LEUPHANA
Incubator

Macauba – Sustainable Palm Oil

Results of the Feasibility Study of the Leuphana University of Lüneburg - Executive Summary -

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European Union
European Regional Development Fund

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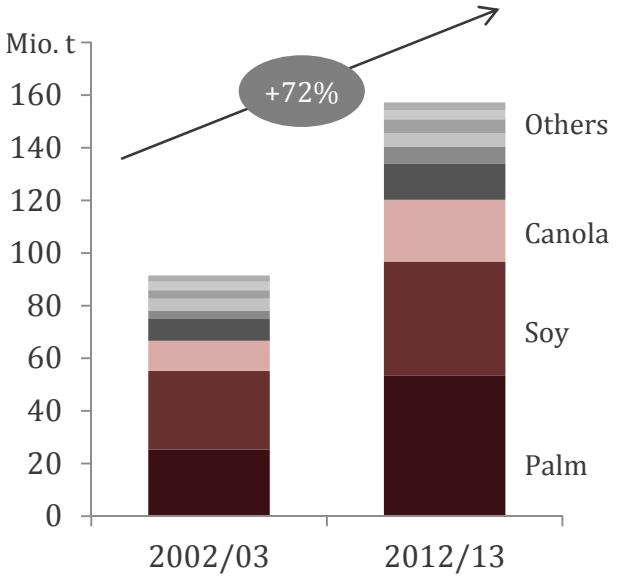
Background: plant oil demand is continuously rising – expanding production triggered deforestation in the past.

According to the U.S. Department of Agriculture (USDA), global demand for plant oil - for food as well as for fuel – has increased at a rate of 5% p.a. over the last decade and is expected to continue doing so in the future (USDA 2013).

Global Plant Oil Demand



Source: USDA 2013

The increase in demand is driven by population growth and feedstock demand from the biofuel sector and other industries (OECD-FAO 2012).

Rising plant oil production traditionally translated into higher demand for crop land. Particularly land for soybean and palm oil production – the most relevant plant oils on the global market (see left) – came at the expense of tropical forests in the past (May-Tobin et al. 2012, UNEP 2011, Schrevel et al. 2008).

Increased palm oil production has also negatively affected the rural poor in some area of Malaysia and Indonesia, which are the most important producing countries. The acquisition of large blocks of lands to set up palm oil plantations has triggered the destruction of livelihoods and human rights violation as smallholders were expelled from their land (Colchester 2010, UNEP 2011).

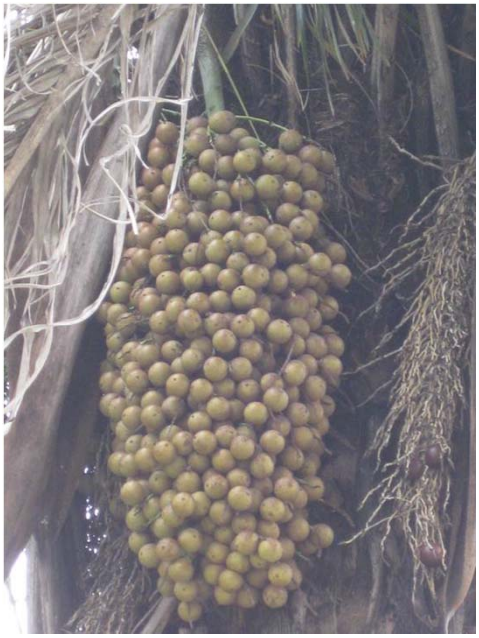
In the light of such negative impacts of increased plant oil production, it is thus crucial to identify more sustainable concepts to meet the world‘s growing demand.

Alternative forms of plant oil production without land use change required to avoid negative social and environmental impacts.

Our approach: produce large amounts of plant oil without land-use change.

Objective of the study

The objective of this feasibility study was to analyze whether Macauba (*Acrocomia aculeata*) Oil can be produced in so-called silvopastoral systems[1] **without land use change and in an economically and socially sustainable way.**



Macauba is a palm tree native to Brazil, which is frequently found on pastures. In contrast to oil palms cultivated in plantations today, Macauba needs less precipitation and therefore grows outside the typical rainforest zones. The tree produces fruits that can be processed into plant oil, animal fodder and a dense biomass granulate (Bhering et al 2010, Cargnin at al 2008, Da Mota et al. 2002, Ferrari & Filho 2012)

A study conducted by the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), indicates that – in contrast to other trees - the yield of pastures is not reduced by single Macauba palms. The authors find the grass to grow even better in the light shade of the palm (Villanueva et al. 2008). Moreover, about 50% of the dried fruit is used as animal fodder, which adds to the total fodder yield of the pasture.

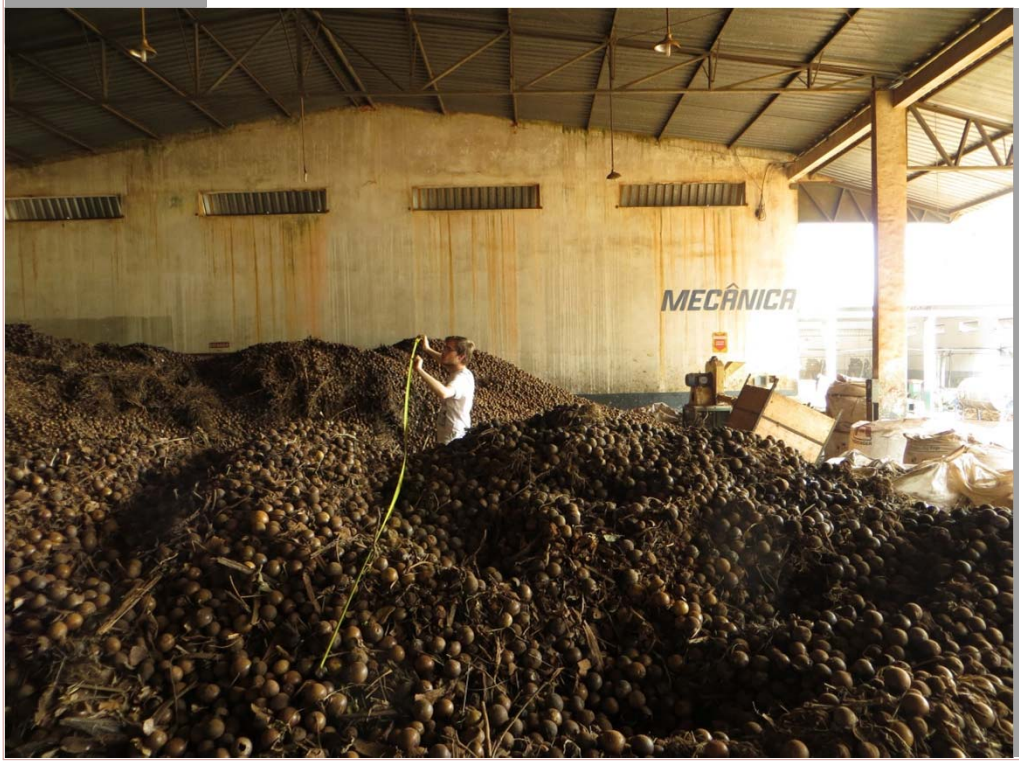
Macauba Oil can be produced without land use change – but is the production economically viable?

1 combination of pasture land and trees, shrubs or palms

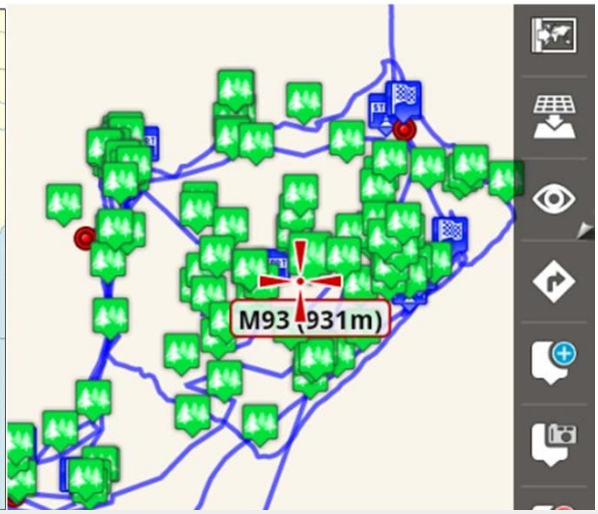
In a feasibility study we analysed the economic and social sustainability of Macauba Oil production harvesting 300t (!)

Methodology of the study

- Harvest of 300t of fruits from native Macauba palm trees growing on pastures in Minas Gerais (Brazil)
- Process the fruits to produce two types of oil, animal fodder (press cake) and granulate in a regional oil mill
- Measure times required for the harvest
- Measure fruit yields of selected, wild Macauba palm trees (n = 103)
- Analyze all cost factors in the harvesting process
- Analyze average revenues of harvest workers over the entire harvesting period
- Conduct qualitative interviews with 1/3 of the harvest workers focusing on working conditions and satisfaction levels
- Analyze costs involved in processing of fruits and logistics
- Conduct a market analysis of the value of all products
- Evaluate the economic viability of Macauba Oil production in silvopastoral systems



In the feasibility study in Minas Gerais workers used bamboo sticks with knives and managed to harvest the fruits quickly.



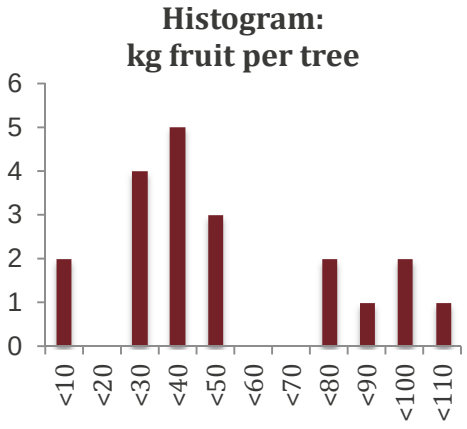
- The feasibility study was conducted in Minas Gerais, Brazil, at 900-1100m above sea level
- Harvesting method: Fruit bunches are cut off with knives fitted on bamboo sticks
- Results: average time to harvest a bunch of fruits was 17 seconds for Macauba palms not exceeding 10m

Tree ID	Start	End	Duration	# bunches	Seconds/ fruit bunch
16	0:03:49	0:04:18	0:00:29	2	00:00:15
23	0:07:50	0:08:09	0:00:19	3	00:00:06
24	0:08:45	0:09:00	0:00:15	1	00:00:15
25	0:10:30	0:10:35	0:00:05	1	00:00:05
26	0:10:57	0:11:45	0:00:48	4	00:00:12
70	0:14:13	0:15:00	0:00:47	2	00:00:23
71	0:15:30	0:15:43	0:00:13	2	00:00:06
72	0:16:43	0:17:14	0:00:31	3	00:00:10
73	0:17:34	0:17:43	0:00:09	2	00:00:05
74	0:17:58	0:18:36	0:00:38	2	00:00:19
75	0:18:54	0:19:47	0:00:53	3	00:00:18
61	0:22:54	0:23:33	0:00:39	2	00:00:20
63	0:25:08	0:25:40	0:00:32	3	00:00:11
62	0:26:06	0:27:12	0:01:06	3	00:00:22
41	0:31:50	0:32:55	0:01:05	3	00:00:22
42	0:33:04	0:33:23	0:00:19	2	00:00:09
45	0:33:37	0:34:45	0:01:08	4	00:00:17
44	0:35:18	0:35:25	0:00:07	1	00:00:07
33	0:37:32	0:38:16	0:00:44	3	00:00:15

Excerpt from the measurements

Measured fruit bunches were 17kg on average, each tree produced about 70kg of fruits.

	# Bunches harvested	Fresh Fruit (kg)	Old Fruit (kg)	Total Fruit (kg)	Avg kg fruit per Bunch
Total	*54.00*	*941.89*	*468.96*	*1410.85*	
Average	***2.70***	***47.09***	***23.45***	***70.54***	***17.44***
StDev	*1.03*	*30.16*	*18.76*	*28.98*	*6.79*
25-Percetile	*2.00*	*28.19*	*9.65*	*50.14*	*14.09*
Median	*2.00*	*36.86*	*20.23*	*66.79*	*17.34*
75-Percentile	*3.25*	*72.41*	*32.07*	*90.32*	*20.59*
Min	*1.00*	*4.11*	*0.00*	*24.34*	*2.06*
Max	*5.00*	*102.45*	*81.15*	*129.23*	*29.90*



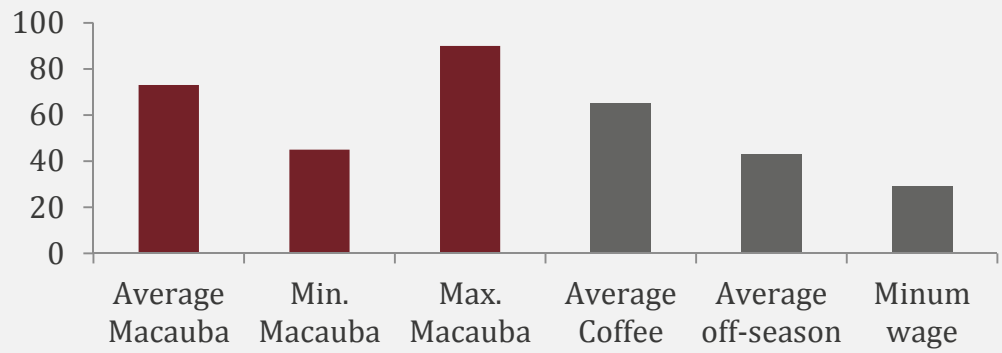
- Fruit bunches of all Macauba palms in the testing area that could be harvested were measured.
- Fresh fruits were defined as those cut from the palm tree, old fruits defined as those picked from the ground around each tree.
- The volume of fresh fruits harvested amounted to 47kg per tree, old fruits added another 23kg.
- Each fresh fruit bunch was 17kg on average.

Average yields measured in our feasibility study were slightly below values found by Novaes in 1952 (82kg/palm), Wandeck & Justo in 1988 (95kg/palm) and Roscoe in 2007 (76kg/palm). The values exceeded yields measured by CETEC in 1983 (65kg/palm) and those indicated by Pimentel et al. in 2009 (45-50kg/palm).

Workers involved in the Macauba harvest earned more than twice the minimum wage.

Over 200,000 rural workers in Minas Gerais work in the coffee harvest (Instituto Brasileiro de Geografia e Estatística 2010). After the coffee harvest the number of workers on the farms decreases and unemployment rates traditionally rise. The Macauba harvest takes place after the coffee harvest (November-January), thus creates off-season income opportunities. In the context of the feasibility study, we analyzed the average incomes of workers involved in the study as well as their opportunity costs as one indicator of the social sustainability of Macauba Oil production in silvopastoral systems.

Average incomes in Brazilian Reais per day



Workers earned on average more than twice the minimum wage and significantly more than in potential alternative jobs during the off-season. 100% of the workers interviewed said they want to work in Macauba harvest in the next season.

Data collected in the study indicates that Macauba Oil can be produced economically sustainable at current market prices.

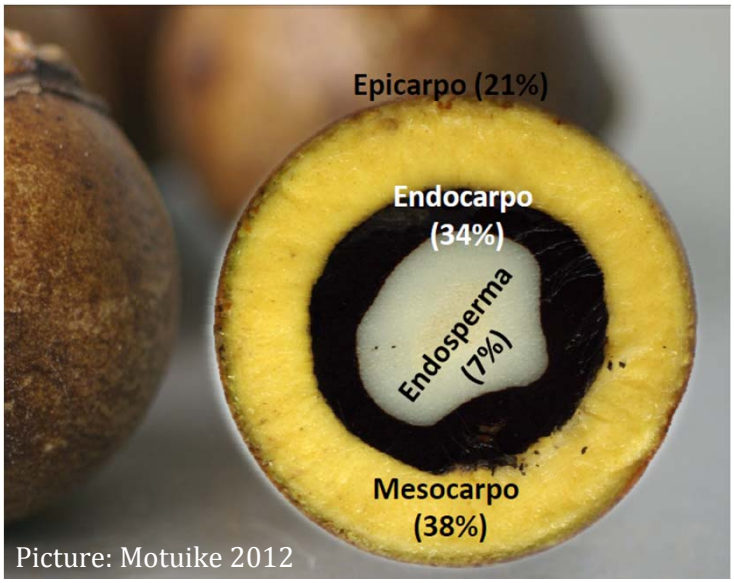
Costs and revenues

Costs analyzed in detail in the feasibility study included labor costs, logistics, storage, drying, pressing of oil as well as amortization and depreciation of machineries.

Revenues can be derived from all parts of the fruit:

Macauba Pulpa Oil: an oil with a fatty acid composition similar to canola or avocado oil with >60% oleic acid (Duarte et al. 2010).

Macauba Kernel Oil: an oil with a fatty acid composition similar to palm kernel oil with a high share of lauric acid (>40%), suitable for the chemical industry.



Picture: Motuike 2012

Endocarp: the dense inner shell can be used as a feedstock for activated carbon. In addition, it is currently tested in sandblasting and cosmetics as substitute for granulates of other nutshells such as walnuts.

Macauba Pulpa and Kernel Presscake: is already used as animal fodder, today with a metabolizable energy content similar to corn silage, yet lower protein content.

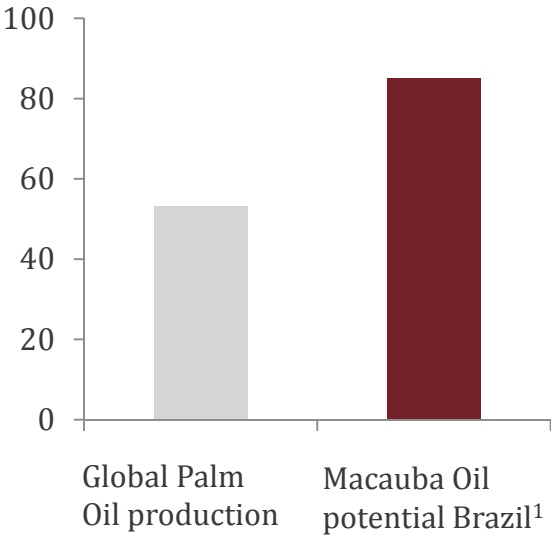
The market analysis included a large number of interviews with industry experts. Moreover, product samples have been send out to companies in various industries.

At present market prices[1] the production of Macauba Oil in silvopastoral systems is economically sustainable while creating incomes above minimum wages and avoiding landuse change

1) Reference prices: average world market prices for palm and palm kernel oil/ soybean oil prices

Avoiding land use change, the production potential of Macauba Oil in Brazil exceeds global Palm Oil production.

Palm Oil and Macauba Potential



Pasture area in Brazil totaled 170 million hectares in 2010 (SECOM 2010). If 50% of those pastures were converted into silvopastoral systems with 200-300 palms per hectare, the Macauba Oil production could exceed today's global palm oil production (USDA 2013).

Without converting a single hectare of arable land or forest, Macauba has the potential to become the world's most important vegetable oil.

In addition to Brazil, Macauba is native to other South American countries such as Paraguay, Colombia, and parts of Argentina , which could equally be suitable for silvopastoral systems

1) Estimate based on 50% of Brazil's pasture with yields of 1ton of oil per hectare (a conservative estimate)

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