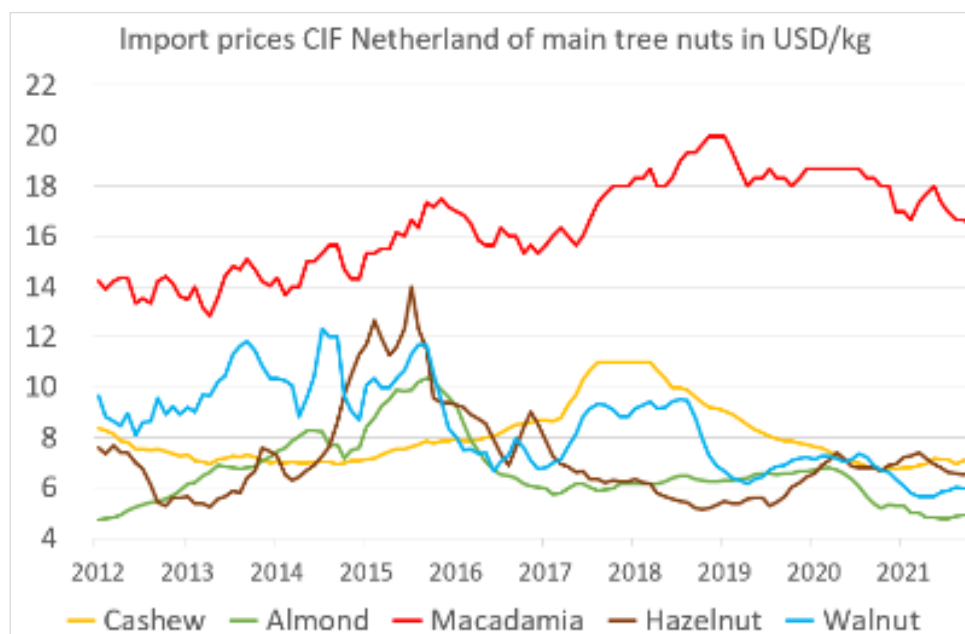


Image 3: Macadamia kernel price evolution compared to other nuts



In terms of price, macadamia is the most expensive nut compared to the others. Indeed, it has always been traded between 16 and 18 USD/kg of kernel in the past 5 years, when the other nuts' prices are generally between 4 and 10 USD/kg (**Image 3**). The hypothesis that could explain this price difference would be the high costs of goods sold of the macadamia compared to the other nuts, but it is not completely confirmed since costs of production and processing vary drastically between countries and production models.

In summary, macadamia holds a “promising outsider” position into the tree nuts market. Of course, it is particularly a niche product because of its high price, but most of the factors that rule the evolution of macadamia are similar to the other nuts.

4.2. Main producing countries

The world production of macadamia is quite concentrated with few leader countries. Indeed, around 50% of the macadamias traded are produced by South Africa and Australia which are the two historical leaders. Then, in a secondary position, China and Kenya are also big producers, providing around 25% of the production. The USA is also an historical producer, but in fact all of its production is coming from Hawaii, which has limited land availability, explaining why it only contributes 5% to the world macadamia supply today.

After these big historical players, some “new challengers” such as Guatemala (5%), Vietnam (3%), Malawi (2%), Zimbabwe and Mozambique are emerging. These countries adopted later the production of macadamia, but they have regions with good climatic conditions, which attracts entrepreneurs and investors since the leading countries South Africa and Australia both face climate change issues (droughts, fire, etc.).

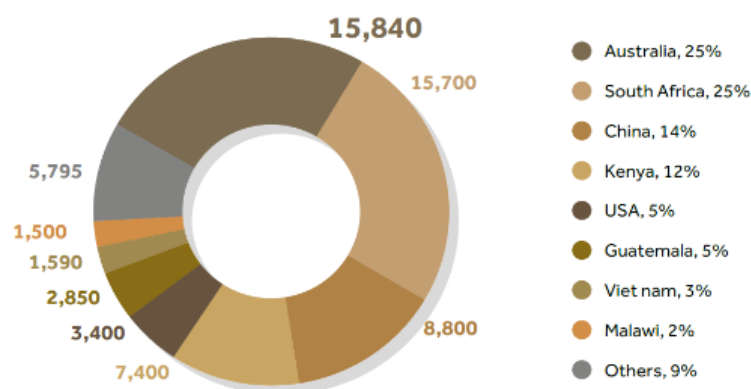


Image 4: Macadamia production by country in 2020 (tons of kernel equivalent) – Source: INC

4.2.1. The two leaders: South Africa and Australia

The Republic of South Africa (RSA) and Australia are the two macadamia leaders in the world. Their production models are mainly macadamia-dedicated estates, managed with intensive agricultural practices (high quality seedlings, irrigation systems, use of chemical inputs, machinery...). This production model can be described as high-investment / high-costs / high-yields / high-quality.



Image 5: Macadamia regions in South Africa



Image 6: Macadamia regions in Australia

In South Africa, 700 farmers are managing around 45'000 hectares of macadamia, which gives an average of 65 hectares farms². They are mainly located in the North-East of the country, in the regions of KwaZulu Natal, Limpopo and Mpumalanga (**Image 5**). The average yield per hectare is around 1,6 tons of DIS/ha, which of course depends on the age of the trees in the orchards, since not all of the planted trees are bearing. In general, the macadamia trees yield between 1,5 and 2,4 tons/ha in South Africa, when bearing. The production costs are around R62'000/ha/year (= 4'000 USD = 260'000 MZN).

In Australia, 800 farmers are managing around 36'000 hectares, hence an average of 45 hectares farms³. They are mainly located on the East coast, in the regions of Queensland and New South Wales (**Image 6**). The average yield in Australia is higher than in RSA since it is around 2,7 tons of DIS/ha, with a range between 2 and 4,5 tons/ha. However, it goes along with higher costs of production as well, around 9'000 USD/ha/year (= 575'000 MZN).

Both Australian and South African macadamia productions have been increasing at a very similar rate these past 10 years, around 4,5% per year.

It is expected that it continues the same way since at least 30% of the surface planted is not producing yet. Also, RSA reports an increase in land planted with macadamia of 4'000 hectares per year; in Australia this increase is around 2'000 hectares per year.

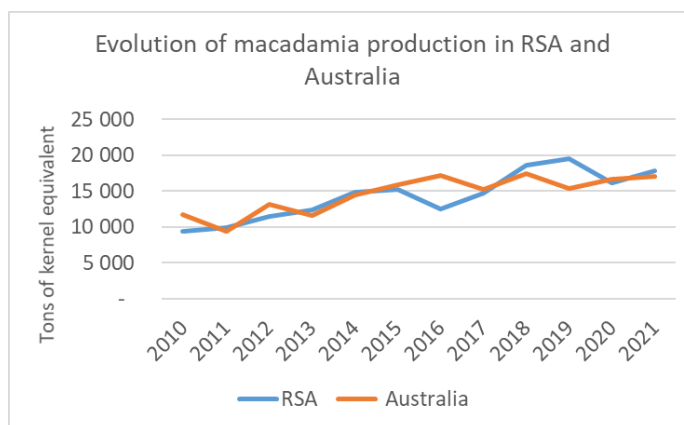


Image 7: Macadamia ramp-up in RSA and Australia

² Source: Macadamia South Africa (SAMAC) website, 2020 data

³ Source: Australian Macadamia Society (AMS), 2021 yearbook



4.2.2. Secondary producers: China and Kenya

As it will be explained later in this report, China has a specific profile since it is both producing and the biggest consuming country. This means that a part of its production is self-consumed and not traded, which makes it difficult to estimate. In the **Image 4**, we can see that China exports 8'800 tons of kernel, but, unlike the other countries, it does not represent its whole production. China is probably the country where it is the most difficult to obtain reliable production data.

Most of the macadamia trees are located in the province of Yunnan, representing more than 80% of the national planted area, and the rest is in the Guangdong province (**Image 8**). It is estimated that 31'000 hectares⁴ are now planted, which is a very big figure. However, some macadamia experts note that the land used for planting is not the most suitable (mountainous hills of Yunnan), and that the varieties are not adapted to this climate, forecasting low yields and low quality of nuts⁵. Hence, China will grow its macadamia production basis in the near future, probably significantly, but because of the doubts on the management of the trees, the predicted boom of Chinese macadamia is unsure.



Image 8: Macadamia regions in China

Kenya has also a unique profile since the majority of its production comes from smallholders, with an estimate of 200'000 farmers producing macadamia⁶. However, this figure is debated to be much more. These smallholders represent 90% of the Kenyan production, but they possess very few trees, each farmer producing in average 100kg per year. They are located in the highlands around the Mount Kenya, which is famous for its high-quality coffee (**Image 9**).

At first, macadamia trees were introduced as shade trees and a diversification crop for coffee farmers, as part of a national support program. It explains why this agricultural extension program did not really take in consideration the best varieties. Indeed, there is a high ratio of the variety *Tetraphylla* in the Kenyan macadamia orchards, which is not favored by customers because of its rough shell. Also, *Tetraphylla* has a lower oil content than *Integrifolia*. This diversity in the planted material causes now disparity in terms of kernel quantity and quality. Moreover, Kenyan

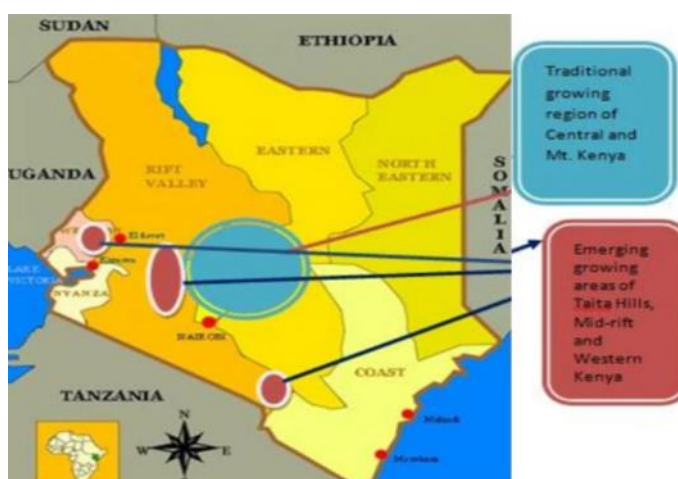


Image 9: Macadamia regions in Kenya – Source: NUTPAK

⁴ China Tree Nut Production & Import Forecast, Pacific Nut Producer, 10/06/2021, [LINK](#)

⁵ China to Produce Half of Global Macadamia Crop by 2022, Produce Report, D. Siekman, 21/08/2018, [LINK](#)

⁶ Value Chain Analysis of Macadamia Nuts in Kenya, CBI, 2019



macadamia production faces other challenges as well, such as premature harvests linked to illegal export of NIS (smuggling) which leads to low quality nuts.

However, even with these challenges, macadamia has been reported to be well adopted amongst the smallholder farmers, thanks to the low maintenance it needs and the complementary cash it brings between coffee harvests. Nonetheless, Kenyan production of macadamia is said to be declining because of the lack of follow-up with the smallholders, putting in question the renovation of the orchards. Moreover, since the smallholders are specialized in coffee, the macadamia cultivation enters in competition for land and manpower. With the recent good prices for coffee, it is possible that farmers would prefer to continue produce coffee rather than extending or renewing the macadamia production.

4.2.3. New challengers: Guatemala, Malawi, Zimbabwe, Zambia and Mozambique

Some new challengers are emerging, representing a small part of the total production, but with dynamic growth. These new origin countries are for example Guatemala, which production model is close to the one in Kenya, where most of the production is done by coffee farmers. It is complicated to obtain production data on Guatemala, but it seems like the land planted with macadamia was around 9'000 hectares in 2013⁷. Since its NIS exports in 2020 was around 10'000 tons, it is possible that macadamia plantations extended up to 12'000 hectares now (taking in consideration that yields should be lower than in RSA or Australia, and part of the production is self-consumed).

The other new challengers are East African countries that benefit from suitable climates for growing macadamias in some of their regions. These countries are Malawi, Zimbabwe, Zambia and Mozambique.

Malawi is the most interesting example, not only because it is the biggest producer amongst these new African players, but also because its macadamia value chain has been initiated earlier and is well structured. Today, 90% of the Malawian macadamia production is done by 7 commercial plantations, and the rest is supplied by 3'850 smallholders that manage between 0,1 up to 4 hectares of macadamia⁸. These smallholders are even organized into cooperatives, gathered under a major farmer organization called the Highland Macadamia Cooperative Union Ltd. (HIMACUL). It is believed that Malawi will duplicate its macadamia volumes in the next 5 years, thanks to the extension of macadamia farming among smallholders, and the replacement of tobacco with irrigated macadamia by commercial estates these past 5 years⁹. The study case of Malawi is very interesting for neighboring countries with intent to build a resilient macadamia value chain that integrates smallholders. That is why a more detailed



Image 10: New African countries for macadamia production

⁷ Industria Guatemalteca de Macadamia SA

⁸ Review of Macadamia Production in Malawi, Emmanuel Zuza, 2021

⁹ Insights from Malawi macadamia expert Andrew Emmott



paragraph is dedicated to the development of the Malawian macadamia value chain in the chapter 7 of this report, about smallholders' integration.

4.3. Consumer countries and commercialization canals

Macadamia nuts can be sold under two different formats: nut-in-shell (NIS) or shelled (kernel). Unlike cashew nuts that need processing before being sold on the end-consumer market, the macadamia nut can be cracked easily by the consumer with a specific tool. Hence, there are two markets for the macadamia: the NIS market and the kernel market.



Image 11: Macadamia Nut-In-Shell (NIS)



Image 12: Macadamia sold in-shell and cracked with a special key



Image 13: Bag of macadamia kernel

When speaking about volumes of macadamia traded, it is very important to pay attention to the fact that the figures relate either to NIS or kernel. There is an average 67% weight loss ratio from NIS to kernel, hence the standard 33% ratio is frequently used. All of the graphs and figures in the beginning of this report were converted to kernel equivalent. For example, in part 4.2 it is stated that the world production of macadamia is 60'000 tons of kernel equivalent, which would be around 180'000 tons in NIS equivalent. Figures of the **Image 4** are also in kernel equivalent, which is the reference when talking about the tree nuts trade.

However, for the rest of this document, NIS and kernel markets will be divided, and volumes will be related to NIS or kernel. It will be important to keep in mind the 33% cracking ratio in order to avoid confusion. This standard cracking ratio can be lower or higher depending on the quality of the nuts, on the intensity of the farm and post-harvest management, and also on the cracking process. Without entering into details, the 33% has been taken as reference for this report. Below is a simplified chart of the post-harvest steps from the nuts in husk that fell of the trees to the kernels ready to be consumed.

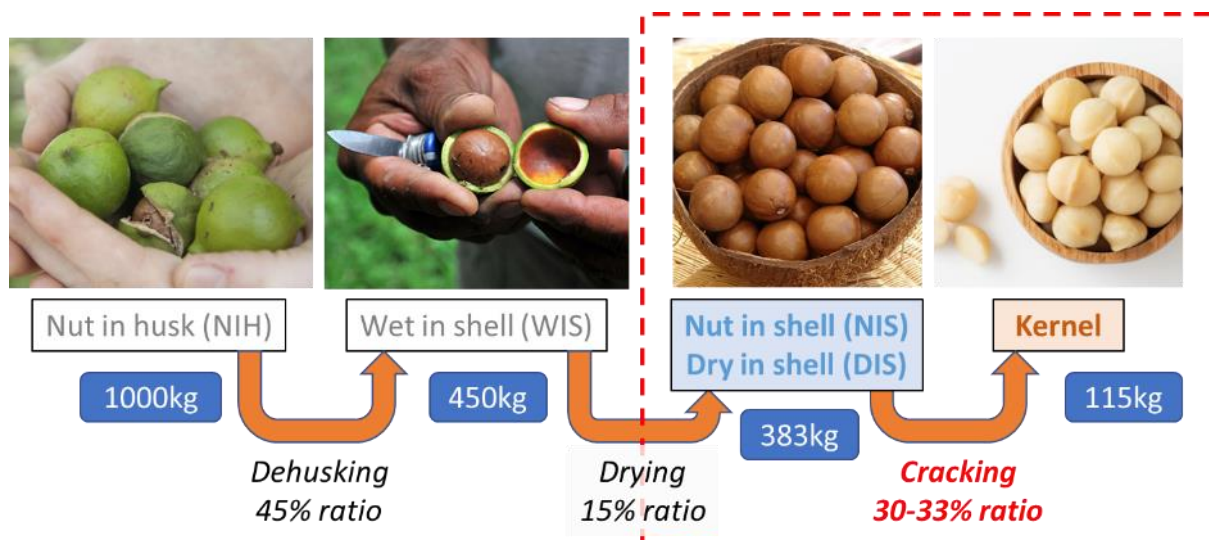


Image 14: Simplified flow chart of the post-harvest processes for the macadamia nuts and its ratios¹⁰

4.3.1. The NIS market: nuts directly shipped to China, without processing

As explained above, the macadamia is sold directly as NIS to an importer, without passing through a cracking factory, and the end-consumer will crack it himself with a specific key (Image 12). This practice is common only in China; hence the NIS market is only represented by Chinese buyers. However, since China has a high share of the world consumption of macadamia, the NIS market is important, representing near 40% of the volumes of macadamia traded (Image 15).

To sell macadamia on the NIS Market, you need first to dry the nut to a 2%, or lower, humidity content. This is why the concept of Nut-In-Shell (NIS) is sometimes replaced by Dry-In-Shell (DIS). Then the nuts will be directly packed and shipped in a container to China, or a neighboring country for the producing countries that don't have the official certificate to export to China (which is the case of Mozambique, see subchapter 5.4).

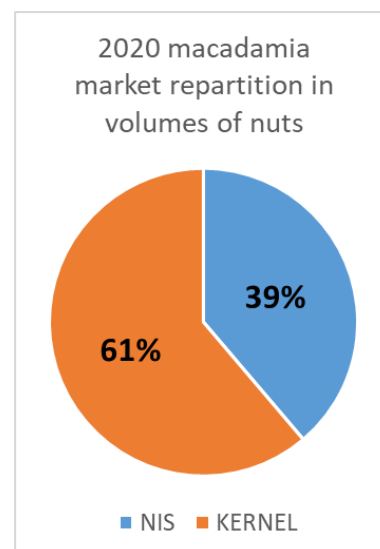


Image 15: NIS and kernel market shares in volumes (NIS eq)

The NIS are classified and priced mainly according to their sizes. Best ones are above 26mm diameter. In order to find a customer on the NIS market, the minimum size would be around 16mm. The origin, variety, and aspect of the nuts will influence secondarily the negotiation price per kg. However, after receiving the NIS, the Chinese clients will make some cracking tests and evaluate the Sound Kernel Ratio (SKR) before stating the final price. This ratio gives the percentage of kernel that are without defaults, if it is too low the negotiated price will be decreased accordingly. This constitutes a challenge for Mozambican producers, as presented below in subchapter 5.4.

¹⁰ Seminário técnico sobre macadamia, Associação da Macadâmia de Moçambique (AMM), H. Laudane, Maputo 28/05/2021

4.3.2. The kernel market: nuts processed by cracking factories

In order to be sold as kernels, the macadamia nuts must be processed in a cracking factory. Hence, the NIS are first sold to a factory that will crack it and package it as kernel, before selling it to consumer countries. Most of the historical big producing countries have cracking factories to process its national production. South African factories even import NIS from neighboring countries that do not have factories, such as Zimbabwe, Mozambique, Zambia and also from growers in Malawi who do not have an established relationship with a local processor. After the cracking process, the factories will sell the kernels to brokers, or other distributors in the consumer countries.

The processing of the macadamia nuts will produce different “styles” of kernels. Some kernels will have the best quality (not broken, big size, white color) and classified as “Wholes”, which refers to styles S, 0 and 1. Then, lower classifications are given based on the level of broken of the kernels: “Mixes” are styles 2 and 3, “Halves” for style 4, and “Pieces” for styles 5 to 7:



Image 16: Examples of styles of kernel, from left to right: Wholes, Mixes, Halves, and Pieces

The styles of kernel have not the same end-use. Best styles (Wholes and Mixes) are sold on the snack market, to be consumed as itself, though often roasted and salted. This market is mainly located in the EU. Lower styles are sold on the ingredient market, to be used in the composition of pastries, sweets, ice creams, etc. This ingredient market is stronger in the USA.

Basically, all of consumer countries buy the macadamia as kernel, except China that buys as NIS and kernel. The biggest consumers of the kernel market are the EU (37% of the kernel imports) and the USA (32%). Afterwards comes China (11%), Japan (10%), Vietnam (5%) and other countries.

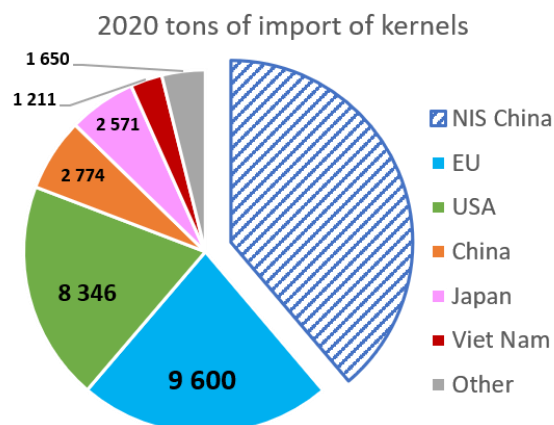


Image 17: Kernel consumer countries with their annual imports (in tons of kernel eq. even NIS China)

4.3.3. Pros and cons of selling on the NIS versus the kernel markets

Most of the macadamia producers have a mixed commercial strategy, selling their nuts both on the NIS and the kernel markets. Indeed, NIS and kernel markets have both their specificities, making them complementary markets. We can even observe this mixed strategy at a national level: for example, the leading countries such as South Africa and Australia process around 70% of their macadamia into kernel and export 30% as NIS (Image 18). There are some exceptions such as Kenya that export all of its production in kernel since a ban on NIS export is active (this will be analyzed in



the chapter 6 about regulation). In Malawi also there is a predominant ratio of kernel, probably due to the good relationship between factories and producers. Other countries such as Zimbabwe or Mozambique, which do not have factories, have to export its whole production as NIS.

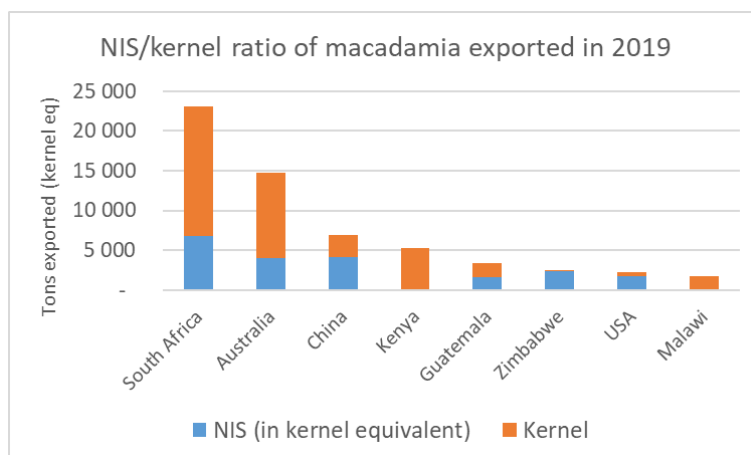


Image 18: Repartition of the exports of macadamia NIS and kernel per country, 2019

After discussion with macadamia producers, the first reason explaining why they have a mixed commercial strategy (sell on the NIS and kernel market) is to keep a diversified network of options. Buyers are not the same on these two markets, and the trends of demand are not related, which means that volumes and prices can fluctuate independently on the NIS and the kernel market (see **Image 19**). Keeping clients both for NIS and for kernel allow flexibility to switch from one market to the other in function of the prices of the year.

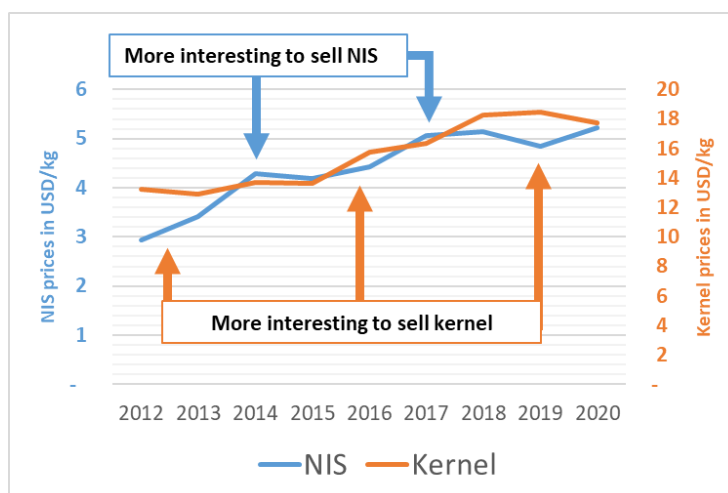


Image 19: Comparison between evolutions of NIS and kernel prices. ATTENTION: the curves of prices are represented with 2 different axes to highlight the fluctuations.

Other factors than level of demand (volumes and prices) influence the interest of selling on one market over another. For example, macadamia producers report that for big size nuts prices on the NIS market are higher than the ones paid by factories. However, selling to the NIS market in China requires to ship the production in containers, which is more and more complicated and costly due to the international logistical issues that occurred these past years due to the pandemic of COVID-19 (prices of container can double or triple, shipment can be blocked for weeks in a port waiting for



a container...), a situation that could worsen with the global increase of fuel prices due to the war in Ukraine. Also, to sell to China the country needs to have an official certificate of macadamia producer, delivered by China.

On the other hand, selling to factories for the kernel market can be easier in terms of transportation, for example for Mozambique, but it is not always the case. Mozambican producers have in general good relationships, or even partnerships, with South African factories. This favored relationship explains why price and quality negotiations are easier between producer and factories than with NIS Chinese importers. However, this is specific to each macadamia producer, and depends highly on the volume and quality it can deliver.

As a conclusion, the commercial strategy of each macadamia producer depends on its situation, and its capacity to create a reliable network of buyers. Keeping a mixed strategy between NIS and kernel market is advised by all of the macadamia producers interviewed.

4.3.4. Certification market (organic, Fairtrade) for macadamia

The supply of organic macadamia is very scarce in the world today. The only examples of organic macadamia is coming from Kenya, where several companies such as [Limbua Group](#), [Ten Senses](#), or [Jungle Nuts](#) are currently working with more than 5'000 smallholders. These companies are both organic and Fairtrade certified since the demand is stronger for products cumulating the 2 certifications.

In terms of market, the demand of organic products is still growing at a fast rate, between 8 and 15% per year, and has been multiplied by 7 in 20 years¹¹. This trend is stronger for healthy niche products such as tree nuts. The example of the cashew market can be analyzed as a reference for the potential of the macadamia market. Today, 4 to 5% of the European cashew market is organic, and it is growing very fast. The premium paid for organic cashew is 15% higher than market price.

With this growing demand and lack of supply, the sector is promising. This is especially the case for smallholders since commercial macadamia farmers all reported that they don't believe their production model could work with organic standards. Indeed, these macadamia estates' models rely on high-investments and intensive agricultural management in order to ensure highest yields. In this context, organic farming is not considered by them as feasible, since they rely heavily on chemical fertilizers and pesticides.

This being said, with the recent increase of prices of gas and, therefore, chemical fertilizers (already +200% in one year without considering the effect of Russia-Ukrainian conflict on the fossil fuel

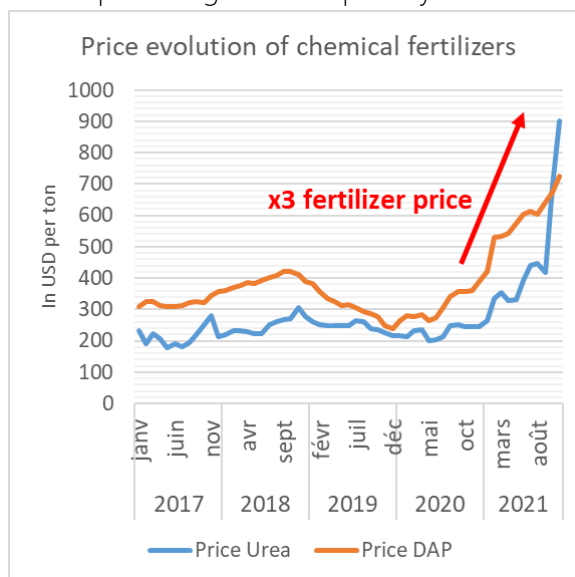


Image 20: Escalation of fertilizer prices

¹¹ L'agriculture bio dans le monde, L'Agence Bio, 2020



market, see **Image 20**), the conventional estates may review their position on the subject, considering organic conversion more attractive than before.

Organic farming is not such a constraint for a smallholder production model, which explains why the only organic macadamias in the world are currently grown by Kenyan smallholders.

5. Mozambican macadamia sector

After the analysis of the international landscape of macadamia, it is time to zoom on the specific situation in Mozambique. As it is described in part 3.2, the following macadamia value chain analysis has been conducted through consultations with existing macadamia producers, as well as discussions with the IAM, and the Macadamia Producer Association.

The macadamia sector is young in Mozambique, with the oldest companies established 15 years ago, and only few of them that reached consistent volumes of macadamia nuts to be exported. However, its attractiveness from specific investors (South Africa) is growing, following the path set by these pioneer companies. It is estimated that approximately a total of 100M USD have been invested in macadamia estates until 2020¹².

5.1. Mozambique's position in the international macadamia landscape

Data about Mozambique's macadamia production and export are hard to find, and the ones reported by duties may be partly unreliable¹³. However, it can be estimated that Mozambique total production and export was between 1'500 and 2'500 tons of NIS in 2021, representing 1 to 2% of the world production of macadamia. This puts Mozambique in the 11th place for the rank of exporters of macadamia. It is important to note that Mozambique do not have factories, hence it exports all of its macadamias in NIS.

Since 2016, the exports have been multiplied by 4 (**Image 21**), and it will continue to grow with an accelerated rate due to the entering in production of more than half of the national planted area (see part 5.2), the projects of extension of existing estates, and the planting of new estates.

The main export partners of Mozambique for NIS are mostly South African factories (41% of the NIS exports in 2020) and China (30 to 50%), through Hong Kong or other countries since it is not yet possible to export directly to China. The remaining percent include Viet Nam, and occasionally Australia.

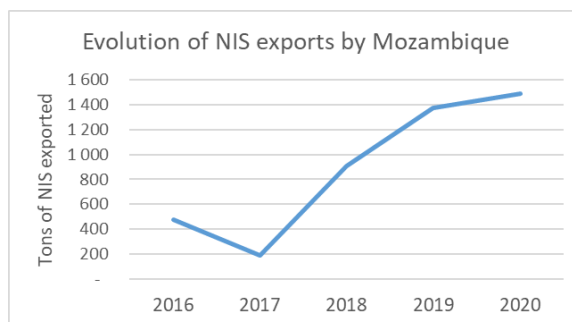


Image 21: Evolution of NIS exports by Mozambique

¹² Southern Africa Trade and Investment Hub, 2020 Workplan, USAID

¹³ The source of the data is UNCOMTRADE which is unable to map all of the fluxes from small commodities such as macadamia, in countries where no dedicated statistical institute can provide clear numbers.

5.2. Main producing regions and study cases

There are currently 3 main provinces of macadamias in Mozambique: Manica with 2'000ha planted and 1'800ha to be planted, Niassa with 1'500ha and 2'400ha to be planted, and Gurué with 700ha planted and 1'500ha to be planted (**Image 22**). There are also two other regions in the South of Mozambique where some macadamia estates began production and investors have declared that they will plant macadamia: in Inhambane and Maputo. However, different macadamia producers interviewed during this study are showing doubts about the suitability of these regions for macadamia cultivation and consider such investment as risky. Indeed, the lack of annual rainfall, high temperatures and risks of droughts make the planting of macadamia a big challenge in these regions.

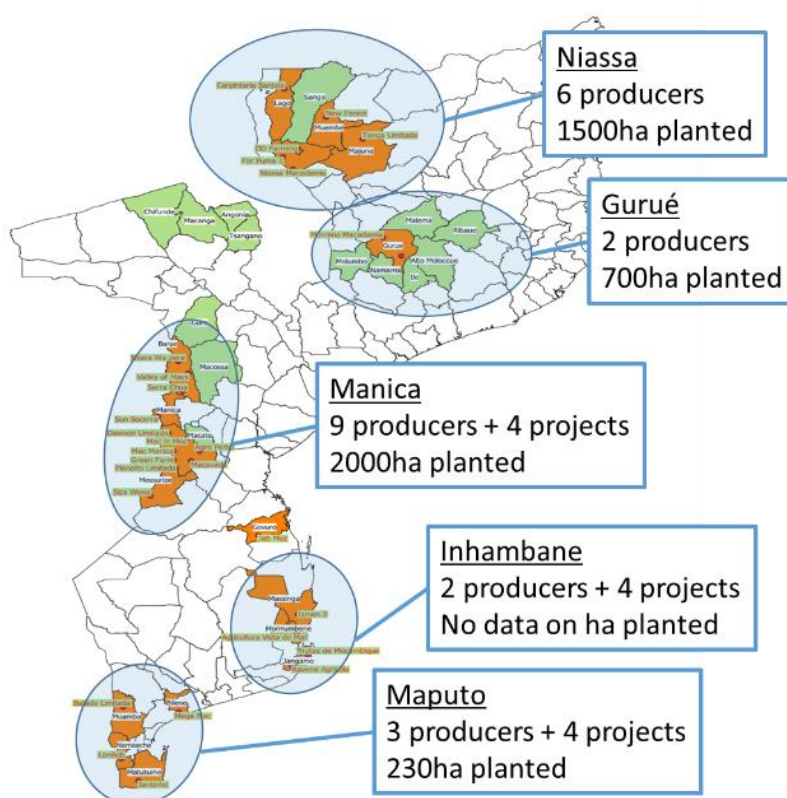


Image 22: Map of Mozambique macadamia regions – Source: Nitidæ consultation, and data from IAM, IP

All of these regions match with reference suitable agroclimatic conditions for growing of macadamias (see **Annex 1: Comparison of rainfall between different macadamia growing regions in the world**), except for Inhambane and Maputo that are below the minimum annual rainfall suitable for macadamia (1000-1500mm per year; only 930mm in Inhambane and 650mm in Maputo). Nevertheless, it is important to stress the importance of local factors on larger regional agroclimatic conditions, for example topography could highly influence rainfall regime and air stream circulation locally. Therefore, suitable conditions are influenced by local conditions and the choice about the location of a new estate should carefully take that into consideration. More information on this topic in the chapter 8 of this report about suitability for macadamia.



Study case in Niassa: DD Farming, near Lichinga

There are 6 estates that planted macadamia in Niassa province: Tenga Lda, DD Farming, Niassa macadamia, New Forest, For Puma 1 and Carpintaria Sanjala. Only two of these estates are currently producing macadamias, since the other ones have young trees that do not bear fruits yet. One of these two estates is DD Farming, that has been visited by the Nitidae team the 25th of November 2021.

This macadamia estate was planted 16 years ago, which makes it one of the oldest in Mozambique. It is currently planted with 250ha of macadamia, of which 60ha are in production. They still plan to plant 700ha more if they can acquire another estate. This estate doesn't have irrigation, and most of its plots are planted with a spacings of 5x5 (very dense compared to what is considered the norm in the macadamia industry) or 5x10 meters. The main cultivar is Beaumont¹⁴. Most of its trees are not grafted and produced in their own nursery, with the initial seedling material coming from Malawi. There is no particular harvesting season in DD Farming, the macadamia trees produce all year round, which makes it difficult to plan spraying against pests (as is not recommended to spray mature nuts).

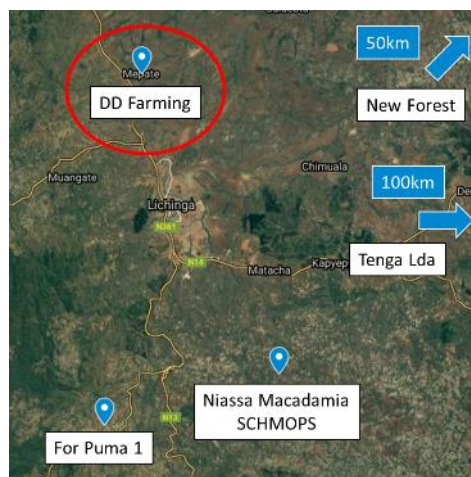


Image 23: Localization of DD Farming and other macadamia estates



Image 24: Photos of DD Farming – left: plot of macadamia – right: one macadamia nut in husk

DD Farming has a high average yield around 3-5 tons/ha, and produced 300 tons of NIS in 2021. They sell their macadamias both on the kernel market to South African factories and on the NIS market to Chinese buyers. However, they reported that they have more problems negotiating with the Chinese buyers, achieving lower prices, and also arguing on the quality ratios (outturn). Since the start of COVID-19 pandemic, they had problems with logistics to ship to China, with lack of containers and shipments that stayed too long in the port, leading to mold and rotting issues in the macadamias. Interestingly, they also stated that the conflicts about quality evaluation are also

¹⁴ Insight by Malawi macadamia expert Andrew Emmott: It has been influenced by the South African partners. In Malawi there has been a much lower rate of planting of Beaumont with some Malawian factories stipulating they will not process this cultivar.



present with the South African factories. The quality control and negotiation process for macadamia constitute two important challenges for macadamia producers, as they would usually wait at least one year after sending their products, to discover which quality and prices they will receive.

In the end, the management of DD Farming explained that these issues would be very much mitigated with a local factory. They are even planning on building one for DD Farming, but only in the long-term since they believe they would need at least 350ha of macadamia in production to consider building a cracking factory.

DD Farming has an unusual production model, based on low-investment and low-costs (no irrigation, no grafting, own production of seedlings¹⁵...). The management explained that they believed their model resilient, particularly in the case of a potential future drop of macadamia prices.

Study case in Zambézia: Murrimo Macadamia, Gurué district

Murrimo Macadamia is one of the two estates near Gurué (the other one is G&F Macadamia). This company is probably the one that currently produces the higher volumes of macadamia in Mozambique. This estate was first planted in 2012, and is now counting around 460ha of macadamia, with almost all of it in production. They plan to expand the macadamia plantations with additional 750ha.

The whole farm is equipped with drip irrigation, and protected with double electric fences, which means high investment. Around half of the trees are of the cultivar Beaumont, and the rest is mixed with A4, 814 and 849. The management reports pests' problems due to the proximity of tea estates, that foster the tea mosquito bug (*Heliopeltis*).

The harvest period is between March (for the cultivar A4), and June (for the Beaumont). They also have a cultivar that produces all year round, the 791, but they don't favor it since it will complicate the farm operations (sprayings, harvesting...). In this climate, the macadamia nuts of the Beaumont don't drop by themselves when mature, Murrimo's teams need to spray them with ethenyl.

The estate produced around 1'000 tons of macadamia last year, of which 20% was sold on the NIS market to China (passing through Vietnam since Mozambique cannot export directly to China), and 80% was sold on the kernel market to South African cracking factories. It is interesting to note that last year the ratio was reversed with 80% to China and 20% to South Africa. Murrimo's commercial team reported big logistical issues that tripled costs of shipping nuts to China, but also to South Africa. They are beginning to consider sending the containers by road to South Africa, and not by sea freight as before, even though it could lead to more damages to the nuts during transport.

In terms of negotiations, Murrimo's team doesn't think that one market is easier to deal with than the other. They believe that it all depends on the relationship kept with the Chinese buyer, or the



Image 25: Localization of Murrimo Macadamia

¹⁵ Seedling production should be very well managed and monitored to make sure that the varieties planted are known. If not, it can lead to kernel quantity and quality inconsistency, just like in Kenya.



South African cracking factory. Each year they review their contracts and adapt the volumes sold on each market depending on the conditions they can obtain. It seems like Murrimo relies on its market positioning, its ties with the South African industry through its investors, and its big volumes of quality nuts in order to have more negotiating power. The management shared that they also consider the building of a cracking factory in a horizon of 12 years.

5.3. Macadamia Producers Association



The Mozambique Macadamia Association (Associação de Macadâmia de Moçambique- AMM) was created in 2020 at the initiative of several commercial macadamia producers, mainly from the province of Manica. Its ambition is to federate, on a voluntary basis, Mozambican macadamia producers and convey their questions and proposals to the Mozambican Government through the IAM, IP and others institutions in the context of public-private dialogue.

The Association, recently created, gather 9 Macadamia producers¹⁶ out of the 46 existing in the country¹⁷. However, it has already carried out some activities with IAM, IP, such as the organization of two technical workshops, and has also joined the Confederation of Economic Associations of Mozambique (CTA), the International Nut and Dried Fruit Council (INC) and is in the process of membership to the World Macadamia Organization.

The creation of an organization such as AMM is a good step towards the consolidation of the macadamia sector, it is always positive to have a representation of the producers that can discuss critical points of development of the value chain with the Government. Therefore, it is hoped that the AMM would be able to federate more producers in the country to constitute a broader representation of their various interests in its dialogue with the Government.

A positive point is that all macadamia growers agree on the advantages of having public representation, and would like to join an association. They all have a relatively similar vision on how to develop the Mozambican macadamia value chain. In addition, several producers also showed interest in a technical assistance and knowledge transfer platform, which could be another AMM assignment, in collaboration with IAM, IP.

In conclusion, the creation of the AMM is a very positive step for the structuration of the Mozambican macadamia value chain, allowing technical advances through R&D programs and knowledge transfer between producers, and facilitating communication with the IAM, IP, others public institutions and the private sector.

¹⁶ Information from Arnaldo Ribeiro, President of the AMM, August 2022.

¹⁷ Information from IAM, IP, August 2022.



5.4. Challenges with commercialization

Unlike cashew, the market for macadamia in Mozambique is not very liquid, meaning that it is not easy to sell the nuts. In the cashew market, there are lots of factories, exporters and collectors, which facilitate tremendously the sale of the nuts.

As it has been said previously, macadamia market is smaller, and much more “niche” than cashew. Relationships between producers, factories and importers take more time to consolidate, and are more ruled by trust. This makes the commercialization of macadamia complicated, and depending strongly on an excellent network of buyers and on good reputation (in particular the volume and quality of nuts), which are both achieved on the long-term. It is particularly true in Mozambique, where there are no factories, no individual collectors and only a handful of active producers.

In this situation, most of the macadamia producers interviewed in Mozambique reported having difficulties with the commercialization, both with Chinese NIS importers and South African cracking facilities. These challenges are various:

Logistical issues:

Sea freight is becoming more and more challenging, mainly due to the pandemic situation these past years. As it can be seen on **Image 26**, all sea freight costs indexes have experienced dramatic increases in 2020, and reached record peaks in 2021. This trend is expected to slow a little in 2022 but will still stay at a high plateau. The increases of fossil fuel prices in March 2022 due to war in Ukraine will certainly have long term influence on freight costs.

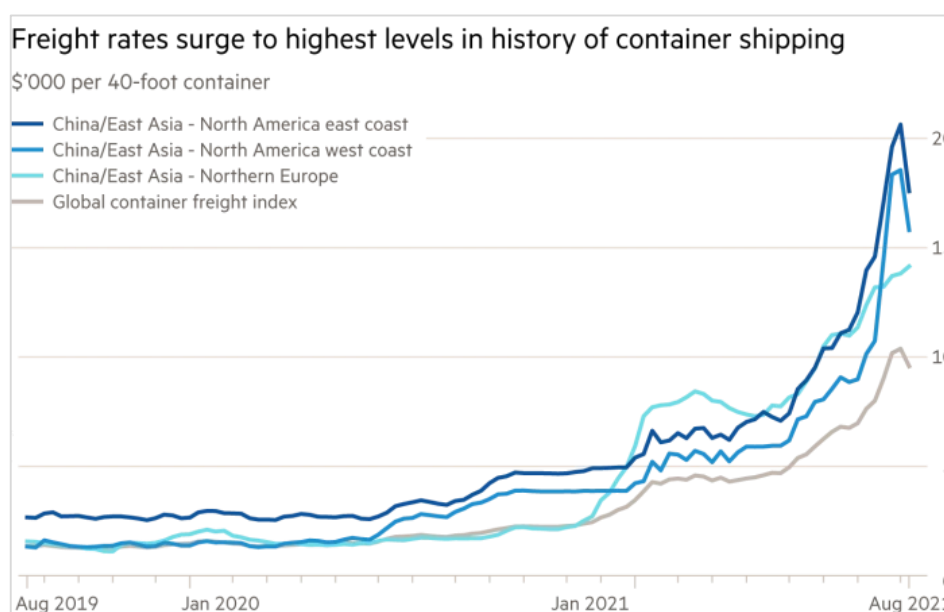


Image 26: Sea freight costs evolution- Source: Freightos

Apart from the surging costs of freight, other issues such as delays impacted negatively on macadamia shipments from Mozambique. The interviewed macadamia producers all experienced



shortages of containers, with macadamia shipments sitting under the sun at the port for several weeks, even months sometimes. In these conditions, risks are very high that mold develop in the shipment, decreasing dramatically its quality and value.

Late payments impact heavily on cash flow

In addition to the logistical delays, it is common practice among macadamia buyers that payments are made after reception of the nuts, and after assessment of the Sound Kernel Ration (SKR), which is the rate of kernel without defaults. Then there is also a payment term that can vary from one contract to another. Taking all in account, a macadamia producer can receive the full payment of its production up till 10 months after harvest. These late payments have a heavy impact on the cash flow, and needs of working capital of the macadamia producers.

Hard negotiations

As explained in the introduction of this part, new macadamia producers, with low volumes of production have lots of difficulties with negotiations. They are usually forced to agree to very hard conditions such as late payments. Also, when the macadamia producer does not have the opportunity of cracking its own nuts, or does not have a good partnership with a cracking factory in South Africa, he cannot assess its own SKR. This leaves the macadamia producer with no arguments to negotiate the SKR assessed by the buyer, and he is then forced to accept the offered prices.

6. Overview of the regulations in producing countries

Nitidæ already produced and shared with IAM a benchmark of the types of regulations currently used by the main producing countries. The content of this note has been used and completed for this paragraph:

First of all, it is of importance to note that none of the leading producing countries (Australia, South Africa) has a dedicated strict regulation for macadamia. In these two countries, the macadamia value chain is very well organized, with producer and processor association. The sector is liberalized and ruled by the market expectations. Contracts and prices are based on agreements between producers, processors and exporters, and related to quality of the nuts, and international market prices. This absence of regulation allows the value chain to be flexible, a key advantage for such a niche and fluctuating market as macadamia. Indeed, actors such as producers or processors must rely on several options to follow the evolutions of the market – for example sell both on the NIS or the kernel market (see subchapter 4.3). That being said, some measures are in place to organize the value chain:

In the case of South Africa, a statutory levy created by the SAMAC¹⁸ (the South African macadamia growers' association) was implemented in 2014 which represents R0,62 (=0,04 USD = 2,62 MZN) paid by the producers per kg of DIS delivered to the processors. This obligatory levy is the continuation of a voluntary levy that was in place since the 1970s. The money from this levy is

¹⁸ Insight from Marcos Agnese – Macs in Moz: The AMM has a certain fee which each member has to pay annually and related to produced volumes, which has not to be confused with the levy of SAMAC, which principles are a bit different.



collected and managed by SAMAC which uses it to fund agronomical research and integration of smallholders into the value chain. **The levy is not related to the South African Ministry of Agriculture, which in a certain sense explains its success and adoption amongst the macadamia producers.**

The other regulation in place is the obligation of obtaining an export/quality certificate from the Perishable Products Export Control Board (PPECB) to export a container of kernel or NIS out of South Africa. This certificate exists to prevent the development of illegal exporters - smugglers, which is frequently related to thefts of macadamia¹⁹. Apart from these two measures, the South African macadamia market is completely driven by a free-market system.

The only major producing country that adopted a strong regulation is Kenya. In this country, the government adopted a ban on NIS export, which disrupted significantly the macadamia value chain. As it is explained in the part 7.1, this type of regulation helped maintaining the Kenyan macadamia processors competitiveness against Chinese buyers, but eventually at the expense of the macadamia farmers. Today, Kenyan smallholders can only sell their nuts to Kenyan cracking factories, which led to important quality issues, precarity of the farmers, and the maintenance of a black market and smuggling activities. Some practices detrimental to the macadamia quality are even stimulated by the current situation: farmers are convinced to harvest too early their nuts and sell them to collectors in order to get incomes during lean season. This leads to a high ratio of immature nuts in the Kenyan production, jeopardizing its image among the importers.

In the end, even if the Kenyan regulation was designed with the objective of protecting the Kenyan macadamia industry and organizing the value chain, it led to an increase of precarity among its farmers, and a hard feeling of distrust between the producers and the processors, which impacts also the general quality of the nuts.

In Malawi, there is no regulation applied to the macadamia market. The only initiative that was attempted is the implementation of a public policy obligating processors to consider 60% of the nuts bought to smallholders as "grade A macadamia". This policy was created to secure higher incomes to smallholders whose nut quality is poor. However, this policy is largely disregarded and ignored by the processors since the government has not sufficient power to enforce it over them, and it has no sense for the processors. Also, even if the goal of such a policy is interesting, it cannot bring good impact on the value chain on the long term because it does not incentivize farmers to produce quality nuts. Much the contrary, it gives the wrong impression to farmers and complicate the transparency of the value chain. In March 2022 the Malawi Macadamia Association was established to help coordinate activities of all producers, commercial and smallholders, and processors²⁰.

In Zimbabwe, regulation of macadamia is well defined. There is a tax of 1,5% paid by the buyers on the value of the nuts, the money is transferred to a fund of commercialization for agricultural products, but it is not clear if it is used for macadamia value chain development. In addition, the Ministry of Finance is supposed to set a minimum price for the purchase of macadamia nuts; **however, as ever minimum price policies not backed by price risk management mechanisms are ineffective, potentially destabilizing and impacting negatively the producers and the whole value**

¹⁹ Insights from South African macadamia expert Phillip Lee, CompleteLee Nuts Consulting

²⁰ Insights from Malawi macadamia expert Andrew Emmott



chain. Finally, every actor of the macadamia business must be officially registered, and any transaction must be entered in the official registry with all the information related to the transaction.

Even though the macadamia regulation is well defined in Zimbabwe, it seems like it has been created prematurely. Indeed, the macadamia sector is just beginning, with no significant volumes produced and very few actors. In this context, it is not possible to assess the efficiency of such a regulation. However, the fact that the money raised from the tax is not clearly dedicated to be reinvested in the macadamia value chain is not wise, it is not possible to know if it will contribute to the development of the sector and can create some mistrust between the government and the private sector. Also, the minimum price policy may not be adapted to such a market as macadamia, since the price of the nuts are much more linked to quality and each contractual agreement.

In conclusion, it would seem like the macadamia value chain of the successful producing countries thrived without dedicated regulations. The only measures that seem to work well and contribute to the development of the sector is the implementation of levies to fund long-term projects (research, smallholder support...). However, it is important to note that these levies were created and are managed by producers' associations, not a public institution. The obligation to register the actors of the value chain is also very important to bring more transparency and dissuade illegal activities.

7. Potential for the integration of smallholders

As it is described in part 4 and 5, the Mozambican macadamia value chain is promising, with adequate climate and an increasing demand on the market. However, up to now, the actors involved in the production of the macadamia are commercial growers, mostly private companies owned by foreign investors. This is due to the history of the macadamia market, which has been mainly led by commercial farmers.

This is why the question of the inclusion of smallholders into this rising value chain is important and constitute a key priority for the IAM and the Ministry of Agriculture and Rural Development. However, as it has been explained before, the macadamia value chain is very different from the cashew value chain. Macadamia market has its own rules and specificities that make the integration of smallholders much more complicated.

7.1. Study cases of smallholder inclusion in Malawi and Kenya

Malawi: integration of smallholders by commercial farmers seems successful

Malawi can be considered as a success story for integration of smallholders into the macadamia value chain. Indeed, macadamia was first introduced in Malawi in the 40s by commercial plantations, then in the 70s by smallholder farmers²¹. At first, smallholders did not consider macadamia as a cash crop, and poorly managed it. Then, the commercial actors, with the help of government support program, began to integrate more smallholders into the value chain, and improving their agricultural practices, mainly through outgrower schemes. This allowed smallholders to access the market and made macadamia more profitable to them, increasing their interest.

²¹ Insight from Malawi macadamia expert Andrew Emmott



For example, there is the Tropha Estate initiative that should be analyzed as a case study. It is a 1'170ha macadamia estate, constituted of 2 farms, and a 1000 tons cracking factory²². Their objective is to supply their factory both from the production of the estate and from 1000 surrounding macadamia farmers. There is a technical assistance program ongoing in order to support the farmers in the production of the macadamia with good quality standards. This project received a 5.7M USD support from a private investor in 2014.

Today, 90% of the Malawian macadamia production is done by 7 commercial plantations, and the rest is supplied by 3'850 smallholders that manage between 0,1 up to 4ha each of macadamia²³, with a maximum yield of 100 kg/ha. Macadamia is now considered as a profitable and low-input crop for the smallholders, with a total cost (with transport to factory) estimated at 200 \$/ha²⁴.

These smallholders are organized into 7 cooperatives, gathered under a major farmer organization called the Highland Macadamia Cooperative Union Ltd. (HIMACUL). The cooperatives aggregate themselves the nuts from their members in business centers, and send them to the HIMACUL that have its own drying and grading facilities. This concentration allows to reach higher volumes and sign contracts with better conditions with the factories. The cooperatives also provide a service of loans and input provisioning, since pests and diseases have a high impact on smallholders' production and nut quality.

In the past ten years, Malawian production increased only slightly²⁵, with annual variations (**Image 27**). It is believed that Malawi will duplicate its volumes in the next 5 years, thanks to the extension of macadamia farming by smallholders. Indeed, as it can be seen in **Image 28**, the areas where macadamia has been developed targeted the best suited climate regions, however there are still regions where it could develop further.

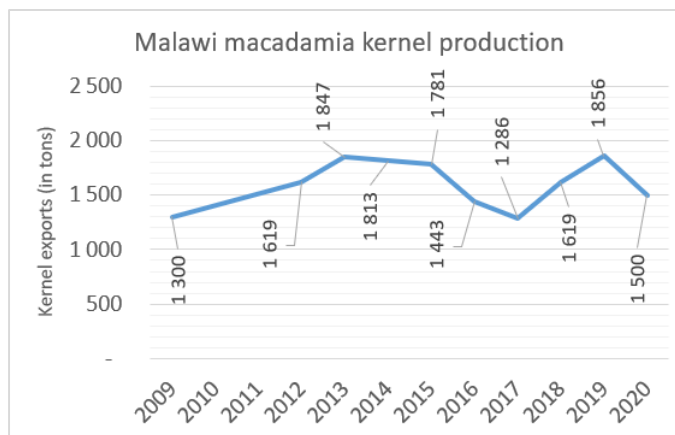


Image 27: Evolution of Malawi's macadamia production

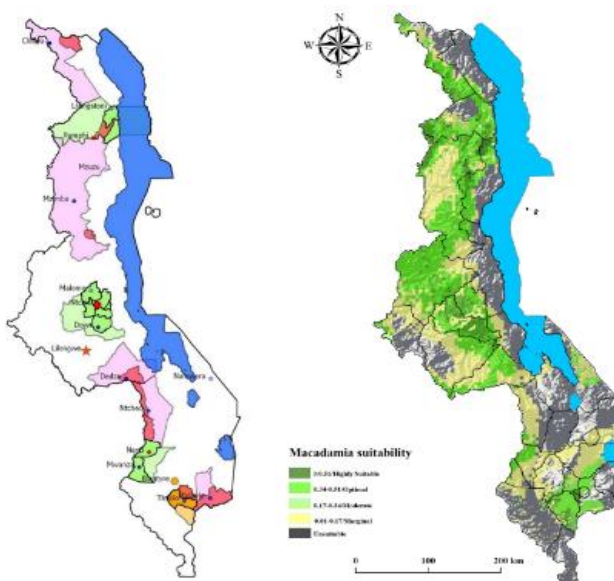


Image 28: Map of macadamia regions in Malawi¹⁴ (left) and map of suitability¹ (right)

²² AgDevCo [website](#)

²³ Review of Macadamia Production in Malawi, Emmanuel Zuza, 2021

²⁴ Can Malawi Increase its Share of the Global Macadamia Market? JP du Toit, FJ Nankhuni, 2018

²⁵ International Nuts Council (INC) statistics



Kenya: disconnection between producers and processors led to big quality issues, and low prices paid to farmers

Kenya is the African leader in terms of macadamia smallholders. As it is presented in the part 4.2.2, Kenya is currently the 4th producer of macadamia, with 90% of its production supplied by smallholders.

In the beginning, macadamia tree was introduced to coffee farmers as a shade tree, promoted by the government in the 80s, and supported by Japanese grants. It disseminated rather slowly at first, with only one processor (Kenya Nuts Company) that

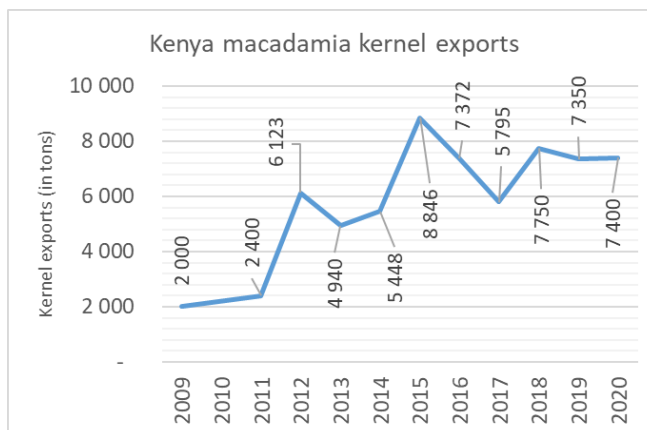


Image 29: Evolution of Kenya macadamia production

achieved to distribute over 1,5 million seedlings to farmers in 1997. These distributions of seedlings were not always done with the best commercial varieties (*Macadamia tetraphylla* which is not appreciated by the market because of its rough shell), leading to quality issues later on. With the liberalization of the macadamia market, competition increased in the industry, with entrance of new processors in the business, and the democratization of the use of middlemen in order to facilitate the aggregation and transport of the nuts to the processors.

Then, in the early 2000s, China began to increase dramatically its demand for macadamia nut-in-shell, which led to the arrival of many Chinese importers in Kenya. These importers proposed higher prices and quicker payments than the factories. In 2008, it was estimated that 60% of the Kenyan production of macadamia have been exported as nut-in-shell by Chinese importers. The newly established cracking factories perceived Chinese buyers as a threat to their supply, strongly lobbying the government so that a ban on NIS export was enforced in 2009. From this point, processors multiplied and passed from 5 to 30 factories, increasing momentarily prices paid to farmer to an historical peak of Sh200/kg (1,8\$/kg) in 2019. However, in 2020 and 2021, this price dropped between Sh30 and Sh50/kg (0,27-0,45\$/kg), due to the lack of outlet of the Kenyan factories.

Since the 2009 ban on NIS export, the Kenyan processing factories found themselves in an oligopolistic situation where they could pay lower prices to farmers without fearing the competition of the market price, led by Chinese imports. This situation is clearly at the advantage of the processors and at the expense of the producers. Several protests have been led by Kenyan farmers in order to lift the ban, and re-equilibrating the prices on the market price.

Apart from being a value-sharing issue along the value chain, this export ban is putting macadamia farmers in dire financial situation, leading to immature harvests and an increasing disregard for quality improvement. The nuts quality, which was already low because of variety issues, is decreasing because of the lack of incentive of the farmers, that prefer to focus on currently more profitable crops such as coffee or tea. Quality is becoming more and more a key competitive advantage on the very niche macadamia market, and the low-quality issue is today a big challenge for the Kenyan macadamia processors, who are now in competition with new market players such as Malawi, Guatemala and such.



The main lesson that can be drawn from the development of macadamia in Kenya is that agricultural public policies should not intensify the misalignment of interest between macadamia producers and processors. In the case of Kenya, the enforcement of the ban of NIS export helped local processors, but clearly put farmers in a disadvantaged position, decreasing their interest for macadamia cultivation, and for quality improvement of the nuts.

In parallel, a sound development of the value chain can be fostered taking as an example the Malawi, where government's support to commercial producers allowed a successful integration of the smallholders through outgrowers schemes, ensuring technical support and market access.

7.2. Agronomical and commercialization challenges for smallholders

Firstly, the macadamia producers interviewed all report that macadamia is a very technical crop, that requires expertise and capital investment. They put forward as main arguments the long cycle of the tree, which needs at least 5 to 7 years before first harvest, the high impact of irrigation on the yields, and the alleged sensitivity to diseases and pests. These arguments are legitimate and true; however, they seem to be the same with other nut trees such as cashew, and they did not prevent smallholders from producing them. Even though it turns out that macadamia is a particularly sensitive nut tree, the study cases of Malawi and Kenya in part 7.1 show that it is not impossible for smallholders to produce macadamia nuts. Of course, it will not be with the same capital-intensive production model as commercial farmers²⁶, and quality expectations will be lower, but as long as it answers needs of farmers, and demand on the market, macadamia cultivation can be adopted by small farmers.

The other main argument put forth by the interviewed macadamia producers is the risk of pest's invasion from the smallholders' fields to their estates. There again, the examples of Malawi and Kenya seem to show that it is not common. Finally, the other risk worrying commercial farmers is the increase of thefts. This risk can be mitigated with a good traceability policy, and the implementation of a strict registry regulation to dissuade illegal activities (see part 6).

Now, it would seem that the biggest obstacles are on the commercialization. As it has been explained in part 4.3, macadamia is a niche market very difficult to penetrate. The level of trust and quality needed by the buyers make it quasi-impossible for smallholders to sell independently macadamia nuts. In Malawi and Kenya, smallholders have access to the market thanks to the presence of close-by cracking facilities, and outgrower programs supervised by commercial farmers, which is not currently the case in Mozambique.

The other possibility for smallholders to sell independently macadamia nuts would be through individual aggregators, that would then export to China for the NIS market. However, this scenario worries commercial farmers since it could encourage illegal activities. It would require a strong traceability system and regulation to control this activity, but it would provide an easy outlet for smallholders.

²⁶ For example, commercial farmers preferred cultivars won't be the most relevant for smallholders. Indeed, cultivars that produce all year round such as 791 will be preferred by smallholders for cash generation, whereas Beaumont, that needs spray of ethenyl to drop its nuts in some cases won't be practical.



As a conclusion, it would seem that the inclusion of smallholders in the Mozambican macadamia value chain will not be possible without a solid partnership with the existing commercial producers. That is why these actors should be supported and reassured by the IAM to foster their involvement. Several measures could promote the interest of the commercial farmers to include smallholders: (i) Facilitate the building of cracking factories with incentives; (ii) Promote outgrower programs with subsidies and technical support and (iii) Prepare a strong traceability system with official registry to prevent illegal activities.

8. Suitability map

Macadamia belongs to the Proteaceae family and is native to south-eastern Queensland in Australia²⁷. The two edible species are *Macadamia integrifolia* and *Macadamia tetraphylla*. Macadamia tree is vulnerable to climate influences such as temperature and precipitation variation²⁸. Macadamia production is therefore only possible within specific geographical and climatic ranges²⁹.

However, little is known to date about macadamia's suitability for cultivation in Mozambique. This analysis aims to delineate areas that are currently climatically suitable for macadamia cultivation under smallholder conditions. For this, we used Species Distribution Models (SDM) based on location data of growing macadamia orchards in Malawi, and climate data.

A multi-criteria analysis based on expert knowledge could be used and could give interesting results. However, this methodology requires precise data on the optimal growing conditions of Macadamia in Mozambique, which are not currently available.

8.1. Macadamia growing conditions and climate

The optimal growth conditions found in the literature are:

- Rainfall: Macadamia grows healthy and is productive in areas with well-distributed rainfall, totalling an average between 1000 to 1500 mm per year²⁸.
- Temperature: Optimum diurnal and seasonal temperatures for macadamia are within the ranges 14°C by night and 30°C by day, with prolonged periods outside this range having adverse effects on growth, yield, and quality²⁸.
- Soil: Most soil types are suitable for the production of macadamias, but poorly-drained clay soils are not suitable.

²⁷ Wasilwa L. et al. (2019) Macadamia nut propagation. Kenya Agricultural & Livestock Research Organization.

²⁸ Zuza EJ et al. (2021) Climate suitability predictions for the cultivation of macadamia (*Macadamia integrifolia*) in Malawi using climate change scenarios. PLoS ONE 16(9): e0257007.

²⁹ Barrueto A.K. et al. (2018) The suitability of Macadamia and Juglans for cultivation in Nepal: an assessment based on spatial probability modelling using climate scenarios and in situ data. Reg Environ Change 18.



8.2. Environment and climate in Mozambique

Mozambique is located on the South-East coast of Africa, bordered by the Indian Ocean in the East. The country has mainly lowland regions in the East and a few mountainous regions in the West of the country, reaching heights of up to 2,436 m (a). The climate is tropical to subtropical, with a semiarid region in the southern provinces and two seasons, a dry cool season from April to September and a rainy hot season from October to March. Annual rainfall ranges from 300 to 2050mm (b) and annual mean temperatures range from 12 to 27°C (c).

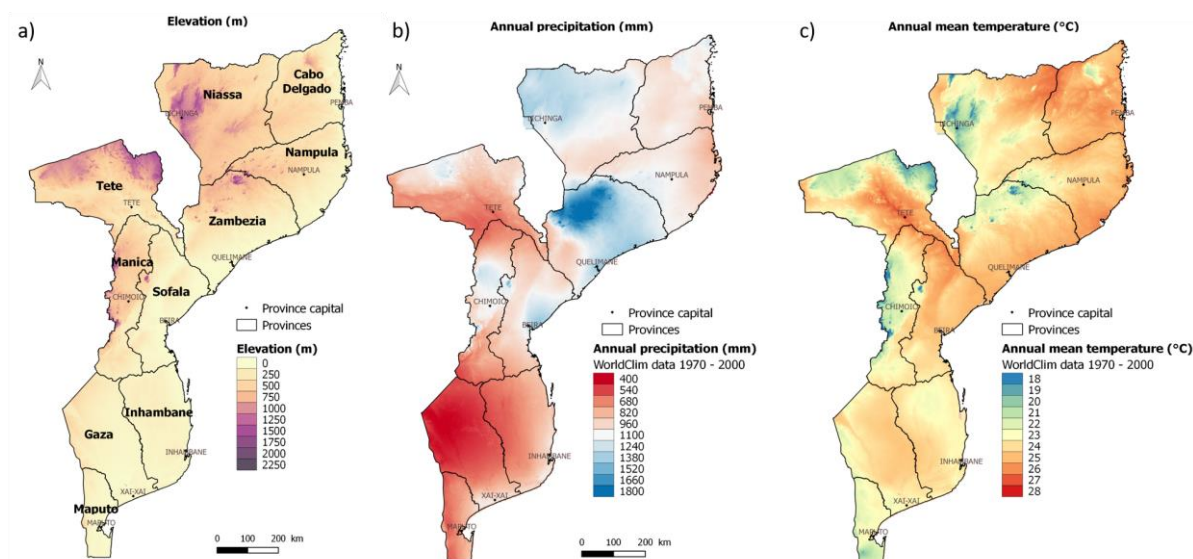


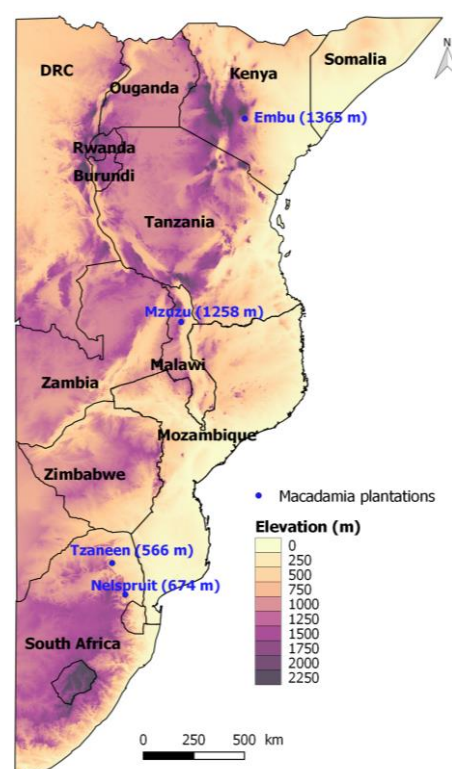
Image 30: Environment and climate in Mozambique: (a) Elevation, (b) Annual precipitation and (c) annual mean temperature over the 1970 – 2000 period (WorldClim data).

Mozambique is low at an average elevation of 345 meters above sea level, compared to other neighboring macadamia producing countries: Kenya= 762m, Malawi = 779m, South Africa= 1034m (Image 31).

As it can be seen on the map on the right, these countries have slightly higher altitude areas which are associated with lower temperatures. Also, the historical locations for macadamia in these neighboring countries are all on elevated zones.

For example, Embu in Kenya has a 1,365m altitude, Mzuzu in Malawi has a 1'258m altitude, Tzaneen and Nelspruit in South Africa have respectively 566m and 674m altitudes.

Image 31: Macadamia plantations and elevation in South East Africa.



8.3. Species distribution models

8.3.1. Methodology

Occurrence data :

Species distribution models require field data on the species presence and absence. In Mozambique no data on macadamia orchard under smallholder conditions exists. In the absence of such data, data collected in Malawi by Zuza et al., 2021³⁰ were used. These data consist of 84 locations of ten-year old macadamia orchard under smallholder conditions (Image 32).

After aggregation to match the resolution of the environmental data, sample size resulted in 80 occurrence points. Since we only have presence data, the insertion of pseudo-absence points is recommended to improve the prediction of the model. We randomly generated 1000 pseudo-absences points for the analysis.

=>As there are no points of occurrence in Mozambique, the results should be taken with caution.

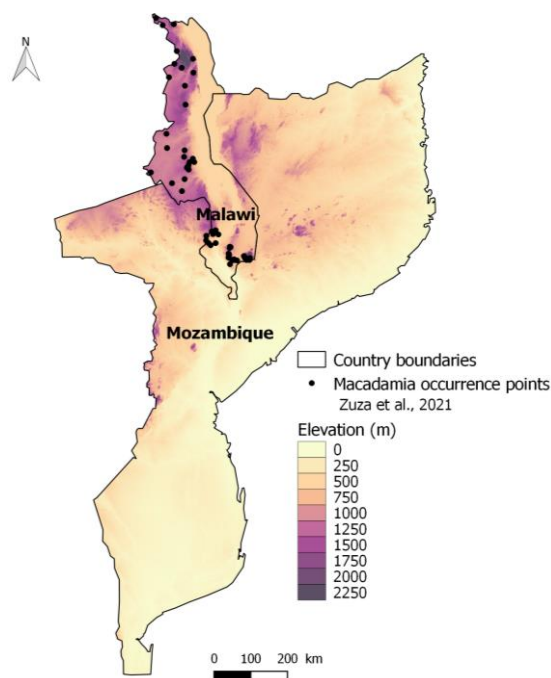


Image 32: Macadamia occurrence points

Climate data:

The 19 bioclimatic variables from WorldClim data set version 2.1 (<https://www.worldclim.org>) at a spatial resolution of 1 km x 1 km were used to produce the suitability map³¹. These bioclimatic

³⁰ Zuza EJ et al. (2021) Climate suitability predictions for the cultivation of macadamia (*Macadamia integrifolia*) in Malawi using climate change scenarios. PLoS ONE 16(9): e0257007.

³¹ Fick S.E. and Hijmans R.J., 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. Int. J. Climatol., 37, pp. 4302-4315



variables are derived from the monthly temperature and precipitation data and represent annual trend (e.g. mean annual temperature and annual precipitation), seasonality (e.g. annual range in temperature and precipitation) and extreme or limiting environment factors (e.g. maximum temperature of the warmest month and minimum temperature of the coldest month)³¹.

Variable selection:

To select variables and avoid multiple correlations between them that may result in overfitting or bias in the suitability model, a variable quality evaluation was used through the variable inflation factor analysis (VIF). We retained variables that had a VIF of less than 10 (**Tableau 2**).

Tableau 2: Bioclimatic variables used in the final suitability model

Covariate	Bioclimatic variable	Unit
Bio2	Mean Diurnal Range (Mean of monthly)	°C
Bio3	Isothermality (BIO2/BIO7) x 100	-
Bio8	Mean Temperature of Wettest Quarter	°C
Bio9	Mean Temperature of Driest Quarter	°C
Bio12	Annual Precipitation	mm
Bio14	Precipitation of Driest Month	mm
Bio15	Precipitation Seasonality (cv x 100)	-
Bio18	Precipitation of Warmest Quarter	mm
Bio19	Precipitation of Coldest Quarter	mm

Modelling approach:

We modelled and projected macadamia's current distribution in Mozambique based on an ensemble modelling method, with the ShinyBIOMOD, an R application based on the R package biomod2³². We used 9 modelling techniques: generalised linear model (GLM), generalised additive model (GAM), classification tree analysis (CTA), artificial neural network (ANN), flexible discriminant analysis (FDA) and random forest (RF), Multiple Adaptive Regression Splines (MARS), Generalised Boosting Model (GBM) and Maximum Entropy (MaxEnt).

First, the predictive accuracy of the 9 modelling techniques was evaluated using a cross-validation technique. The presence and pseudo-absence data were randomly divided into two parts: 70% of the data will be used to calibrate the model and the remaining 30% to validate and evaluate the predictive performance of the models. The performance of the models was assessed using the validation metrics of the Area Under the Curve (AUC) and the True Skill Statistics (TSS). An AUC and TSS value of 0.7 were used as thresholds to select modelling techniques to calculate the final ensemble model.

For each selected modelling technique an AUC is calculated and the probability values of species occurrence based on climate of each pixel. Results of all the models selected were then combined

³² Thuiller, W., Lafourcade, B., Engler, R. and Araújo, M. B. 2009. BIOMOD - a platform for ensemble forecasting of species distributions. - *Ecography* 32: 369 - 373.

by calculating for each the weighted average (weighted by AUC for each model) of the probability values from each model to generate the ensemble suitability map. Finally, the predicted suitable area for the probability of macadamia production was determined using a threshold value, ≥ 0.3 for suitable area and <0.3 for not suitable area.

8.4. Smallholder's macadamia production suitability in Mozambique

Results of the current suitability analysis using species distribution models reveal that only 7% (5,129,941ha) of the surface area in Mozambique is suitable for macadamia production under smallholder conditions (Image 33). Suitable areas were observed in the highland parts of the country, mainly in the Niassa, Zambezia, Tete, Manica provinces and in some parts of the Maputo province.

The most suitable areas for Macadamia production, in the context of smallholders, are located in the highland areas of the country. These areas have lower temperatures and higher annual precipitation than the lowland areas. In particular, the lowland areas in the south of the country in the provinces of Gaza, Inhambane and Maputo have an annual precipitation of less than 500mm per year and some parts of the Tete province have temperatures during the warmest months above 36°C. Some parts of the lowland areas in Mozambique are too hot and dry for good growth and tree health.

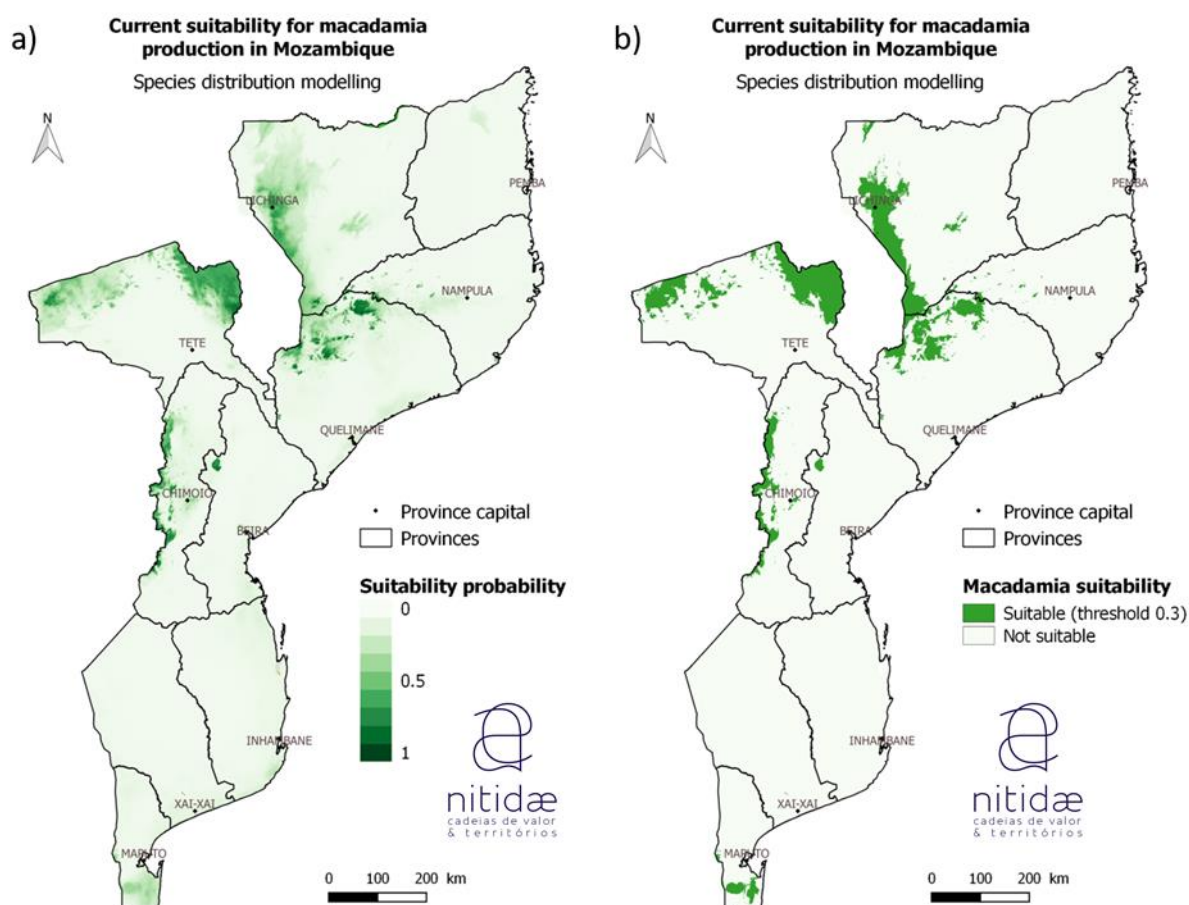


Image 33: Current suitability for macadamia production in Mozambique based on species distribution model: a) suitability probability, b) binary map (threshold value: 0.3).



9. Recommendations to IAM to consolidate the value chain

As explained throughout this report, the macadamia in Mozambique is still a very young value chain, which means that there are a lot of needs, and opportunities of improvement all along the chain. However, it also means that priorities should be set on the most impactful actions to be taken, this is important in order to coordinate efforts from the Government, the development partners, cooperation agencies, the private sector and the AMM. Indeed, one of the first priorities should be to foster the development of the primary production, focusing well on quality since macadamia is a niche delicacy market that is ruled mostly by reputation. Moreover, since macadamia is a long-cycle production, it is important to undertake this promotion early. In order to meet this objective, several actions should be undertaken:

In the short and mid-term (next 5 years):

1. To support the commercial plantations, several actions should be implemented:
 - Reinforce the existing pioneer macadamia producers:
 - Facilitate direct export to China³³ by obtaining the official origin certificate (see subchapter 4.3);
 - Facilitate the installation of new commercial producers and investors:
 - Postpone the implementation of a regulation (see chapter 6);
 - Promote the potential of macadamia in Mozambique (communication sheets).
2. To create a smallholder production basis:
 - Launch Public Private Partnerships (PPP) to co-finance the commercial farmers in implementing outgrower programs;
 - Support planting material distribution programs in the areas suited for smallholder macadamia farming (see suitability map, chapter 8);
 - Promote capacity building on quality standards requirements (see subchapter 4.3)
3. Foster agronomical research and experimentations, and knowledge transfer on macadamia
 - Support the AMM so that it can take in charge more technical exchanges (see subchapter 5.3) and trips to capture lessons learnt from major producing countries, and more advanced neighbors (Malawi). These technical exchanges should be realized in coordination with IAM, IP to ensure the transfer of knowledge to the public institution as well.

In the long-term (for example in a 5-to-7-year horizon): After having completed the priority actions mentioned above, other actions should be undertaken to develop further the value chain:

- Promote the processing of macadamia through investment incentives in local cracking facilities, which is planned by some macadamia producers (see subchapters 5.2 and 5.4).
- Re-assess the need for the implementation of a regulation based on the progresses to reinforce the value chain and the lessons learned along the first phase

³³ Insight by Marco Agnese 17.05.22 – Macs in Moz: Direct export to China is a debated topic among growers. This 2022 season, the DIS market is apparently facing challenges, because of various factors. There are a lot of unconfirmed rumors about what is going on in China, but for sure no-one of the brokers we know have offered a price so far, because it seems like China is currently not very keen to buy big volumes.

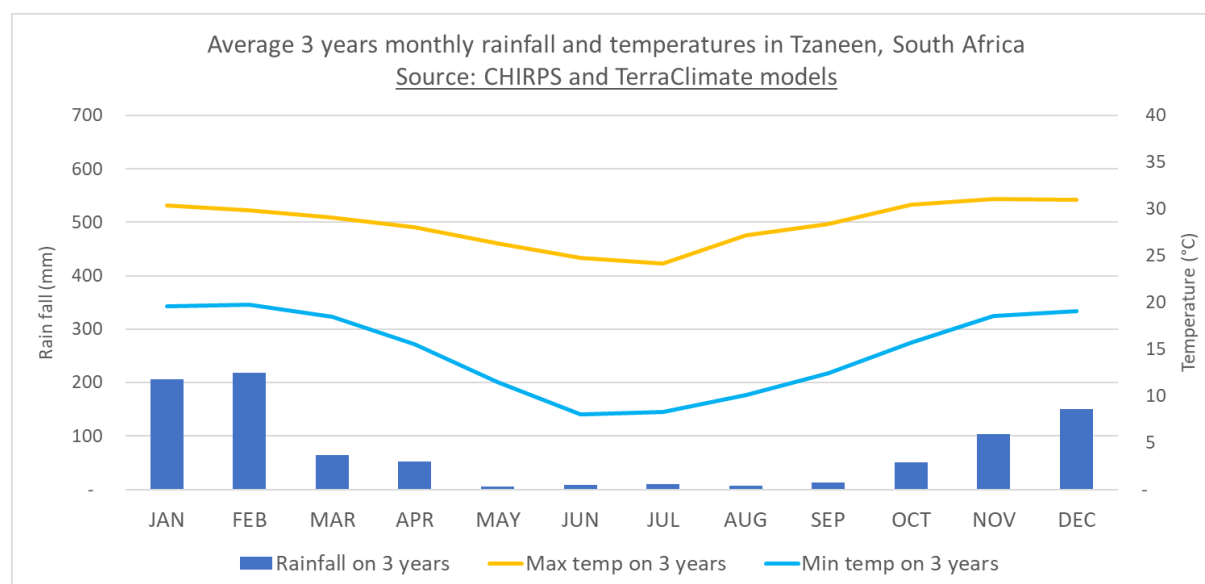
Annex 1: Comparison of rainfall between different macadamia growing regions in the world

Below are graphs of the rainfall volumes and repartition over the years, along with maximum and minimum temperatures, in the main macadamia growing regions in the world (Tzaneen and Nelspruit in South Africa, Bundaberg and Northern Rivers in Australia, Embu in Kenya, Mzuzu in Malawi, Yunnan in China), and in Mozambique (Manica – Chimoio, Niassa – Lichinga, Zambézia – Gurué, Inhambane and Maputo).

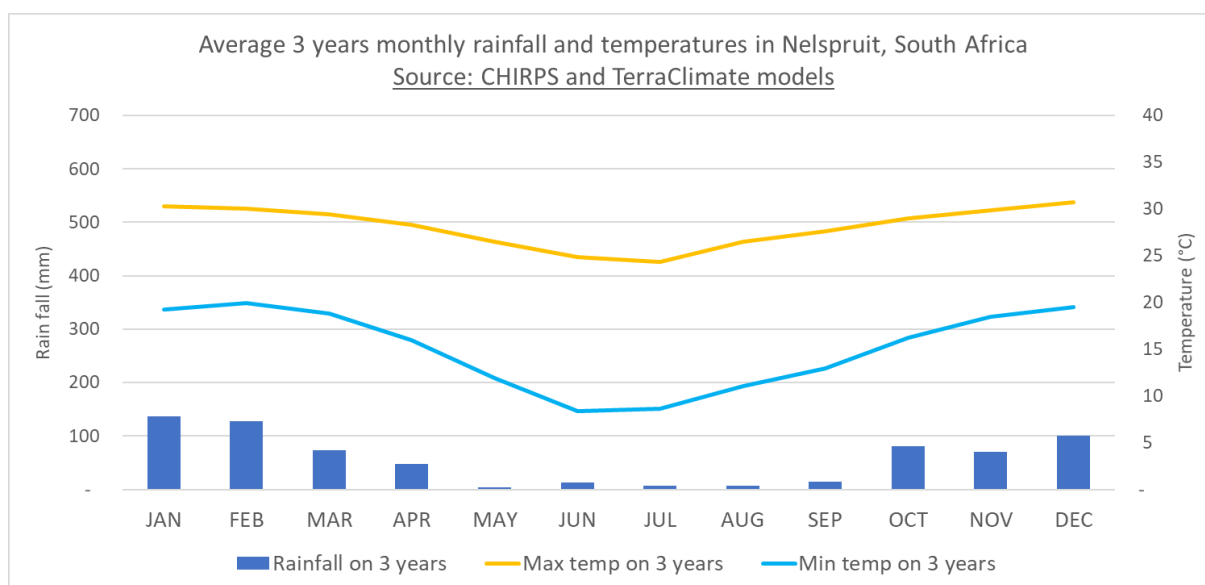
The following table are reference data about suitable conditions for growing macadamias, in the context of Malawi smallholders³⁴, which would be close to the Mozambican smallholders' situations.

Description	Category	Adverse	Moderate	Optimal
Minimum temperature of the coldest month.	$T_{\min}[^{\circ}\text{C}]$	≤ 1	1–4	5–10
Annual mean temperature.	$T_{\text{mean}}[^{\circ}\text{C}]$	≤ 9	10–15	16–30
Max temperature of the warmest month.	$T_{\max}[^{\circ}\text{C}]$	≥ 36	31–35	25–30
Annual rainfall.	Prec[mm]	0–700 & ≥ 1750	900–1000 & 1300–1750	1000–1250

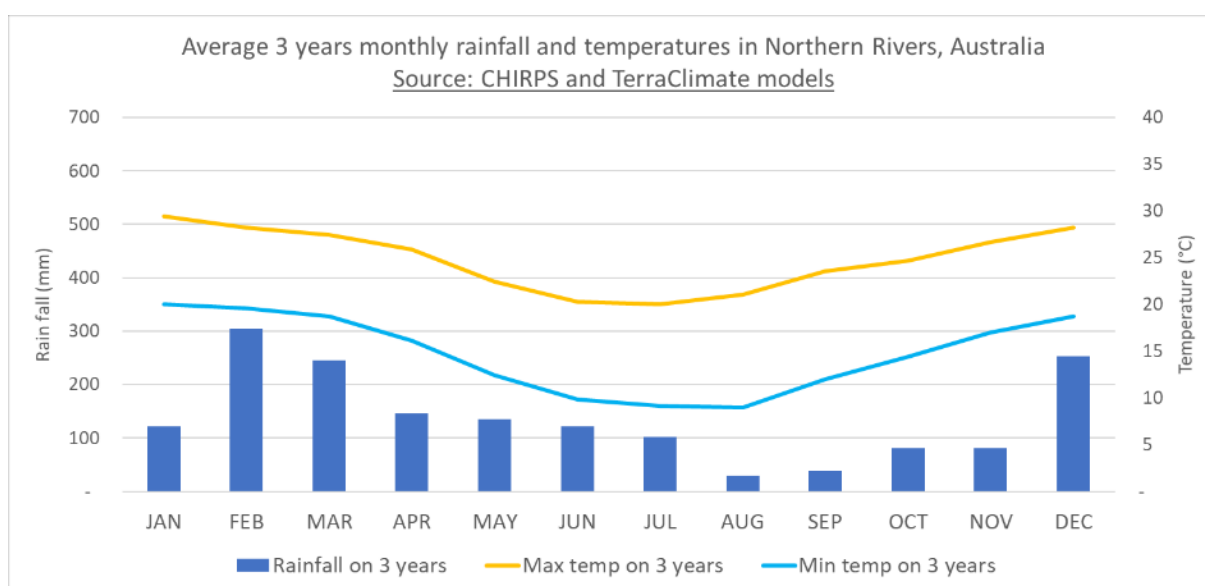
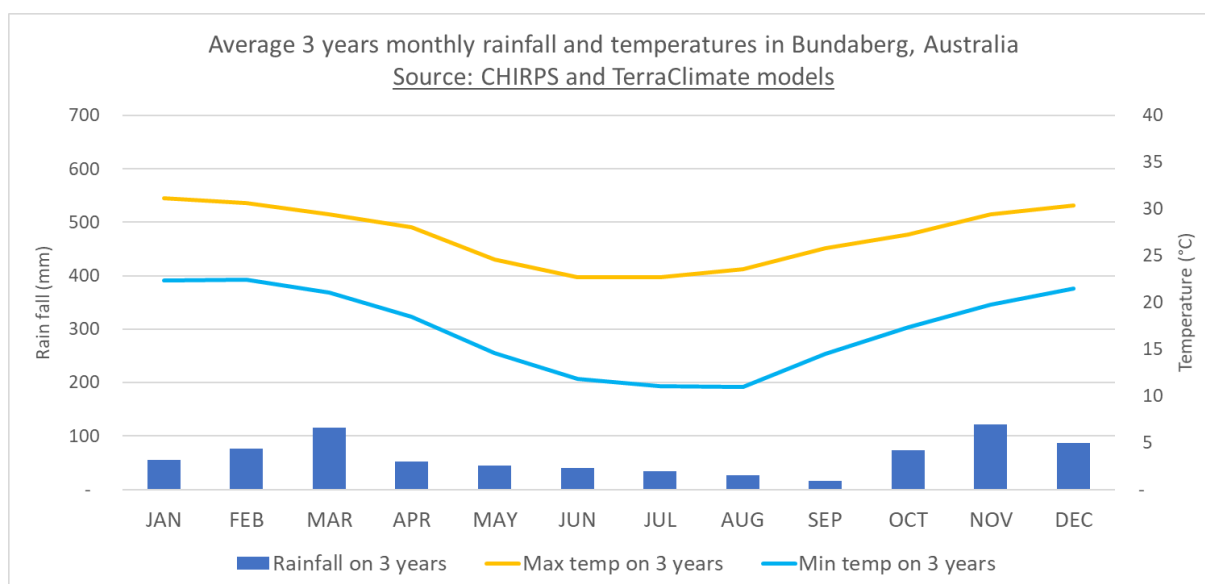
South Africa



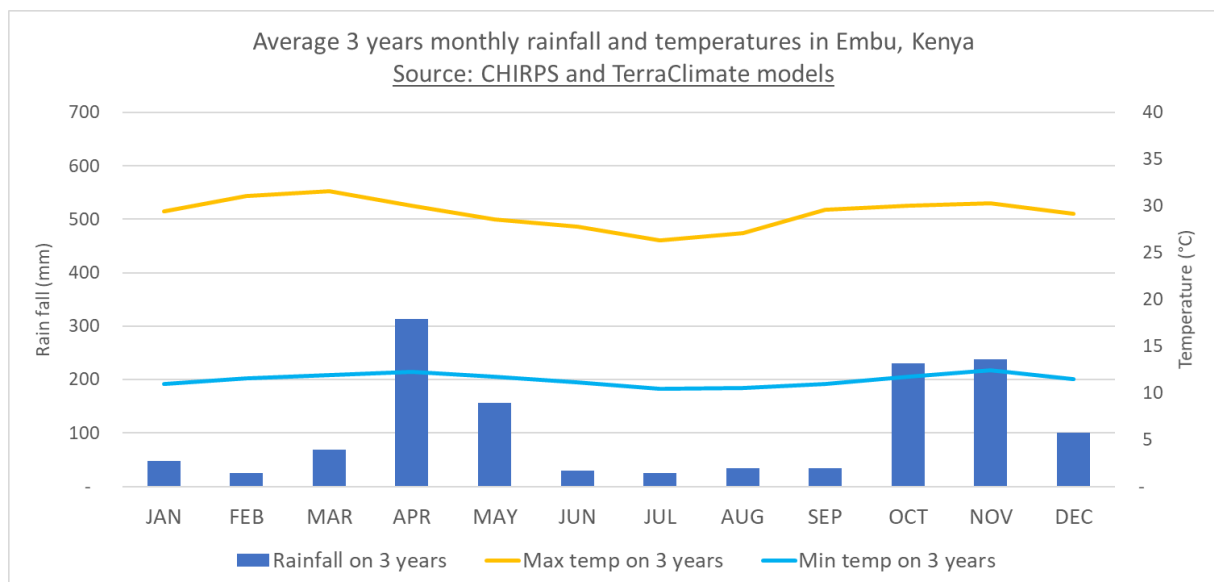
³⁴ Climate suitability predictions for the cultivation of macadamia (*Macadamia integrifolia*) in Malawi using climate change scenarios. Emmanuel Junior Zuza, Kadmiel Maseyk, Shonil A Bhagwat, Kauê de Sousa, Andrew Emmott, William Rawes, Yoseph Negusse Araya.



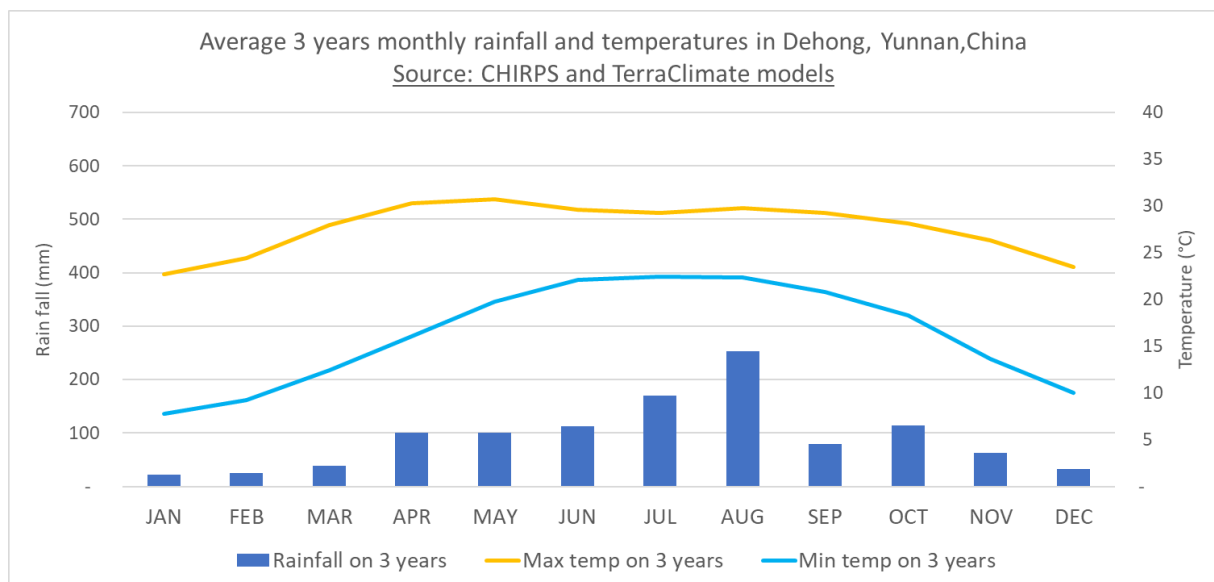
Australia



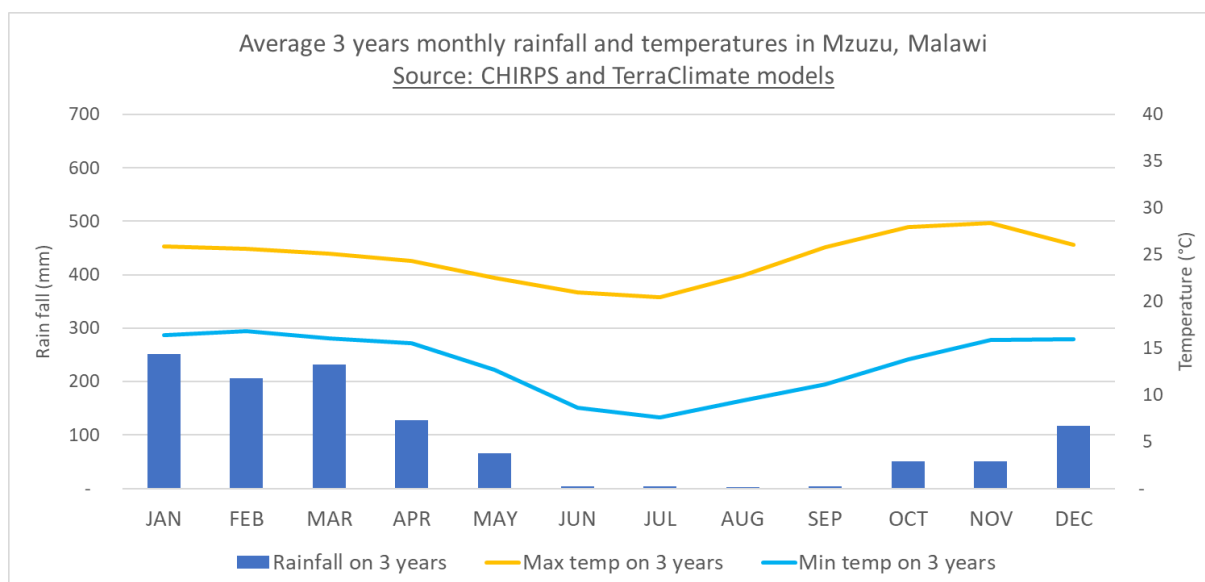
Kenya



China



Malawi



Mozambique

