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Contribution to the Protection of the Amazon Rainforest of Brazil from Deforestation

Improvement of value creation process for Brazil Nuts through adapted technologies instantiated in a solar dryer for Non Timber Forest Products

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Executive Summary

Deforestation of the Amazon rainforest is one of the main factors causing climate change and the loss of biodiversity. The main reasons for deforestation in the Amazon region are medium and large scale cattle breeding, large scale soya-beans agriculture, timber extraction, and land speculation.

Calculations of specialists conclude that trade in Non Timber Forest Products (NTFP) such as nuts, fruits, roots etc. has more economic value in the long term than cutting the rainforest down for cattle or timber. By encouraging the inhabitants of the rainforests to use the forest in a sustainable way and by creating new and sustainable sources of income, the deforestation of the rainforests can be suppressed.

The commercialization of NTFP is an opportunity to increase the income of forest inhabitants while preserving the forest. One of the most commercialized NTFP in the Amazon rainforest communities is the Brazil Nut. The supply of Brazil Nuts is limited since the Brazil Nuts only prosper in the Amazon rainforest of Bolivia, Brazil, eastern Colombia, Ecuador, Guianas, Peru, and Venezuela and are demanded worldwide.

This thesis describes ways to increase the value of Brazil Nuts for the inhabitants of the Amazon rainforest communities Sao Carlos do Jamari and Cunia, in the of state Rondônia, Brazil. In order to empower the inhabitants in increasing, improving, and developing their work with Brazil Nuts, the traditional knowledge on the Brazil Nut process has been analyzed. This knowledge has been compared with the industrial and scientific knowledge on how to process the nuts. As a result, both practices were evaluated in cooperation with the Brazil Nut harvesters of the communities.

Processes in the value chain of Brazil Nuts – in collection, processing, and commercialization – were analyzed; missing technologies were identified and artifacts were constructed. Available state-of-the-art devices have been adapted for the process of Brazil Nuts and adjusted to the needs and requirements of the Amazon rainforest communities. A process chain for Brazil Nuts was implemented exemplarily. The first experience in commercializing the final product as shelled, dried, vacuum packaged nuts has been made on the national market of Rondônia's capital Porto Velho.

The implemented project has encouraged the inhabitants of Sao Carlos do Jamari and Cunia communities to improve their work with Brazil Nuts. Furthermore the interest of teenagers in Brazil Nuts has awakened what can prevent the loss of traditional knowledge in the long term, and the drain of young adults who move into cities and slums to find a source of income.

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List of Abbreviations

ASA	Arbeits- und Studien-Aufenthalte
COVEMA	Cooperative Verde de Manicoré
FMEA	Failure Mode and Effect Analysis
GET	Global Engineering Teams
GTZ	Gesellschaft für Technische Zusammenarbeit
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis
IBENS	Instituto Brasileiro de Educacao em Negocias Sustentáveis
NAPRA	Núcleo de Apoio à População Ribeirinha da Amazônia
NTFP	Non Timber Forest Products
VC	Value Chain
VHP	Vakuum Härterei Petter

1 Introduction

1.1 Project Structure

The project took place from the 15th of April until the 2nd of October 2008: first three months it took place in Germany and the next three months in Sao Carlos do Jamari and Cunia, communities located in the lower area of Madeira River in the Brazilian state Rondônia (Figure 1.1).

Figure 1.1: *Map of Brazil [Cab-10]*

1.2 Project Players

The project players consisted out of four students, two from Germany: Giani Gangloff, Elena Mechik and two from Brazil: Fabiana Bezerra Neves dos Santos, Joaquim Piza and out of three inhabitants of local communities of the Amazon rainforest: Ademilton Alvés Lopes, Manoel Braga, Marcio Santana de Lima. The team was supported financially and supervisory by three organizations: Global Engineering Teams – GET, Arbeits- und Studien-Aufenthalte – ASA, and Núcleo de Apoio à População Ribeirinha da Amazônia – NAPRA.

During six months the project became not only the main activity of the team members but it also became their life. Many unforeseen situations have occurred, whether it were language barriers, cultural interferences, or different perceptions of project's problem statements.

1.2.1 Student Participants

Fabiana Bezerra Neves dos Santos lives in Porto Velho. She is a biology graduate and master student for Regional and Environmental Development at the Federal University of Rondônia, Brazil.

Giani Gangloff lives in Tübingen. He completed a Double Diploma Program between Mexico and Germany, and graduated in the fields of Economy with focus on Environmental Economics and in International Business Administration with focus on Development Politics.

Elena Mechik lives in Berlin. She has graduated from Touro College Berlin with the BA in International Business and is currently studying Industrial Engineering at the Technical University of Berlin.

Joaquim Piza lives in Sao Paulo. He is an Industrial Engineering Student of University of São Paulo. He has participated in the one-month trip to Sao Carlos do Jamari in the Amazon forest in the year 2007 and was working with local producers.

1.2.2 Participants from local communities

Marcio Santana de Lima lives in Sao Carlos do Jamari, Brazil. He is 36 years old, is married and has one daughter of 5 years. His main sources of income are harvesting and selling of Non Timber Forest Products, and fishing.

Manoel Braga lives in Sao Carlos do Jamari, Brazil. He is 56 years old, is married and has ten children. His son of 10 years and his sick daughter of 32 years live with him and his wife. His main sources of income are harvesting and selling of Non Timber Forest Products, fishing, and welfare for his sick daughter,.

Ademilton Alvés Lopes lives in Cunia. He is 28 years old and single. His main sources of income are fishing, harvesting and selling of Non Timber Forest Products.

1.2.3 Global Engineering Teams (GET)

Global Engineering Teams (GET) is an interdisciplinary global university course offered by the department of Assembly Technology and Factory Management. Students from six partner universities work within GET on project-oriented assignments coming from the industry and international organisations. It is a fraction of the engineer study of the Technischen Universität Berlin (TUB). GET has the aim of building experts for the cooperation between future engineers of different specializations and cultural background.
(www.global-engineering-teams.org)

1.2.4 Arbeits- und Studien-Aufenthalte (ASA)

The program Arbeits- und Studien-Aufenthalte (ASA) for development cooperation is a nonprofit and politically independent internship program. More than 200 students and young professionals participate yearly with the ASA-Program. InWEnt GmbH is since 2001 the supporting organisation of the program. The ASA-Program is being financially assisted by the Federal Ministry for Economic Cooperation and Development (BMZ), most of the federal states in Germany, and other Institutions.
(www.asa-programm.de)

1.2.5 Núcleo de Apoio à População Ribeirinha da Amazônia (NAPRA)

Núcleo de Apoio à População Ribeirinha da Amazônia (NAPRA) is an organization for the support of riverside communities situated in isolated areas of the Amazon rainforest, surrounded by legal conservation units. It began its activities in 1995 and became an independent non-profit organization in 2003. Some importants local partners are: IBAMA and ICMBio (Brazilian Environmental Agency) and Porto Velho City Hall Secretary of Education and Health.
Napra's main activities are in the field of education, health services, and income generation based on sustainable forestry management. The project takes place under the latter of these activities.
(www.napra.org.br)

2 Thesis Structure

The structure throughout the thesis is based on ecological, economical, and the social factors. These factors as dimensions of sustainability have been taken into consideration while developing and implementing the project (Figure 2.2).

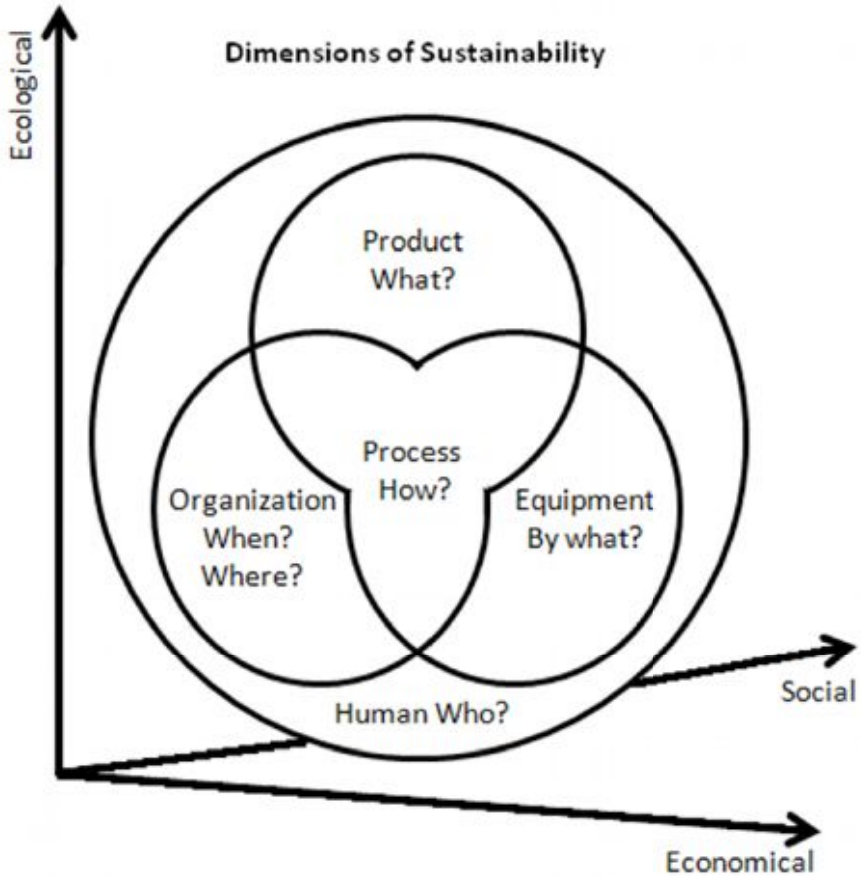


Figure 2.2: *Module of factors for value creation [Pos-09]*

First of all an as-is-analysis of the project area, the communities, and the inhabitants of the communities (Human – Who?) has been fulfilled. The product on which to concentrate on during the project has been identified and analyzed (Product – What?) and the process for adding value to the product (Process – How?) has been looked at. The next step was to identify the missing equipment for adding value to the product and to adapt technologies while constructing the missing equipment in order to fulfil the needs of the equipment users (Human – Who?) and in order to create the appropriate supportive technology (Equipment – By What?). As the final step for this project and as the first step for a follow up project is the organization of the final product producers (Organization – When? Where?). It amplifies the organized adding value to the product and organized commercialization of the final product.

3 As is Analysis

3.1 Amazon Rainforest of Brazil

The biggest continuous forest in the world is the Amazon rainforest. It represents 26% of the world's existing rainforests [Tak-00]. Brazilian rainforest contains about one third of the world's rainforests. The land area of Brazil is 8,456,510 km². 67% of this land is forest or woodland. Brazil counts as one of the most bio-diverse countries on earth. For example 60% of 1700 worldwide known kinds of birds are living in the Brazilian rainforest. [Enc-09]
At the same time, Brazil has a loss of over 600,000 km² of forest since 1970 which are equal to about 15% of the Brazilian rainforest. For comparison, size of Germany is about 350,000 km². Between May 2000 and August 2006 an area of about 150,000 km² has been deforested for medium and large scale cattle breeding, large scale soya-beans agriculture, timber extraction, or land speculation. The forest destruction often starts with the entrance of loggers, opening roads and improvement of infrastructure. [Ama-09]
The invaders often use force to banish traditional families from the region and guarantee the land with false documents. Later the farmers arrive with cattle and after that with soy plantations [Gre-06].

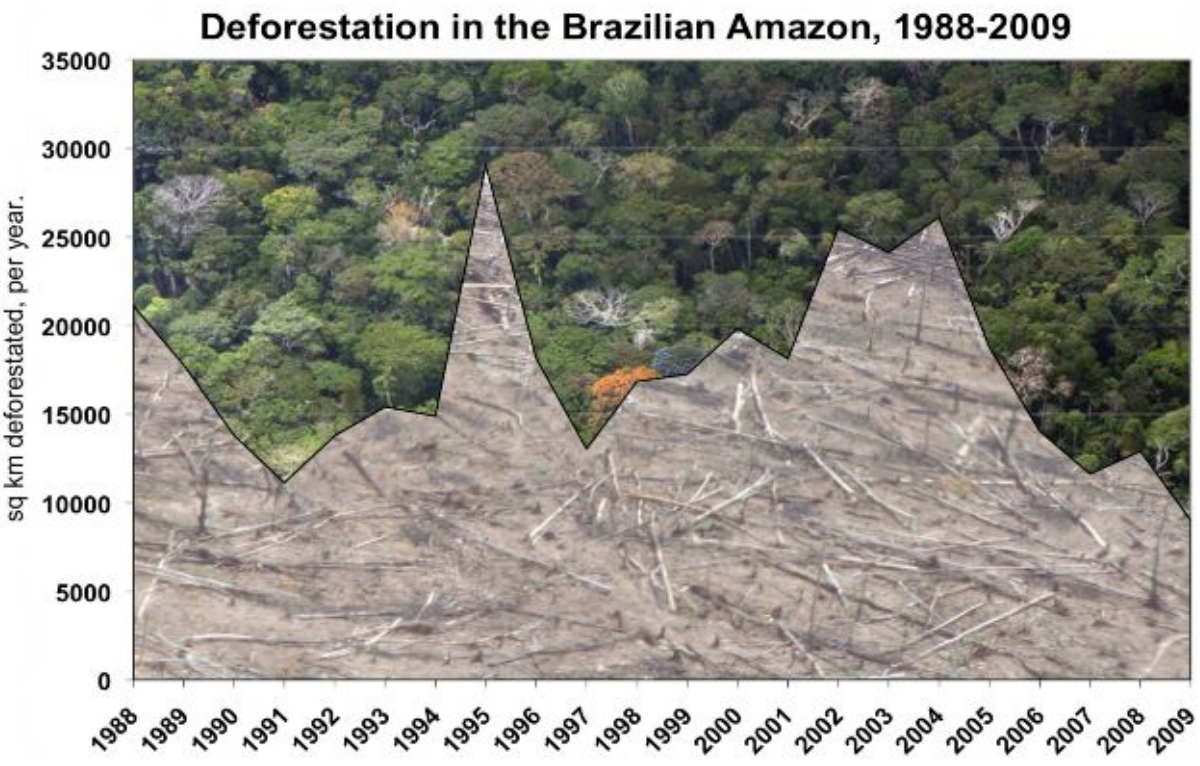


Figure 3.3: *Deforestation in the Brazilian Amazon, 1988-2009 [Mon-09]*

Deforestation rate in the Amazon rainforest is about 16.000 km² each year. 16.000 km² are about a size of the German Region Thüringen. Each 10.000 m² deforested wood are equal

to 120 till 300 tons of Carbon emitted to the environment. Reduction of deforestation by for example 10% per year will generate about 500 millions $ a year if transformed into Carbon Credit. [Ama-09]

In order to protect the Brazilian rainforest from deforestation, different kinds of conservation units were created by the Brazilian government. One of the goals is to provide a sustainable development for the forest citizens. A possibility for fulfilling this purpose is the commercialization of Non Timber Forest Products (NTFP) in order to increase communities' income inside the forest, to preserve the environment with sustainable harvesting methods, and to keep the inhabitants of communities living in the forest. The constraints for NTFP as a source of income are the low prices of the products, the unorganized structure of the inhabitants and sellers of the NTFP, and as a result a too low income.

For the Environmental Ministry of Brazilian government, to some civil organizations, and universities the protection of the forest and of the forest citizens are some of the main objectives. The creation and maintenance of Conservation Units are an important step for the protection of the forest, in order to reduce the speed of ecological devastation and to legalize the existence of citizens that traditionally use the forest in a sustainable way. In the Brazilian rainforest there are 286 Conservation Units with 999.790 km² [Sal-07]. These are about 19.97% of the Amazon rainforest. 183 of these Conservation Units are for sustainable use only (13.01%) what means for using the NTFP for consumption only and not for commercialization. 103 units are for integral protection (6.96%) [ISA-07]. Beside that land, the Indigenous lands represent other 20% of the legal Amazon rainforest [Sal-07].

The protection of those areas depends on factors like political transparence, guarantee of communities' rights, research, and the sustainable development of the communities [Sal-07].

3.2 Rainforest Communities along the Low Madeira River

The communities regarded during the project are located along the Madeira River within the state of Rondônia. Rondônia comprises 238,512 square kilometers, which is equal to the size of Holland and approximately five percent of this land is the Amazon region. It is bordered to the north by the state of Amazonas, to the east by the state of Mato Grosso, and to the south and west by Bolivia.

Most forest destruction is concentrated in the three Amazon region states of Mato Grosso, Para, and Rondônia [Cle-08].

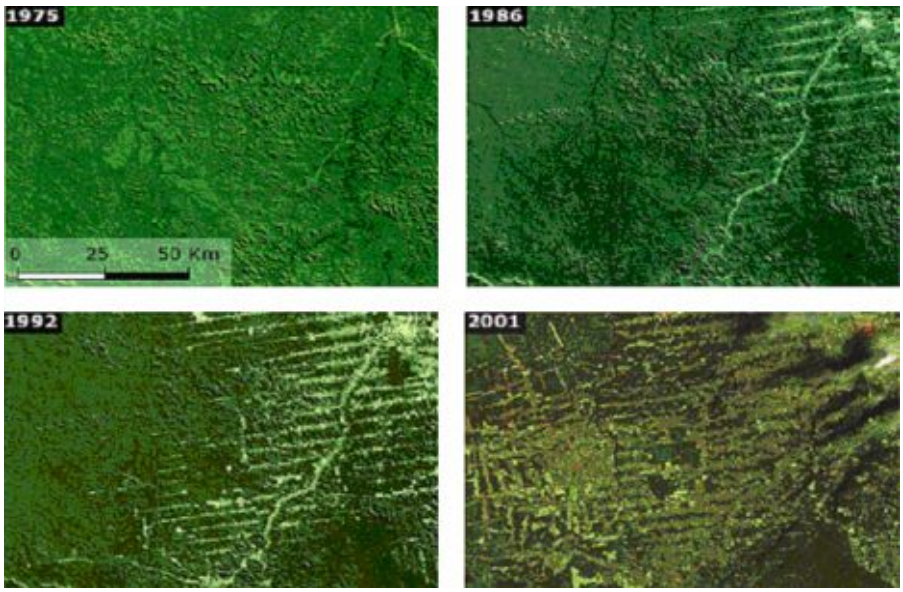


Figure 3.4: *Satellite picture of deforestation in Rondônia 1975 -2001 [Sat-01]*

The communities regarded within this project are located in the rural area of the state's capital city, Porto Velho. The number of inhabitants in the communities varies from approximately 20 citizens in the smallest until about 2,500 in the biggest communities in the lower Madeira river region. Sao Carlos do Jamari and Cunia are the both communities the project was concentrating on.

These communities were officially recognized as traditional forest communities by the Brazilian government in 2007 [Ins-07]. The riverside communities are famous for their knowledge about the forest and especially for their relationship to the nature, their sustainable way of life, their traditional medicine, and culture. Those are the reasons which enabled them to live in harmony with the nature for hundreds of years without deforestation or big damages to the eco-system. [Sal-07]

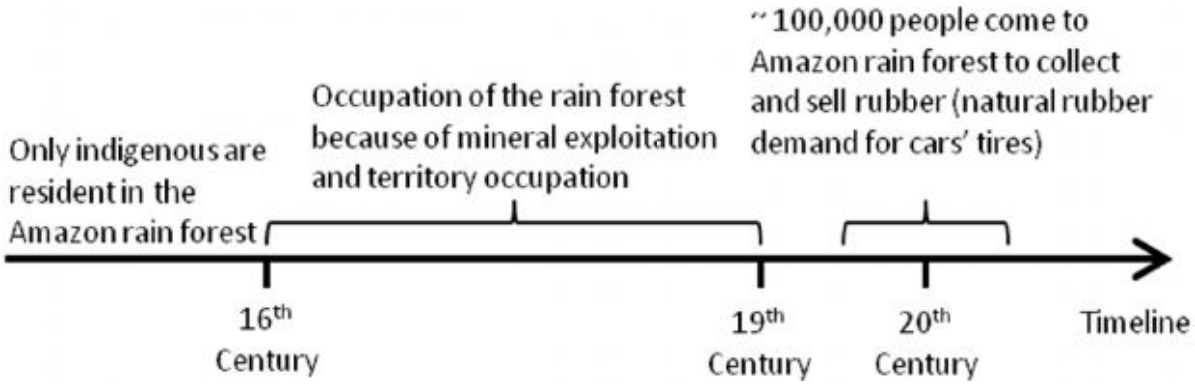


Figure 3.5: *Historical development of the Amazon rainforest occupation*

By the end of the 19th century about 100,000 new residents came to the Amazon rainforest in order to collect and sell rubber. The "rubber bosses" with initial capital have brought new residents to the rainforest form different parts of Brazil or Bolivia in order to collect rubber for them. The "bosses" provided the new residents with a house and food and got the collected rubber almost for free instead. Since then the main source of income for

those communities were the NTFP, especially rubber and Brazil Nuts. By decades those were the main products commercialized by the "rubber bosses" that kept the population into a semi-slavery system. In that system the producers were always in debt with the bosses, exchanging their products for industrialized ones, usually double or triple cost compared to the city. [Sal-07]

And still today a similar dependency is happening between the middlemen on the riverbank who are the actual buyers of the products and the local inhabitants. The middlemen have connection to buyers for the products like processor industries, markets, and fairs. They usually pay a two or three times lower price to the communities' sellers compared to the prices they get while selling the products [Mar-03].

There are three environment conservation units around the area. Two of them are for sustainable use and the law allows communities to extract natural resources in a managed way. The other one is classified as whole protection unit, and no one is allowed to reside there or to make use of the assets. The Low Madeira River communities are part of three federal conservation units. The communities are either directly inside the conservation unit, as a sustainable conservation unit, or indirectly, as part of the borders of the reserves [Sal-07]. For example the Lake Cunia is located inside an environment conservation unit with the possibility of extracting natural resources in a managed way (Harvesting Reserve Area). Theoretically, these areas are protected by law and by the government against loggers, miners, farmers and invaders [IBA-00] but the inhabitants who are legally living on this territory need alternative ways to develop and to guarantee access to their rights.

The Brazilian law that regulates the Conservation Units around the country and the utilization of lands for traditional communities says that those units were created to preserve the environment and the traditional way of living of forest communities and that it is a civil and government duty to promote the welfare of those inhabitants [IBA-00]. This exactly is the challenge the communities, government, universities, and the organized civil institutions are facing today.

3.2.1 Social situation of the inhabitants – education, security, religion, work

Sao Carlos do Jamari has a population of about 2000 and Cunia of about 600 inhabitants. Most of the inhabitants are either in the age under 17 or over 35 years old. The inhabitants after graduating from school by the age of about 17 are often moving to the cities like Porto Velho to study or to work because of mostly no attractive working opportunities for this age inside the communities. In order to get a higher education degree after graduating from high school they have to move at least to the nearby city Porto Velho.

Inhabitants in the age of 35 and older mostly have own families with up to ten children. They are generally busy with subsistence activities in order to generate income for their families. There is no bank system in the community. The inhabitants mostly do not save money. Their saving is the forest since they can get almost everything from it, like food, house, and transport. They work when the money or food is needed. Agriculture and

fishing are the most important sources to assure survival. In order to generate income NTFP as well as fish are commercialized.
The education level of the inhabitants is connected with their age. The generation over 50 years old often has difficulties to read or write since the education system was worse during the time they were young. The younger generation mostly can read and write and has a high school degree.

Transportation
The transportation between the communities mostly happens on the boot over the river. Since 2008 a road between Porto Velho and Sao Carlos do Jamari has been built. With the construction of a road starts the deforestation along the road. Because of better transportation possibilities, the level of illegal deforestation is growing (Figure 3.6). Investments into infrastructure in the Amazon rainforest mean at the same time the destruction of the nature.

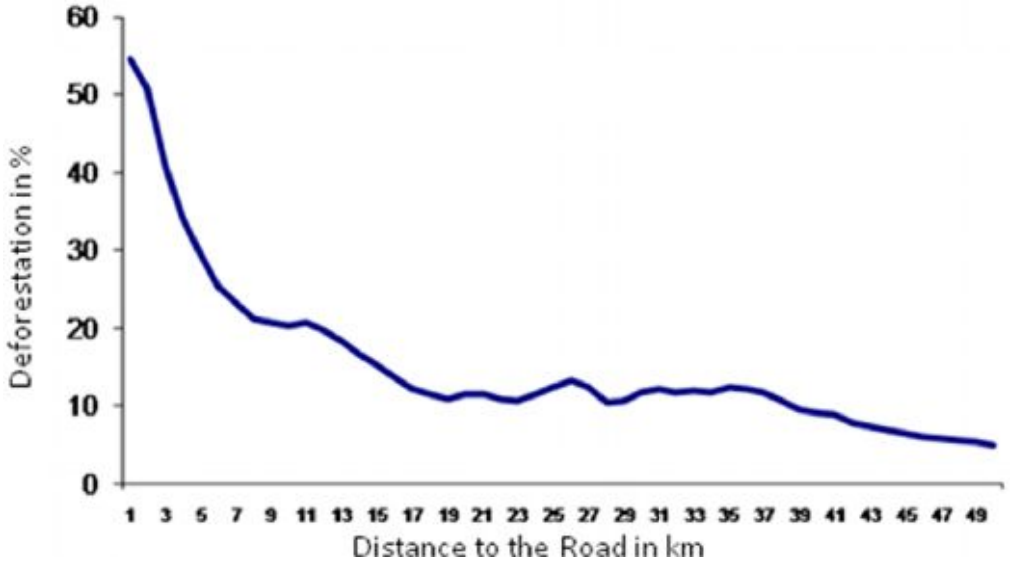


Figure 3.6: *Deforestation in regard to the distance to the road [Str-07]*

There is a possibility of using a cab or a mini-bus while travelling from Porto Velho to Sao Carlos which takes about two hours. There is always a car available to go to Porto Velho from Sao Carlos and vice versa. Sometimes one has to wait for the car to get full with four passengers. The distance is ~100km. It takes about 4-6 hours to travel by boot from Porto Velho to Sao Carlos do Jamari and about 6-8 hours from Sao Carlos do Jamari to Porto Velho due to the water flow. This distance by car takes about 2 hours. The boat schedules are unreliable and there is a limited number of weekly routes. The commercial boats are mostly fully booked and there might be problems in getting a place if coming short before departure.
The transportation inside of the community is either by bicycle or by foot. To go harvesting forest products or hunting one either has to use a boat in order of getting to the needed area and walk then or walk through the jungle closed to the community. While walking

through the forest one needs to have a machete and/or a weapon in order to cut through the way or to protect oneself from wild animals.

Medical office, churches

A medical office is open every day with the availability of a nurse assistant at any time in Sao Carlos do Jamari and in Cunia. The nurses' assistants know about the common infections one can get in the communities and know how to act in special situations. A speed boat is available for critical medical situations at the river bank of Sao Carlos. In Cunia there is no access to a speed boat during the months from April till February. These are the months without rain and Cunia is not connected to Sao Carlos through lakes over this time. During this time doctors are coming to Cunia very seldom since the way to get there is complicated. There is the possibility of interacting with a doctor from Sao Paulo over an online video conference (project performed by NAPRA in 2006).

Almost all the population is religious with nearly no atheists. The religions are Evangelism, Baptism, or Catholicism. Every community has access to a church either in the community or nearby.

Communication – telephone, post, internet

Communication happens over telephone. Most of the communities have public phones. Inhabitants of Sao Carlos do Jamari and Calama have private phones as well. The public phone lines as well as land lines are sometimes out of order and may stay inoperative over few weeks. The only way of sending a message is via a boat. There is no postal office available in the communities. But the postmen are coming over the river in order to bring letters or packages to the communities.

Internet connection is available in the communities like Sao Carlos or Cunia but only few of the inhabitants can afford to have a computer with internet connection at home. In Sao Carlos, there is a possibility of using internet in someone's house against payment.

Security

Police did not exist in the community until February 2008 but with the construction of the road the level of prostitution or drug consumption has gone up and the need for police has occurred. There is police in Sao Carlos since 2008.

3.2.2 Financial situation of the inhabitants

Almost everyone in the communities works with NTFP, as they are a good opportunity for subsistence or for extra income. NTFP are all forest products except timber, including materials obtained from trees such as resins, fruits, nuts and leaves. NTFP are historically and currently a sustainable way of income for communities. NTFP secure income if crops fail to supply basic needs. The main NTFP are Brazil Nuts and Açaí. Their commercialization is pulled by the huge demand in the surrounding urban areas. Communities' economy is much diversified. The seasons of the main products are specified below.

Main products	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brazil nuts	x	x	x	x							x	x
Açaí	x	x	x	x								
Handcrafts	x	x	x	x	x	x	x	x	x	x	x	x
Copaiba oil	x	x	x	x	x	x	x	x	x	x	x	x
Fishing	x	x	x	x	x	x	x	x	x	x	x	x
Manioc flour	x	x	x	x	x	x	x	x	x	x	x	x
Watermelons						x	x	x				

Table 1: *Harvesting seasons of the main rainforest communities' products [Asm-07]*

Some inhabitants have public jobs like teachers and health agents. Some work for private companies like electricity companies. Manioc, banana, watermelon, beans and corn are the main agricultural products in the region. Manioc can be processed to flour. Manioc flour is a basic ingredient for the riverside population's diet. Producers are selling their agricultural products, fishes, NTFP to the local intermediates, who make the connection with the city markets [Asm-07]. During the project the team has concentrated on the Brazil Nuts as one of the main NTFP commercialized by the communities.

3.3 Brazil Nut

Family	Lecythidaceae
Genus	Bertholletia
Species	Excelsa
Common Names	Brazil Nut, Castania, Castanheiro do Para, Para-Nut, Creamnut, Castana- de-Para, Castana-de-Brazil [Tay-05]

Figure 3.7: *Brazil Nut tree*

Brazil Nut trees are of a height of 50m or more (Figure 3.7), have a diameter of up to 2m, can get over 800 years old, and are found in the Amazon rainforest in Bolivia, Brazil, eastern Colombia, Ecuador, Guianas, Peru, and Venezuela. Brazil Nut trees grow very slowly. It takes about 10 to 30 years until the trees start producing nuts [Tay-05].

Brazil Nuts are located in the nut pods which are round wood capsule of a size of an orange and a weight of about 2kg (Figure 3.8).

Figure 3.8: *Brazil Nut pod with nuts [Sor-04]*

The pods are growing at the ends of thick trees' branches. About 12 till 25 nuts with their own shells are located in one nut pod (Figure 3.8). One mature Brazil Nut tree can produce over 300 nut pods annually. [Tay-05]
A certain species of a bee is required to pollinate the flowers of the Brazil Nut tree in order to produce the nuts [Mor-92]. This bee on the other hand requires a certain species of orchid to survive [Arm-05]. Male bees should acquire the aroma of this orchid in order to attract the female bees [Arm-05]. A rodent, the agouti, is required to plant the nut trees in the natural ecosystem of the Amazon rainforest because it is the only animal capable of chewing through the nut pod (Figure 3.9).

Figure 3.9: *Agouti opening a Brazil Nut pod [Rot-05]*

Agouti opens the pods, eats some of the nuts, hides the rest of the nuts in the ground of the forest, and forgets about them afterwards. This is the only way of how the trees are being planted under the natural rainforest's circumstances. The survival of the orchid, the

bee, the agouti, and the Brazil Nut tree are all dependent on each other in natural circumstances of the Amazon rainforest and would not survive without each other.
Because of all the circumstances which are needed for the survival of Brazil Nuts, it is not possible to cultivate plantations of Brazil Nut trees.

Figure 3.10: *Brazil-nut-lamp [Dun-03]*

A Brazil Nut consists of about 70% fat and 17% proteins. Because of such a high fat content, the Brazil Nut can burn as a candle when lit (Figure 3.10) [Tay-05]. The inhabitants of the Amazon rainforest communities are extracting the oil from the nuts and using it for cooking, lamps, soaps and so on. The empty nut pods are often used for handcrafts as candle holders, or for jewelry (Figure 3.11).

Figure 3.11: *Brazil Nut pods as candle holders*

Besides fat and proteins, Brazil Nuts provide the highest natural source of selenium. Selenium is an essential trace mineral in the human body with antioxidant, anticancer, and cancer-preventative properties. [Tay-05]
Brazil Nuts are mostly used as food. The oil of Brazil Nuts is used for production of soaps, shampoos, hair conditioning, and skin creams.
Around 20,000 tons of Brazil nuts are harvested each year, of which Bolivia accounts for about 50%, Brazil 40% and Peru 10% [Col-00]. The only way of harvesting Brazil Nuts is manually.
Brazil Nuts are a seasonal fruit. The nut pods are falling from the trees between November and March, during the rainy season. Because of the high humidity during the rainy season,

nut pods should not be left on the ground for longer than five days [Bay-04]. The nuts can get affected by a fungus, aflatoxin, which is one of the most potent toxic substances that occur naturally, if left in the humidity for too long [Tay-05]. But it is not possible to know the exact moment when the pods are falling from the trees. The harvesters mostly know from experience at what time from which tree the first pods are falling. Another way of finding out about the fallen pods is while passing by the trees for hunting or for collection of seeds.

Figure 3.12: *Humid Brazil Nuts in a pod [Gol-07]*

First of all the whole value chain of Brazil Nuts as it is today will be analyzed.

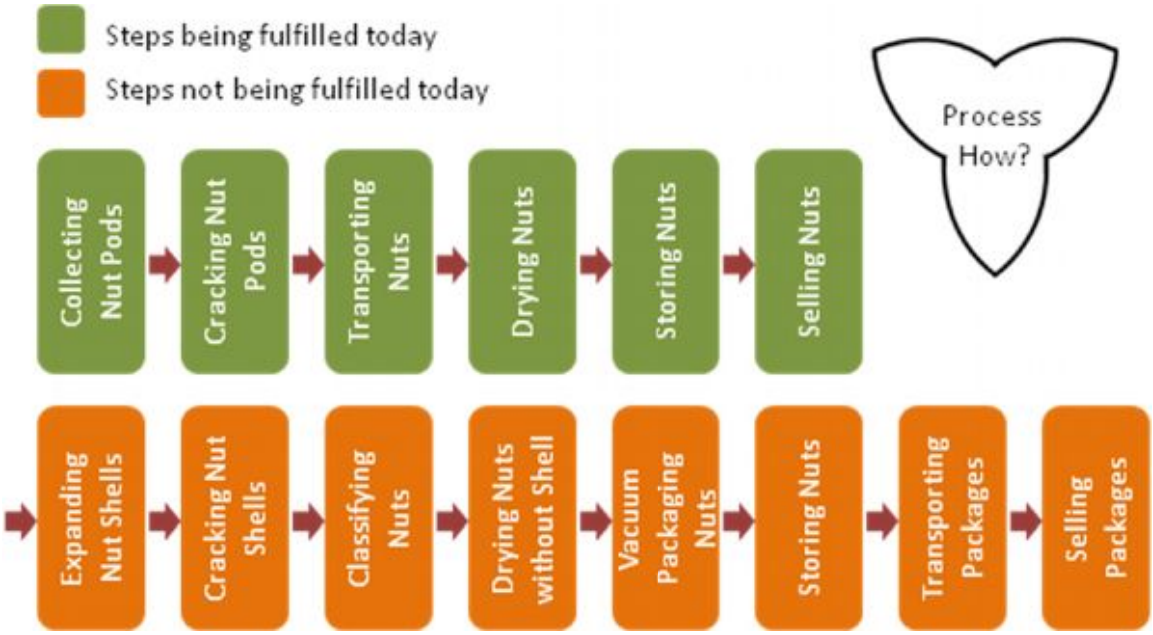
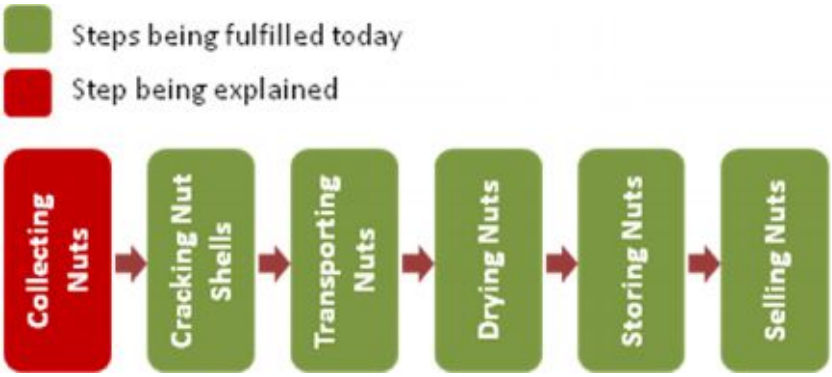


Figure 3.13: *Brazil Nut collecting and processing steps*

The value chain as it is today in the communities Sao Carlos do Jamari and Cunia starts with the collection of the nuts in the forest and ends with the selling of unprocessed nuts after storing them at homes. The steps which are marked brown in Figure 3.13 are not being

fulfilled today because of absence of either machinery for processing or motivation of producers. The steps which are being fulfilled today are explained in detail below.



The process starts with the collection of the nuts. The harvesters only go to the forest to collect the nuts when they know that the nuts have fallen. Every harvester may collect from the same tree every year. Harvesters do not know about each other. If someone is collecting at one tree, another harvester would pass by and go to the next.

The lianas savage the trees which results in low fertility of the Brazil Nut trees. From the experience of the producers the lianas savage only few trees but when they attack, they do it a lot. Harvesters are normally cutting the lianas when they see them at the trees while passing by. During the collection the harvesters do not know how long the pods have been on the ground before collecting them.

In Sao Carlos the harvesters make mounts of pods on the way and crack the pods on the way back home during the same day. If they would leave the pods over night or for longer time, someone else might take the pods away.

In Cunia every harvester has a special area in the forest he is allowed to use. Because of no competition between the harvesters, the mounts of nut pods sometimes stay for about two weeks on the ground before being taken away.

Figure 3.14: *Collection of Brazil Nuts [Sal-04]*

The producers are cracking the nut pods with the same machete they use for cutting the way through the forest. The nut pod is usually very hard and the harvesters have to be very careful while cracking the pods. The pod is hold with one hand while the pod is being broken with the other (Figure 3.15).

The nuts are then put into a sack which is transported inside of a backpack to the community. The sack has a capacity for about 60kg of nuts, a weight which can be transported by one person on the back.

Some of the harvesters are making a visual selection of good nuts after cracking the nut pods. Bad nuts have a different colour, smell and weight. They are mostly darker, lighter, and smell “acid”.

Figure 3.15: *Breaking of Brazil Nut Pods [Sal-04]*

Figure 3.16: *Opening of Brazil Nut Pods [Sal-04]*

The broken nut pods are left on the ground next to the tree or seldom taken home for making handcrafts. While left in the forest, the pods are often getting a fungus (Figure 3.17) and are a danger for the new pods which are falling from the trees.

Figure 3.17: *Broken Nut pods with a fungus [Sal-04]*

There are different ways of transporting the nuts. Most harvesters are using bag which is carried on the back with a connection to the head in order to distribute the weight to different parts of the body. Producers are mostly carrying about 60kg per day per person. It is not common to carry more weight during one day.

In Cunia the harvesters are sometimes using a one wheel wagon to transport the nuts if the surroundings allow it.

Figure 3.18: *Transportation of nut pods [Sal-04]*

Figure 3.19: *Transportation of nut pods [Sal-04]*

The collected nuts are mostly humid when brought home. Almost all of producers are putting the nuts in the net and inside of the river in order to clean the nuts and to separate the good nuts from the bad. Good nuts are staying inside the net and the bad ones are lighter and are flowing away.

The nuts have to be dried after. Most of producers put the nuts during the sunny day on a plastic plane from midday till 6pm and bring them home after. Because of high humidity during the night, the nuts have to be brought inside the house after 6pm. From experience of the producers, six hours of sun is enough for the nuts to get relatively dried. Some of the harvesters are leaving the nuts in their house on a table or “pallet” for drying.

The storage happens for short time in a room at home. There is often a damage of nuts because of humidity. The community and the harvesters do not have a special storage place for nuts.

The nuts are then sold to the intermediates on the riverbank. The price changes depending on the amount of available nuts. During the nut season between November and April the price of nuts may fall to 5,-R$ and get up to 8,-R$ per lata. One lata is a measurement for 12kg of nuts and is a usual selling unit. In between the seasons the price gets up to 22,-R$ per lata. The price for nuts is set by the intermediates at the river bank. They sometimes meet several times a week in order to have a common buying price for nuts. The harvesters while working independent have only low quantity of nuts available and are following the rules the intermediates are setting.

4 Problem Statement

4.1 Global Problem Statement

Rainforests are the most bio-diverse ecosystems on Earth with about 40 million different species [Nix-10]. Amazonia produces about 20% of earth's oxygen and is considered as a major CO2 reservoir in the world [Ros-08]. Despite of their immense importance, rainforests are highly threatened. Within the last 50 years more than half of the world's rainforests have been destroyed irreversibly [Tay-04]. Each year areas of the size of England are being eliminated. More than 20% of global carbon emissions are due to the clearing of rainforests [God-10]. Deforestation of rainforests is a major factor for climate change.

Brazil counts as the fourth largest emitter of carbon dioxide because of deforestation [Fra-09]. Brazil has a loss of over 600,000 km² of forest since 1970. Between May 2000 and August 2006 an area of about 150,000 km² has been cutover. [But-10] The main causes for deforestation are medium and large scale cattle breeding, large scale soya-beans agriculture, timber extraction, or land speculation [Thi-05].

The area concentrated on is located in the communities Sao Carlos do Jamari and Cunia in the state of Rondônia (Figure 4.20). It is the rural area of the state's capital Porto Velho. The pink spots on the map are the deforested areas. Conservationists estimate that about 16,000km² of the Amazon rainforests are destroyed annually [But-10].

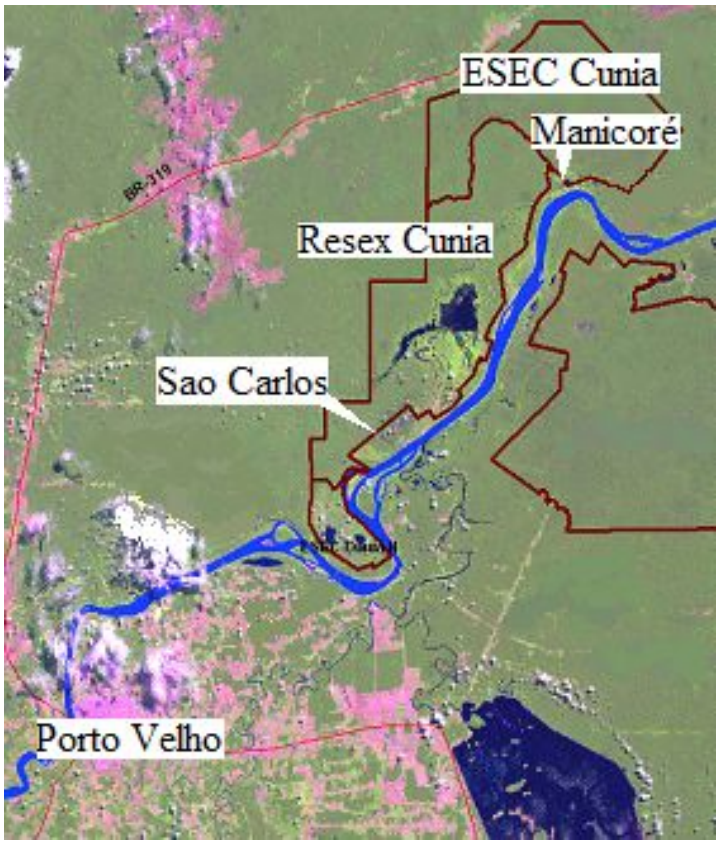


Figure 4.20: *Map of rural area of Porto Velho, Rondônia [IBA-03]*

4.2 Specific Problem Statement

NTFP create a way for adding value to the trees without destroying them and for promoting a sustainable management of the forest at the same time [Kan-96]. Some researchers estimate that the potential profitability from one hectare of forest could exceed the profitability of the wood production in the same area [Pet-89] [Sal-07]. Brazil Nuts and Açaí are the main NTFP being used and commercialized within the communities today. Their commercialization is pulled by the huge demand in the surrounding urban areas. As well as fish and agricultural products, NTFP are traded with local intermediates, who sell the products further to the city markets [Asm-07]. This trading results in a low income for producers because of the dependency relationship between the community producers and the intermediates [Bel-07, Mar-03, Mor-04]. Other problem while working with NTFP is the overall lack of information of the producers about the local, national, and international market conditions [Mar-03, Mor-04, Pad-90]. Due to the almost non-existing market structure and nearly no access to market information, producers obtain bad conditions for commercialization and low earnings out of it [Asm-07]. There is a constant changing of demand and prices on the local, national, and international markets [Mol-07]. Lack of information makes it impossible for producers to react to the changes in demand.

In addition, producers do not realize the opportunities of dealing with products other than the commodities demanded by the local intermediates [Asm-07]. As a result, despite of the vast availability of forest products with good market potential, most of producers are dealing with only few products [Asm-07, Bel-07, Esc-03, Mor-04, Mor-06]. This turns the supply for these products up and the market price down [Asm-07].

The producers are selling the products mostly unprocessed; in the condition they collect them in the forest. By starting a micro enterprise for NTFP, according to UNEP these micro enterprises often suffer from relative lack of training, know-how, technology, and money [UNE-03]. There is a lack of skills and knowledge on how to process the products as well as a lack of organizational education and initial capital for processing the products in order of adding value [Esc-03, Mor-04, Pet-89]. Because of no or very low value adding, the income out of these products stays low [Mol-07, Ole-06]. At the same time there is a lack of infrastructure in the sense of transportation for the products to the market [Mol-07]. Another problem while working with NTFP is that the supply of NTFP change monthly or yearly. This causes that only the current but not the future availability of the products can be calculated.

Another problem is the loss of traditional knowledge on how to work with NTFP. The older generations are giving their knowledge further to their younger family members. If the income with NTFP is not sufficient, the younger generation is moving out of the rainforest communities to cities and slums in order of searching for a source of income. The loss of the younger generation means at the same time an irreversible loss of the traditional knowledge [Bus-98].

5 Methodology

The improvement of Brazil Nuts process steps happens through three steps:

- Acquiring of knowledge,
- Knowledge transfer, and
- Adapting technologies.

The accumulation of knowledge happens by gathering traditional knowledge and experience of Brazil Nut harvesters, comparing this knowledge with already available scientific knowledge, structuring and adapting this information into the frame of Brazil Nuts process steps. Adapting technologies describes how available state-of-the-art technologies for Brazil Nut process can be adjusted to the needs and requirements of Amazon rainforest communities.

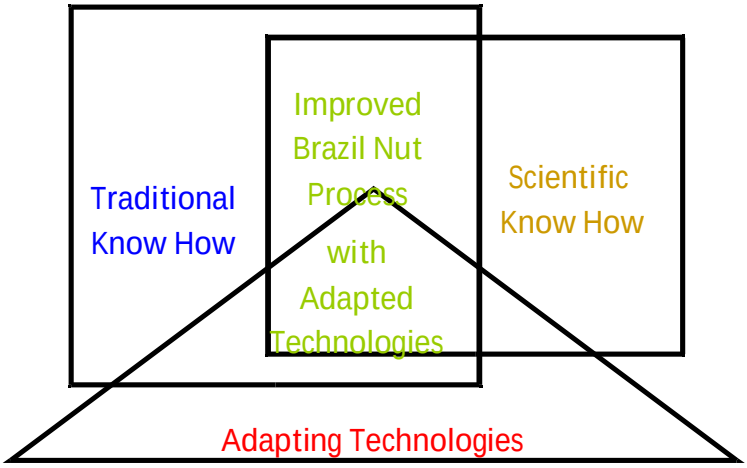


Figure 4.21: *Improvement of Brazil Nut Process*

6 Concepts for Adding Value to Brazil Nuts

6.1 Best Practice Example of Adding Value to Brazil Nuts with an implemented Quality Management Concept (COVEMA / Manicoré)

In order to learn from experience of other Brazil Nut producers, the team has visited a close by city Manicoré and the cooperative "COVEMA" (Cooperative Verde de Manicoré) which concentrates on processing and marketing of Brazil Nuts produced by local forest communities of Manicoré area.

Figure 6.22: *Quality management workshop in Manicoré*

"COVEMA" is a cooperative which is working with Brazil Nuts since 1997. At the beginning, "COVEMA" has concentrated on marketing of Brazil Nuts with shell. The first market for nuts with shell was in Porto Velho. "COVEMA" was selling the nuts to intermediates but the results were unsatisfactory because of big income losses through the intermediates. "COVEMA" started to increase the price of Brazil Nuts. As higher the price of nuts got as more producers were willing to work with nuts. There was an increase of the price from 2,- R$ in the year 1998 to 12,-R$ in the year 2008. When a producer brings nuts to a common storage room, he gets 2,-R$ more for his nuts than he would get from the intermediate. After some time of storing, nuts are being sold and 60 % of additional earnings are then

divided between all producers. Other 40% are distributed between workers like sales men, book-keepers.

It was difficult for “COVEMA” to find a good buyer for nuts. There was a buyer who wanted to export the nuts to Italy. He started to mix his own bad quality nuts with the nuts of “COVEMA”. This buyer was caught and punished by the police. “COVEMA” made a loss of 60.000,-R$ (~25.000,-€). At that moment, because of this experience, producers stopped trusting in the cooperative.

“COVEMA” achieved to keep some producers from before but had to go through the whole process of searching for new producers who would be willing to work with the cooperative again. They were talking to communities, discussing the process, were arranging meetings about good handling of nuts.

After bad experience with the buyer, “COVEMA” decided to deliver nuts to private persons or organizations only after receiving the payment. “COVEMA” had to legalize the cooperative in order to get funds from the state. After some time, “COVEMA” has got a credit in order to buy machinery for processing nuts and on the 3rd of December 2007 started to work with this machinery.

Today there are associations from different areas around Manicoré which are working with “COVEMA”. Every association has to choose three persons who work for “COVEMA” factory. Some of the persons are working full time with salary, and some are working sometimes depending on the seasonal amount of nuts.

“COVEMA” has started to work with processing nuts but did not have a buyer for processed nuts yet. Finally “COVEMA” has found a buyer who would sell the nuts in Sao Paulo. This buyer had the idea of getting a certification for nuts. He helped to make a contact and has got an Organic Certification from IMO (Institute for Marketecology). IMO is specialized on quality assurance of eco-friendly organic agriculture and management systems.

The certification costs 10.000,-R$ (~4300,-€) per year but this certification helps to get buyers (Figure 6.23). The usual way is that buyers are coming to the organizations who are giving out the certifications and these organizations are giving out the names of qualified sellers. “COVEMA” has yearly a representative stand at the BioFach exhibition, the World Organic Trade Fair. One certification is missing in order for “COVEMA” to export their products to international market. The missing part is a license from MAPA, the Ministry of Agriculture. For that “COVEMA” needs to fulfill requirements like having floor tiles in their storage room. At the moment “COVEMA” does not have enough funds to fulfill these requirements. It would cost about 100.000,-R$ (~43.000,-€) to construct everything what this license requires.

Figure 6.23: *Quality certification*

Today “COVEMA” has about ten trustful buyers from Rio de Janeiro, Manaus, Brazilia, Sao Paulo, and Gaiania. “COVEMA” has a connection to IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis), IBENS (Instituto Brasileiro de Educacao em Negocias Sustentáveis), and Bank of Brazil.

A new idea of “COVEMA” is to work directly with the customers. In order to overcome the intermediates, “COVEMA” started to package and sell the nuts in small quantities of 250g and 500g.

Figure 6.24: *250g Package of nuts with shell*

There are a lot of small storage rooms located in the forest. Every storage room has one responsible person who receives the nuts and gets 1,-R$ (~0,44€) for each lata. A lata is a mass for about 12kg of nuts. The responsible person is writing down all information about how much and from whom he has received the nuts.

Steps for Adding Value to Brazil Nuts in Manicoré

1st step:

The main storage room is receiving bags with 40 to 60kg of Brazil Nuts with shell from small storage rooms of different forest areas. The nuts have been dried in these small storage rooms before. After reception of nuts, the quality of nuts is checked. If needed, the nuts are being dried one more time. At this step nuts are divided into the ones with checked quality from certain communities and the ones from other communities without the quality check. Organic nuts are as well separated from not organic nuts. In this case, organic means that the producers as well as workers are not using any chemistry during the cleaning of nuts and no chemistry is being used against insects.

Figure 6.25: *40kg bags of nuts with shell*

2nd step:

The 40 to 60 kg bags of nuts are being opened and put into big wooden boxes above the ground. The boxes are divided by communities (Figure 6.26). On every box there is a sign on how many latas of nuts the box includes and the date of receiving them (Figure 6.27).

Figure 6.26: *Boxes for storage of nuts*

Figure 6.27: *Sign with details about date of delivery and quantity of nuts*

3rd step:

Brazil Nuts with shell are dried in a rotator. There are two dehydrating machines which are connected with each other (Figure 6.28, Figure 6.29). This drying process takes eight hours a day and there is a possibility to dry one ton of nuts in each machine. It means, two tons of nuts with shell are being dried per day. The source of energy for these machines is electricity, Brazil Nut shells, and wood.

Figure 6.28: *Nuts dehydrator from the top*

Figure 6.29: *Dehydrator from the front with boxes for storage of nuts on the right side*

4th step:

After drying the nuts, they are being classified. The bad ones are thrown away, the good ones are either being put in big bags for packaging and the others which will be shelled are put into net boxes with wheels (Figure 6.30).

Figure 6.30: *Transportation of dried nuts with shell to the shelling area*

5th step:

Next step is the temperature shock in order to prepare the shell for breaking. The nuts are kept in the net boxes with wheels and are brought inside the autoclave for temperature shock (Figure 6.31, Figure 6.32).

During the temperature shock, the shell is expanding and the nut is remaining unbroken during cracking. The goal is to expand the brownish thin shell around the nut as well as get it away from the nut while cracking the shell. As less of the brownish thin shell stays on the nut as better the quality of the nut.

Figure 6.31: *Autoclave from the front*

Figure 6.32: *Autoclave from the side*

6th step:

The cracking of the shell happens manually. The nuts have to be hold vertically with the left hand and are being broken while pushing down a lever with the right hand. The plastic on the lever is exchanged every day.

Figure 6.33: *Table with cracking machines*

Figure 6.34: *Cracking machine*

Figure 6.35: *Shelve for dehydrating of nuts*

If a nut with a fungus is being broken, the worker has to put disinfection spray all over the cracker. Only women are working in this step because they are more patient and more sensitive. After breaking the shell, the nuts are put in a bucket. It is not allowed to keep the bucket on the floor.

In the same room the women put the nuts on aluminum shelves for the dehydrator of nuts without shell.

7th step:

During this step the nuts without shells are being dried. The temperature inside of the dryer is between 35° and 40° Celsius. It is the perfect temperature for the nuts to get dried without losing their qualities and taste. The nuts stay inside of the dryer for 60 hours. The ventilation system of machines is not very efficient. The cooperative wants to change the machine but an investment of 40.000,-R$ (~17.400,-€) for changing the machine is not available at the moment.

Figure 6.36: *Dehydrator for nuts without shell*

Figure 6.37: *Energy supply for the dehydrator*

8th step:

Next step is the vacuum packaging of nuts. Before packaging the nuts are being classified. The workers are dividing them in small, medium, and big nuts. This happens in a divided, closed room with high hygienic environment.

Figure 6.38: *Packaging of nuts in a sterile room*

There are two different vacuum packaging machines. One is for packages of 20kg and the other one is for packages of 250 till 500g.

Figure 6.39: *Classification of nuts*

Figure 6.40: *Classification and packaging of nuts*

9th step:

There are different kinds of final products:

- 20kg packages of small, medium, and big nuts without shell
- 250g packages of Brazil Nuts with shell (Figure 6.42)

Figure 6.41: *Box of shelled Brazil Nuts*

Figure 6.42: *250g packages of nuts with shell*

- 250 and 500g packages of Brazil Nuts without shell

Figure 6.43: *Package of dried, vacuum packaged nuts without shell*

Figure 6.44: *Brazil nut project team with managers of COVEMA*

6.2 Development of a Quality Management Concept for Brazil Nuts

Because of the humidity in the rainforest, Brazil Nuts are under danger of getting affected by fungus. A fungus can occur if the nuts are in contact with heat and humidity. If one nut gets affected, the nuts which are next to it are getting affected as well. In order to improve the handling with nuts and to protect the nuts from damages, a workshop has been organized. The goal of the workshop was to exchange the scientific knowledge about collecting and processing nuts of the student participants with the traditional knowledge of working with nuts of the community members and at the end to develop a list of steps which are possible to implement in the community.

The Good Handling workshop was taking place on the 1st of August 2008. The participants were the main project participants of the communities: Marcio, Ademilton, and Manoel, and four additional participants: Jessy, Crispim, Odiel, and Ajulton.

Figure 6.45: *Quality management workshop*

The workshop has started with the question of why it is important to maintain the quality of the nuts. The answer was that in Sao Carlos do Jamari as well as in Porto Velho the quality does not matter. The producers are selling their nuts and the intermediaries are not checking and do not have the possibility to check or to know whether the quality of the nuts they buy is good or not. An advantage of the good quality nuts is that the producers might develop trust with the buyers. In that way the producers would be able to sell more. Another reason is that by having a good quality of nuts the producers would be able to store the nuts and to sell them later for a higher price. It is also easier to process the nuts later, if the nuts are of a good quality.

The following table is showing all Brazil Nut processing steps in detail. It describes the current situation as the traditional knowledge for work with Brazil Nuts (Actual Situation), the theoretical best practices regarding work with Brazil Nuts (Objective), and the final column which is the result of a discussion whether it would be possible to implement the theoretical knowledge into the practical work (Possibility of Implementation).

STEPS	Actual situation (traditional knowledge)	Objective (scientific knowledge)	Possibility of implementation

Before Collecting Nut Pods	Different Brazil Nut trees get their pods at different times. The first ones are falling around November. Every harvester may collect from the same tree. Harvesters do not know about each other. If someone is collecting at one tree, another harvester passes by and goes to the next tree.	The objective is to have a map with all Brazil Nut trees in the area, the age of the trees, how many nut pods in average the tree gets during one season, about what time the pods are falling from which trees etc. It is important to put the broken pods which stay on the ground after the last season away from the tree, so that the new pods would not get affected by the fungus of the old pods.	It is difficult to make such a map at the moment. There are no tools available for allocating the trees, no knowledge on how to make a map, and no time in order to develop a map.
	The harvesters mostly know from experience at what time at which tree the first pods are falling. Another way of finding out about the pods is while passing by the trees for hunting or for a collection of seeds. The harvesters only go to the forest to collect the nuts when they know that the nuts have fallen. In Sao Carlos they wait until all pods have fallen and go then to collect the pods.		
	From the experience of the producers the lianas savage only few trees but when they attack, they do it a lot. Harvesters are normally cutting the lianas when they see them at the trees while passing by.	It is important to cut the lianas from young and adult trees. One should not cut the lianas from the old trees which do not get nuts anymore (Figure 6.46).	It is possible to implement this step.

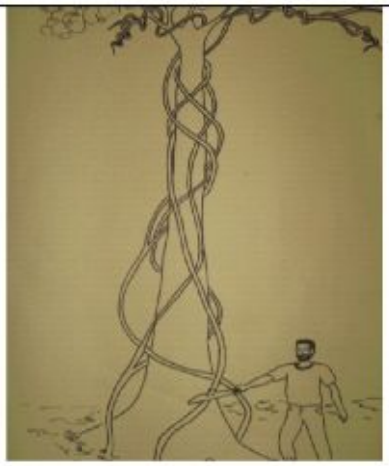


Figure 6.46:*Methodological material – cutting lianas*

Collecting Nut Pods	During the collection of the nut pods, the harvesters do not know how long the pods have been on the ground before they collect them.	It is important not to let the nut pods on the ground for more than five days [Bay-04] because of the fungus which can affect them.	It is not possible to know for how long the nuts have been on the ground without having a map (see step "Before Collecting Nuts").
	In Cunia all the forest areas have an owner who gives the permission to collect NTFP. Every harvester has his own area he is allowed to collect nuts from. The harvesters do not have to compete with each other and may leave the nut pods for some time on the ground without being afraid that someone else might take them. In Cunia, on the example of Ademilton, the harvesters are working together as a family or with friends. They collect a lot of pods and spend about six hours each to break them. They collect together and divide the nuts and money afterwards. The quantity of nuts collected depends on the transportation. In Cunia the producers need about two days to collect the pods of one tree.		
	It is dangerous to collect nut pods during the rainy season since the pods might fall on harvester's head.	The solution is to use a helmet during the collection of nuts.	The producers do not want to use a helmet while collecting nuts. It would be too hot and not comfortable. The solution for them is to believe in God.

Storing Nut Pods in the Forest	In Sao Carlos do Jamari the harvesters make mounts of pods while passing by a Brazil Nut tree and crack the pods and take the nuts home the same day on the way back. If they would leave the pods for longer time, someone else might take the pods away. In Cunia every harvester has a special area in the forest he is allowed to use. Because of no competition between the harvesters, the mounts of nut pods sometimes stay for about two weeks on the ground before being taken away.	An objective is to build small storage rooms (paiolzinhos) in the forest. It is important to put the new nut pods to a different place then the pods from the last season and not to leave the mounts of pods longer than three days on the ground. The nut pods might get affected by a fungus on the humid ground.	In order to build a small storage room in the forest, a group of producers is needed who are interested in having a possibility of storing nuts in the forest. Since the producers are currently working independently, it is not possible for them to construct a storage room.
Cracking Nut Pods	The harvesters are cracking the nut pods in the forest with the machete. The machete is the same which they use for cutting their way through the forest.	The objective is to have an additional machete for cracking the nut pods, so that the dirt from a used machete would not affect the nuts.	It is difficult to carry two machetes to the forest. Every additional weight is ballast.
	The harvesters are cracking the pods on the ground.	It would be good to use a piece of plastic for putting under the pods while cracking them in order to protect the nuts from fungus which might be on the ground.	Every additional weight is thought out while going to the forest. A plastic plane would get cuts very often and would bring dirt to the forest. The possible solution is to use banana leaves instead.
	It is possible to separate good nuts from the bad on the signs like: different colour or weight compared to the usual qualities of the nuts. Bed nuts are not being collected after cracking the nut pod.		

<table>
<tr><td>Selection of Good Quality Nuts</td><td>Depending on the selection area, the harvester may put the nuts into the water leaving the nuts in a bag. The bad nuts are lighter and would go to the top and the good ones would stay in the bag.</td><td>Washing and putting nuts into the water should only happen if the nuts can get dried after.</td><td>This objective can be implemented depending on the collection area and the drying possibilities.</td></tr>
<tr><td>Transporting Nuts</td><td colspan="3">In Sao Carlos one harvester can transport about 6 latas (1 lata ~ 12kg) of nuts during one day.
The transportation happens in a “Panheira” (Figure 6.47) which has enough holes in it for the airflow or in a bag which is carried as a backpack and has a connection to the head in order to divide the forces and the weight of the nuts. In Cunia the harvesters are sometimes using a bag with wheels, if the surroundings allow it.</td></tr>
<tr><td></td><td colspan="3"> 
Figure 6.47: Transportation of nut pods in a “panheira” [Sal-04]</td></tr>
<tr><td>Drying Nuts</td><td>The nuts are usually dried on a plastic plane on the fresh air during the day. Producers do not leave the nuts outside over night because of the humidity.
Some harvesters are leaving the nuts to dry in the house on the table for about three days.</td><td>The objective is to have a dryer above the ground for nuts with shell (Figure 6.48).
 
Figure 6.48: Dryer for nuts with shell</td><td>There is a need for money and construction material in order to construct a dryer. It is not possible to implement this step in the moment.</td></tr>
<tr><td>Storing Nuts</td><td>The nuts are usually stored for about two months in a room at home. There is often a damage of nuts because of humidity and no</td><td>A storage room for all the producers of the community should be built.</td><td>There is a need for money and construction material in order to construct a dryer. It is not possible</td></tr>
</table>

	special storage place.		to implement this step in the moment.
Selling Nuts	The nuts are sold to the intermediates for the price the intermediates are setting because of the need of money.	The objective is to improve the cooperation between the producers and that producers will set the price for the nuts.	An organized group of harvesters is needed in order to set a common price for nuts.
Expanding Nut Shells	-These steps are not being performed today-	A temperature shock should be done by putting the nuts first into the hot cooking water for 5-7 minutes and into cold 15° Celsius water afterwards [Bay-04].	This step is possible to implement.
Cracking Nut Shells		The objective is to crack nut shells manually with gloves and special shell cracking tools.	The tools for cracking nut shells are available at the community. This step is possible to implement.
Classifying Nuts		The objective is to classify the nuts manually with gloves by size and quality.	It is possible to implement but classifying of nuts will only be needed when the nuts will be sold to national or international markets. For the regional market of Porto Velho, classifying is not required.
Drying Nuts without Shell		The objective is to dry the nuts without shell with a drying machine.	This step is not possible to implement since a drying machine is not available at the community.
Vacuum Packaging Nuts		The objective is to package the dried nuts without shell durably so that the humidity	This step is not possible to implement since there is no possibility to package

		will not damage them.	nuts in the community.
Storing Packages of Nuts		An objective is to have a storage room with different areas for different kinds of nuts, like dried, shelled, and unshelled nuts.	This step is not possible to implement since there is no storage room at the community and no capital in order to build a storage room.
Selling Packages of Nuts		The objective is to build a network of buyers in Porto Velho and to have a group of harvesters who are going to set the selling price of nuts and have negotiation power.	This step is not possible to implement in the moment since an organization form of harvesters is missing.

Table 2: *Brazil Nut harvesting steps with actual situation and objectives*

7 Adapting Technologies

Adapting technologies is the method of adjusting technology to the requirements of its future user. The idea here is to make the available state of the art technologies for Brazil Nuts accessible to rainforest communities. The technology for Brazil Nut process will be suited to economical, social, and ecological characteristics and adapted regarding these special needs to requirements of its future user.

7.1 Selection of a Process to be Improved

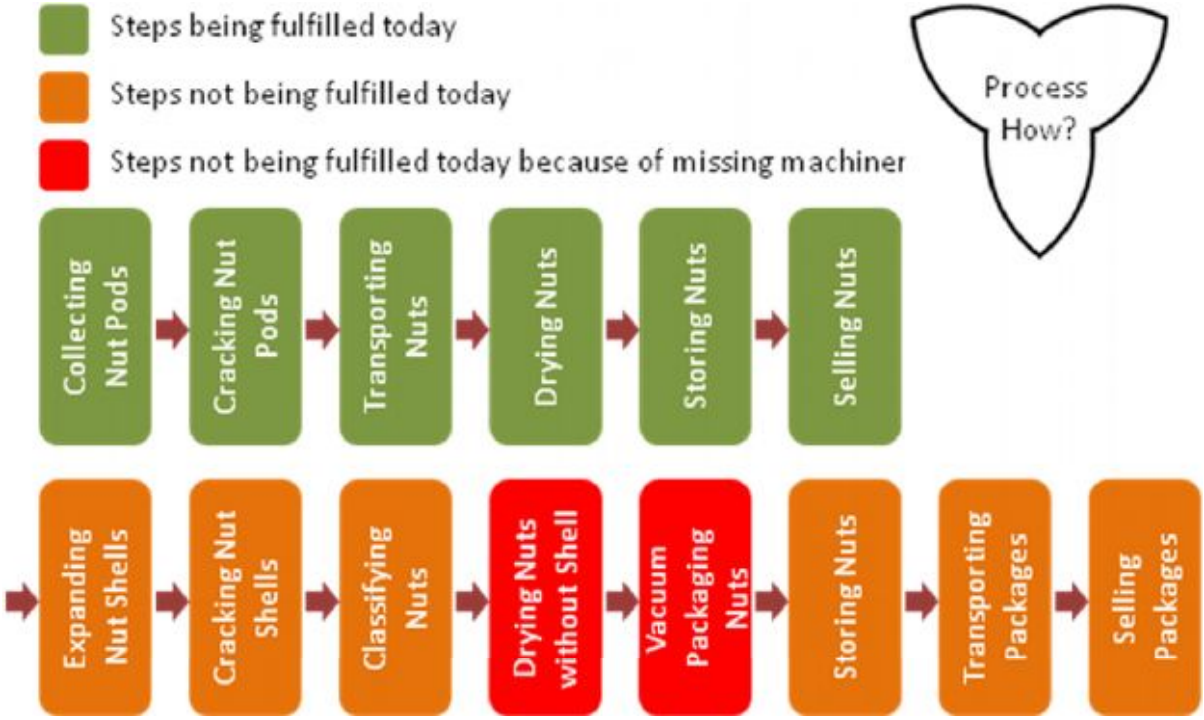


Figure 7.49: *Brazil Nut processes*

Like described in chapter 5.2 “Adding Value to Brazil Nuts”, not performed process steps for adding value to Brazil Nuts are drying nuts without shell and packaging of nuts. State of the art analysis of dehydrating machines is being fulfilled before deciding about which drying machine will be built and what technologies have to be adapted in order to fulfill the needs of the future dehydrating machine users of the communities.
A vacuum packaging machine has been selected that was available at the local market and able to package nuts in the required quantities.

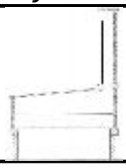
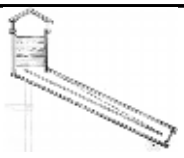
7.2 State of the Art of Technologies for the Process Drying

The team has done research on dehydrating machines which could dry Brazil Nuts in Sao Carlos de Jamari and Cunia. One important requirement for the dryer to be selected is that it would work in a humid environment and that it could be built with the materials and tools available at the rural area of Porto Velho.

It is significant that the community would be able to buy all the materials, as well as to build the dryer without any help of the team members. That is why availability of materials in Porto Velho as well as the simplicity of the construction of the dryer has been taken into consideration.

After making a state of the art analysis of dehydrating machines, six dehydrators have been chosen and evaluated.

The following table shows the evaluation of six potential dehydrating machines which could be built in the rainforest communities:

	Solar cabinet dryer	*Solar chimney cabinet dryer*	*Glass-roof solar-dryer*	*Polythene-tent dryer*	*Solar horizontal dryer*	*Solar vertical dryer*
						
Technical Factors						
Availability of construction materials	X	X	X	X	X	X
Indirect drying process			X		X	
Transport capacity	X				X	
Seasonal functionality		X	X		X	
Loading capacity (flexible)			X		X	X
Economical Factors						
Low construction cost	X	X		X		X
Access to replacement parts	X	X	X	X	X	X
Low maintenance costs	X	X		X		X
Social Factors						
Low operational complexity	X		X	X	X	X
Flexible	X	X		X	X	X

Functionality						
Safety			X		X	X

Table 3: *Choosing the appropriate dehydrating machine – Pahl Beitz*

After evaluation the team had two favorites: the Solar Vertical Dryer and the Solar Horizontal Dryer.

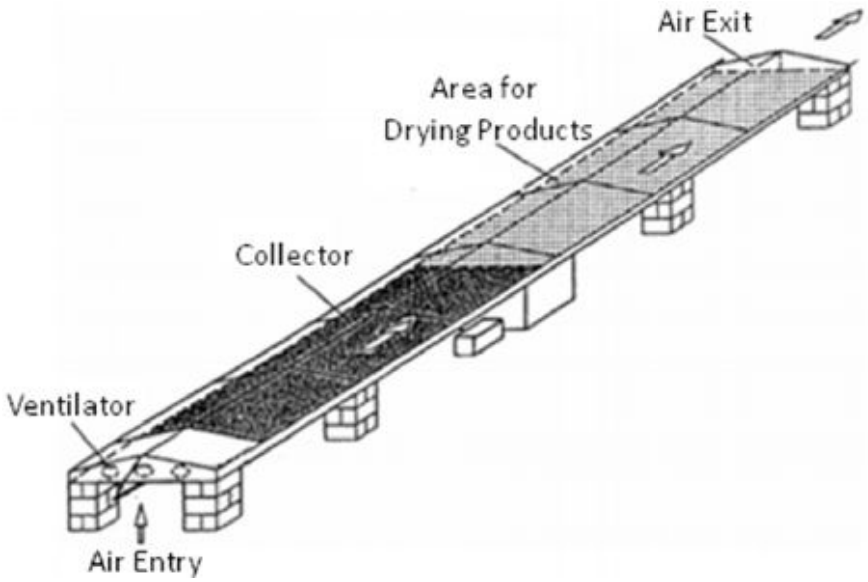


Figure 7.50: *Horizontal solar dryer [Sol-06]*

Solar Horizontal Dryer in form of a long table is whole covered by a plastic film which creates greenhouse effect inside the dryer. The dryer is separated into the heat collection part and the part for drying of nuts. The air is coming through the entry (Figure 7.50) and is circulated with help of a ventilator. The collector develops a high air temperature inside the dryer.

The main Solar Horizontal Dryer advantages are that it can be allocated in the climate of Rondônia, has low operating expenses and is easy to assemble. By changing the pressure of the ventilator it is possible to regulate the temperature inside the dryer.

The dryer does not need a constant monitoring while drying the nuts. The main disadvantage of this dryer is the external energy which is needed for the ventilator, in order to dry the products.

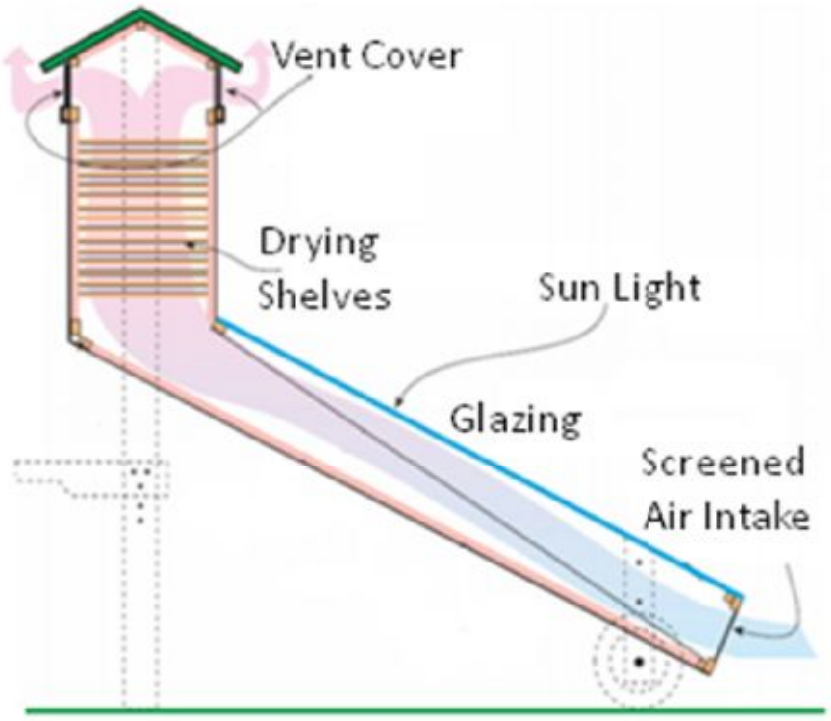


Figure 7.51: *Vertical solar dryer [Dom-99]*

The vertical solar dryer (Figure 7.51) is only working with solar energy and does not need additional electricity. Air is getting inside the dryer through the lower valve as seen on the right lower corner of Figure 7.51. The air is getting heated up by solar energy through the glazing. The warm air rises up and goes through the shelves with nuts. The upper valves let the air out and evolve airflow.
The main advantages of this dryer is that it is applicable in all climates. The airflow and temperature are easy to regulate through opening or closing the lower or upper valves. The dryer has low operating expenses and is easily transportable. There is no constant monitoring needed during the drying process. Compared to the Solar Horizontal Dryer the Solar Vertical Dryer is more complicated to build what can be seen as a disadvantage for this dryer.

7.3 Selection of an Appropriate Dehydrating Machine

In order to select an appropriate dehydrating machine for Sao Carlos do Jamari and Cunia communities economical, social, and ecological criteria were taken into consideration.
For making a decision on which prototype to build, the team has created a Selection Criteria Matrix (Table 4). The economic criterion plays the biggest role in the decision making process with 40% of relevance because the community will not be able to construct the dryer if it is too expensive. The second criterion with 35% is the social fact. The dryer should be for example easy to use and the community members should be able to construct and maintain the dryer by themselves.

	Weight	*Vertical Dryer*	*Horizontal Dryer*
Economical			
- availability of construction materials	0,10	5	1
- low construction cost	0,10	5	5
- optimal airflow	0,10	4	1
- loading capacity	0,10	1	2
Social			
- low operational complexity	0,12	1	5
- transportability	0,12	4	1
- safety	0,12	3	3
Ecological			
- longevity	0,08	4	4
- renewable energy source	0,08	4	1
- environmental friendly materials	0,08	3	1
TOTAL	1	3,35	2,45

Legend:
1: *Non-compliance*
3: *Good compliance*
5: *Very good compliance*

Table 4: *Comparison of dryer models*

After comparing the both dryers, the Solar Vertical Dryer was chosen by the team. Choosing this dryer does not necessarily mean that this dryer has to be built in Sao Carlos do Jamari. It is important that the decision on what dryer to be built will be made by the community members. Only in that way the producers will be able to identify with the dryer and feel as a part of the decision making process.

Failure Mode and Effect Analysis (FMEA) for the Solar Vertical Dryer is developed (Table 5) in order of seeing what problems can occur during the construction process of the dryer and what action can be done for preventing problems. Because of FMEA the team decided to construct a prototype of the Vertical Solar Dryer and to have the first experience on constructing it.

Potential Failure	Potential Effect	Recommended Action
Lack of Material	Time Loss	▪ Detailed Bill of Materials ▪ Communication with NAPRA ▪ Action Plan
Bad Quality of Materials	Bad Quality Drying Short life time of materials	▪ Communication with NAPRA ▪ Action Plan

Lack of Tools	Time Loss	▪ Detailed List of Tools ▪ Communication with NAPRA ▪ Action Plan
Lack of Construction Know-How	Bad Construction of the Dryer	▪ Experience by Building prototype

Table 5: *Failure Mode and Effect Analysis of vertical solar dryer*

The prototype will be built in Germany for having the first experience of how to construct the dryer and about which steps in which order should be done.

7.4 Validation of the Vertical Solar Dryer

There is an immense difference of constructing a dehydrating machine on the university's shop floor or in a carpenter's area of a rainforest community.

In order of validating the construction of the vertical solar dryer, a prototype of the dryer was constructed in Germany. The first step before the construction was the buying of materials. A detailed bill of materials has been written for the prototype as well as a not concrete list of materials for the real size dryer.

After buying two slides of plywood (20mm, 1500 x 1000 mm and 15mm, 1200 x 800 mm) the detailed drawing on the plywood began.

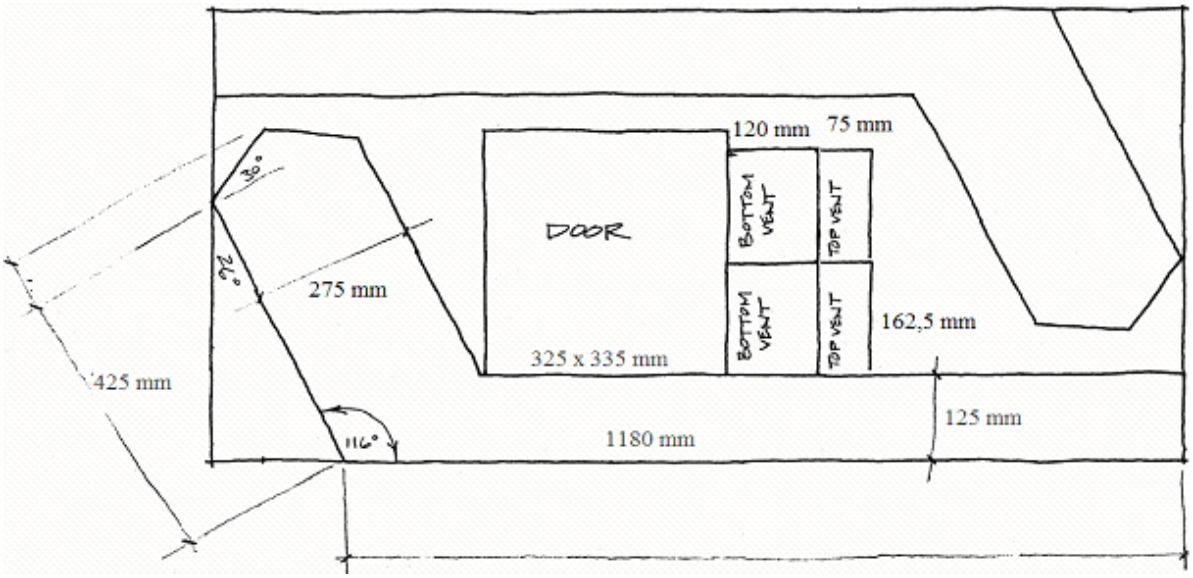


Figure 7.52: *20mm plywood layout [Ame-83]*

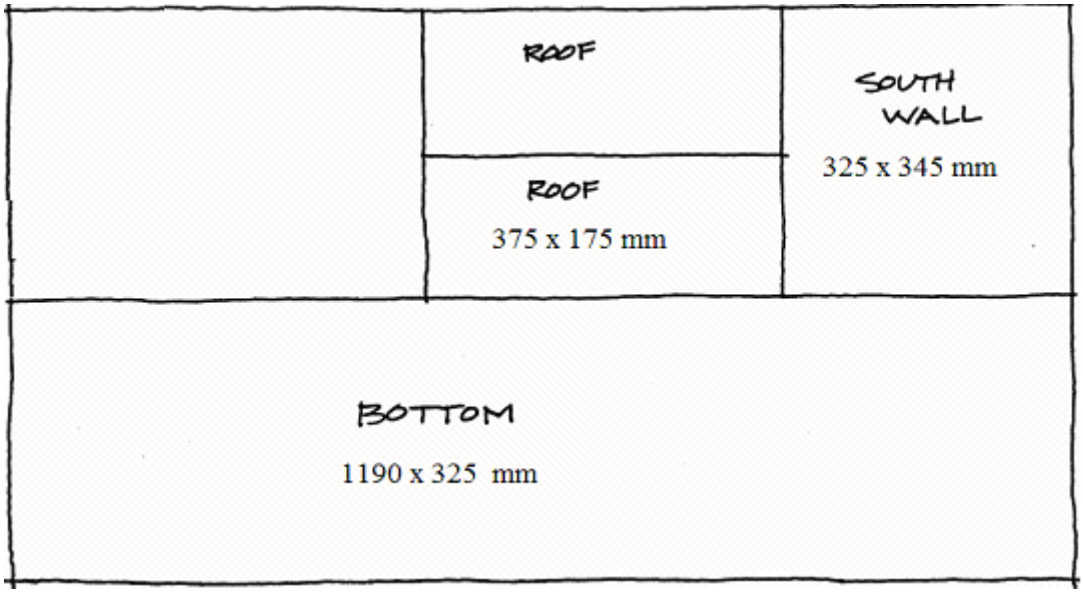


Figure 7.53: *15mm plywood layout [Ame-83]*

After sketching parts of the dehydrator on plywood started a very precise work of sawing the plywood. The next step was to drill the roof, the south wall and the bottom before putting the parts together.

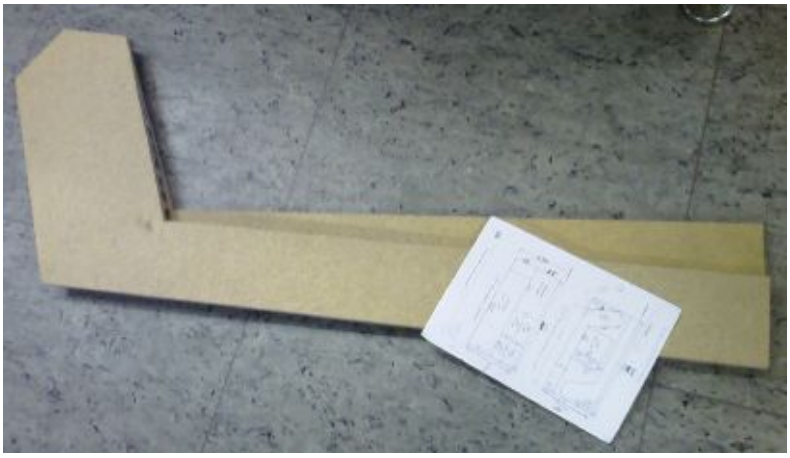


Figure 7.54: *Two sides of the plywood*

The battens for the drawers have been fixed on the inner sides. The door has been screwed with long hinges to the bottom. In order to keep and to attract the sun, a curved aluminum sheet was connected to the bottom.
Because transportability of the dryer is an important factor for the community, wheels were attached to the dryer's bottom. Only then the south wall could be connected to both sides and the bottom to the sides (Figure 7.55). At that point the deck has been attached.

Figure 7.55: *Construction of a prototype in Germany*

The next step was to construct and to fixate the vents.
Afterwards the glass was fixed, the chains connected to the door and the legs fixated to the dryer. As the last step the shelves could be constructed.

Figure 7.56: *Prototype of a dehydrating machine*

Because of the FMEA analysis and with regard to the complications which can occur while building the dryer in the rainforest environment, it was important to write every detail for the construction of the dryer. A list of steps on how to build the dryer was developed.

7.5 Adapting Technologies and Constructing a Vertical Solar Drying Machine

Adapting Technologies

In order to construct an appropriate drying machine, it should be adapted to the requirements of its future users and the rainforest environment. Technology can only be validated in relation to the social group that creates and uses it.
One of the requirements for the dehydrating machine is its ability to collect as much solar energy as possible during the day and to be humidity resistant during the night. The

machine should be constructed with the local tools and local materials. It should be easy to construct, to maintain, and to use. The dehydrating machine should be transportable and easy to reproduce in other communities. Two critical elements in designing practical technologies for the dehydrating machine are costs and feasibility.

Constructing a Vertical Solar Dryer

In order to start with the construction of a dehydrating machine in Sao Carlos do Jamari the community team members decided which dryer they prefer to construct. The horizontal and the vertical dryers were presented to the community team members. The advantages and the disadvantages of both machines were analyzed. The community team members decide to construct the vertical solar dryer together with the project team members because of the construction complexity and to construct the horizontal solar dryer by themselves after the project team leaves the communities.

First of all a bill of materials has been prepared. With regard to the bill of materials for the prototype which was constructed in Germany, the team develops a new bill of materials:

Quantity	Description
1	Plywood plate 320cm x 130cm (19mm thick, it also can vary and be about 20mm)
1	Plywood plate 220cm x 130cm (19mm thick, it also can vary and be about 20mm)
1	Curved sheet aluminium plate 220cm x 65cm
100	Screws for wood, 3mm x 35mm (explanation: diameter 3mm and length 35mm)
100	Screws for wood, 3mm x 25mm
100	Screws for wood, 3mm x 15mm
6	Screws for wood, 3mm x 35mm first 20mm without screw thread
6	Hinge, 30mm x 60mm (for wood screws)
1	Plexiglas (acryl, not polycarbonate) 65cm x 125cm (8 to 10mm thick)
1	Hinge for the door, length of 650 mm x 40mm
2	Wheels, radius of 10 till 15cm
10	Stainless steel net (0.8mm thick) 380mm x 605mm
2	Steel chain for the door, length of about 80cm, thickness does not matter much (but has to hold a door out of plywood, which is 65 x 66cm big)
3	Aluminium film (roll)
Silicon for wood (without toxic properties)	
Black paint for wood	
Black paint for curved aluminium sheet	
Stable wood sticks:	
10	30mm x 15mm, length 2m (Lengths of the sticks: 605mm, 590mm, 365mm, and 365mm)
10	10mm x 15mm, length 2m
10	15mm x 15mm, length about 80cm

2	8cm x 8cm, length 1,5m

Table 6: *Bill of materials – solar vertical dryer*

In order to buy the materials the team travelled to Porto Velho. The bought materials were transported by boot to the community. It is difficult to transport plywood because of its weight of over 100kg. The transportation could only be managed with four persons (Figure 7.57).

Figure 7.57: *Transportation of plywood, curved aluminium sheet, and Plexiglas*

At that point the construction of the dryer could begin. The local carpenter of Sao Carlos do Jamari has allowed the team to use his working area and his tools for the construction of the dryer.

First of all the plywood plates have been sawed. It was a challenge since all the corners should have right angles and all the parts a very precise length. The local tools for sawing right angles and straight lines were very limited. The team used a pupil square set for sketching right angles on the plywood and was very concentrated in order to saw the details of the dryer very precisely.

Figure 7.58: *Sawing of plywood*

The next step was to fix the slats for the shelves at the two side parts of the dryer (Figure 7.59) in order to paint the dryer afterwards (Figure 7.60). All slats should have the same distance between them and be equal on the two sides of the dryer. The slats have been fixed already at that point so that the sides can be connected to the bottom after painting black the parts.

Figure 7.59: *Fixing of the slats for the shelves*

All the parts were painted black so that the dryer would absorb as much heat as possible which was needed for the sufficient airflow inside of the dryer. The parts were painted from both sides equally even if one of the sides would be inside the dryer and would not absorb the sun light. The plywood changes its qualities when painted. If only one side of a part would be painted, the shape of the part might change unpredictably.

Figure 7.60: *Painting all the parts of the dryer*

After painting the parts black and letting them dry, all the corners and sides of the dryer parts were sanded using abrasive paper (Figure 7.61).

Figure 7.61: *Working environment and sanding all parts of the dryer with abrasive paper*

Only at that point all the parts of the dryer could be assembled.

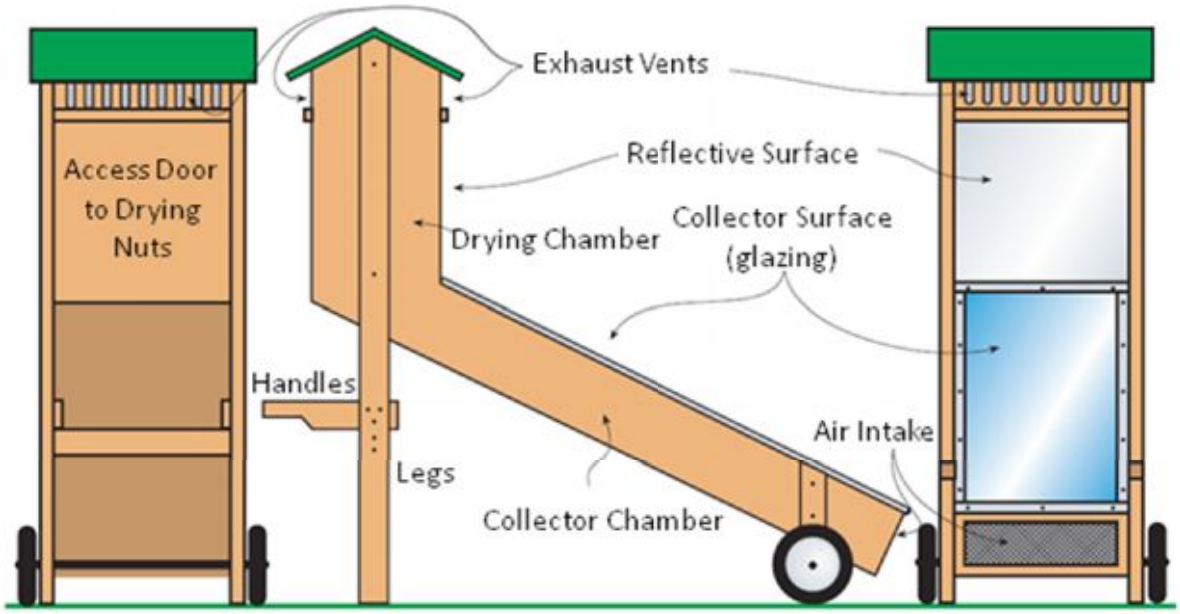


Figure 7.62: *Multiple views of the vertical solar dryer [Dom-99]*

First of all the two side parts were connected to the south wall, the reflective surface (Figure 7.63) and secondly to the bottom of the collector chamber so that the construction already got the shape of the future dryer.

Figure 7.63: *Fixing the parts of the dryer*

The exhaust vents were fixed. The dryer has three vents: two on the top under the roof and a third one at the bottom as an air intake. The valves are important for developing airflow inside of the dryer. The lower vent lets the air inside the dryer and the upper vents are letting the cooler air out. By changing the size of the valve spans one can change the heat and the speed of the airflow inside the dryer.
After fixing the valves, the roof was connected to the sides of the dryer and then covered with an aluminum panel in order to protect the wood of the roof from rain (Figure 7.64).

Figure 7.64: *Covering the roof with an aluminum panel*

As the next step the wheels were connected to the dryer. In order to divide the forces of the weight, the wheels were first of all connected to an external 20cm thick wood stick (Figure 7.65) and then to the dryer's bottom.

Figure 7.65: *Fixing the wheels*

The curved sheet aluminum plate was placed inside the collector chamber. First of all it was painted black in order to absorb the sun light (Figure 7.66). Black aluminum plate absorbs sun light and saves the heat inside the chamber. As hotter the air gets inside the collector chamber as faster is the airflow inside the drying chamber and as better the drying quality.

Figure 7.66: *Painted aluminum curved sheet*

The aluminum curved sheet was placed between the bottom and the collector surface of the dryer (Figure 7.67).

As the next step the access door to drying nuts was connected to the bottom and side walls. The two chains provide the possibility of using the door if open also as a table (Figure 7.68).

Figure 7.67: *Fixing the aluminum curved sheet*

Figure 7.68: *Fixing the chains at the dryer door*

After connecting the legs to the sides of the dryer, the glass Couleur be fixed. It is Plexiglas of 10mm which is being used as the collector surface. The Plexiglas lets the actinism to the collector chamber which heats up the air inside the chamber.

The lower vent as the air intake was connected to the dryer after fixing the glass (Figure 7.69).

Figure 7.69: *Drying machine with glass, lower valve, and legs*

The reflectors were connected to the dryer at that point (Figure 7.71). They are important in order to collect as much sun light as possible on the collector surface.

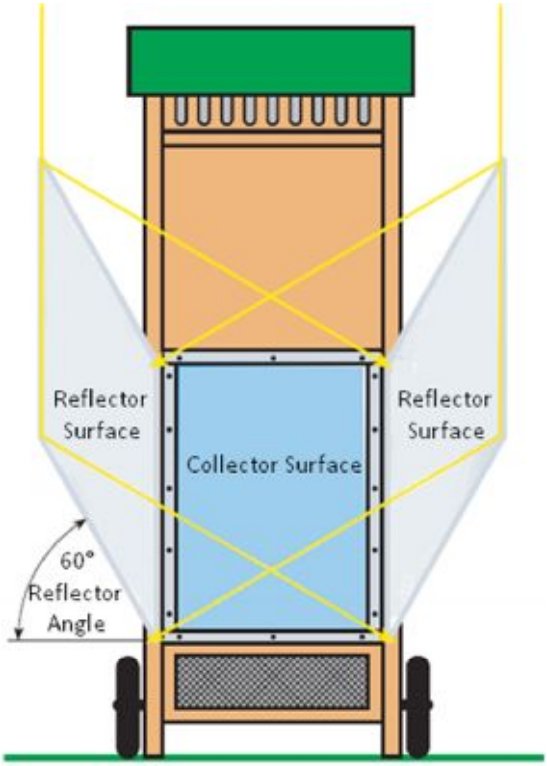


Figure 7.70: *Ideal angle for side-mounted reflectors [Dom-99]*

In order to get the ideal angle of 60° [Dom-99], triangles were mounted to the reflectors (Figure 7.71).

Figure 7.71: *Fixing reflection sides to the dryer*

Figure 7.72: *Dryer with reflectors*

An aluminum film was glued to the reflector surfaces for reflecting the sun light to the collector surface (Figure 7.72).

The last dryer parts to be constructed were the shelves (Figure 7.73). The material for the shelves should be rustproof in order of not being affected by the humidity of the nuts and decreasing the nuts quality. The frame of the shelves was constructed out of wood sticks. The upper wood sticks were thicker then the lower for protecting the nuts from falling down above the frame.

Figure 7.73: *Shelve*

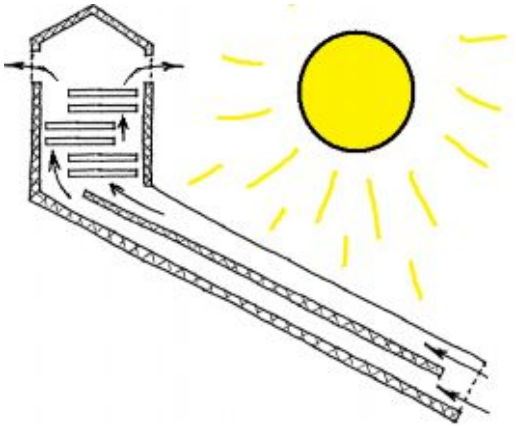


Figure 7.74: *Airflow inside the dryer*

The lower shelves are usually getting more hot air then the upper ones. In order for the upper shelves to get hot air and for developing an efficient airflow inside the dryer, the shelves were ordered shifted compared to each other (Figure 7.74). The hot air can pass by through the area without shelves and get directly to the upper shelves. The upper shelves still get colder air than the lower ones but this assembly ensures a better airflow. In order to get an equal drying level of the nuts, the lower shelves should be exchanged with the upper shelves after half of the drying time needed for the nuts.

Ten shelves were constructed for the dryer. One shelve is sufficient for 1kg of nuts.

Figure 7.75: *Transportation of the dryer*

After finishing the construction of the vertical solar dryer, it was transported from the carpenter's working area to the mini-factory for the processing of the nuts. Four men were needed for the transportation of the dryer (Figure 7.75).

Figure 7.76: *Constructed dryer*

Figure 7.76 shows the constructed vertical solar dryer in the area of the mini-factory.

7.6 Integrating of the Vertical Solar Drying Machine in the Process Chain

After constructing the vertical solar drying machine, the production of the final product as of shelled, dried, vacuum packaged Brazil Nuts can begin. Figure 7.77 shows the Brazil Nut adding value process schematically, starting with the collection of the nuts in the forest and ending with the distribution of the final product as a shelled, dried, and vacuum packaged Brazil Nut.

Figure 7.77: *Brazil Nut Process* [Pos-09]

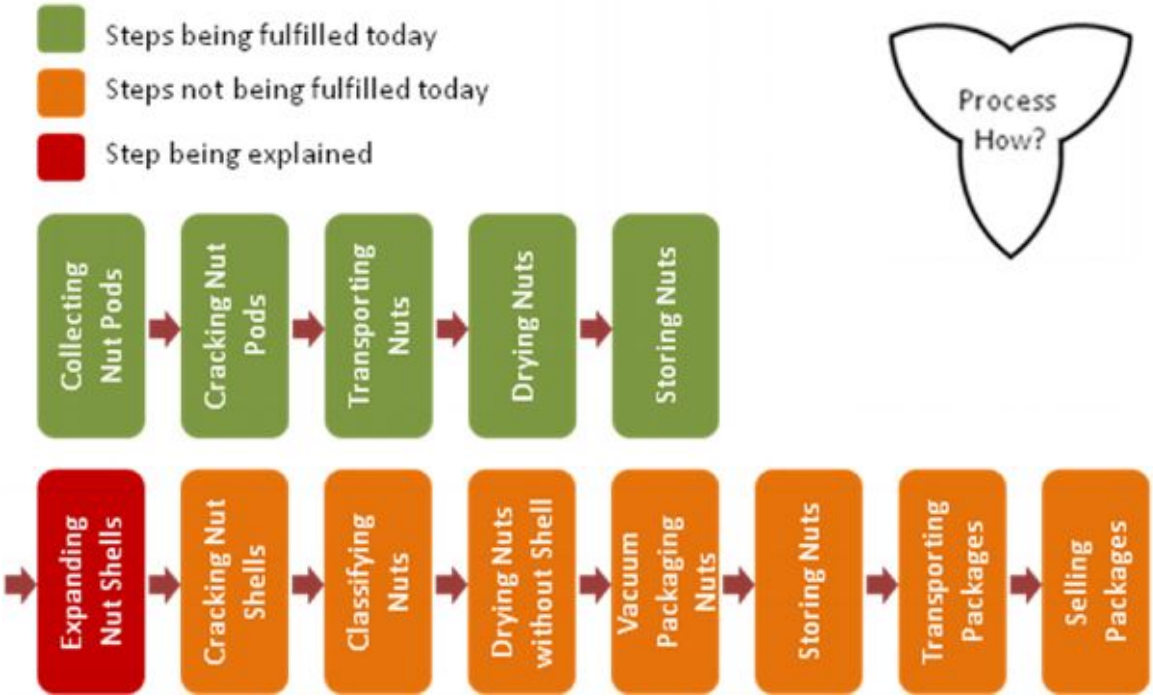


Figure 7.78: *Brazil Nut process*

The first step after storing nuts is the expanding of shell in order to process the nuts further. Expanding the shell of the nut is important in order of not breaking the nut while cracking the shell during the next step of processing. Expanding nut shell can be done with different methods. One of the methods is to put the nuts into a water chlorine dilution with 2mg of chlorine per 1 liter of water. This method is useful for a big nut processing company but not for a small start-up business. In this case a method of making a temperature shock for the shell can be a solution. Temperature shock can be achieved by leaving nuts in hot, cooking water for 5 minutes and putting these nuts into 15° C cold water afterwards. In that way the nut shell expands and makes it easier to crack the shell during the next nut processing step.

Figure 7.79: *Temperature shock of Brazil Nuts*

There are three different quality levels of nuts regarding the way they look. The best and the 1st quality nuts are nuts which absolutely do not have brown thin skin above them. The 2nd quality level are nuts which are partly with a brown skin and partly not and the lowest quality level are nuts which mostly stay brownish after cracking them.

Figure 7.80: *Different quality levels of Brazil Nuts*

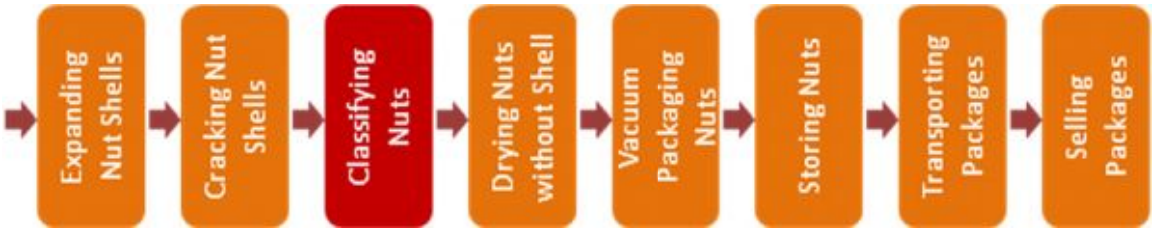
By expanding the nut shell, the brown skin around the nut expands as well and it becomes easier to take it off. The selling price of nuts rises in regard with the levels of the quality as well as with the size of the nuts.

Here again a distinction is drawn between small, medium, and large nuts size.

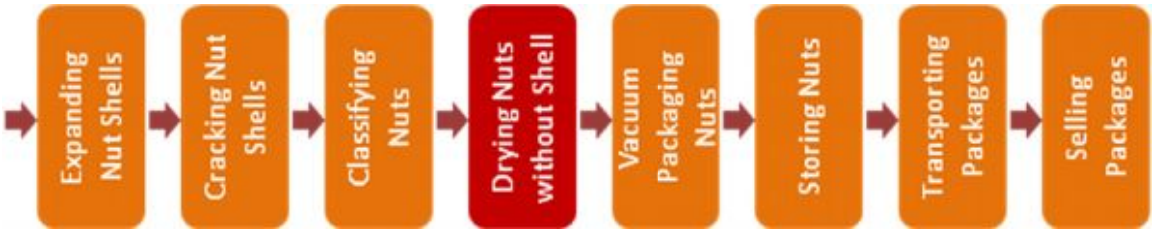
The next step is cracking of the nut shell. Cracking of Brazil Nut shells can only be done manually. It is a very discreet work. The shell should to be cracked in a way that the nut will not get damaged and that the brownish skin will be as much as possible separated from the nut. There are special mechanical machines which are being used for cracking of shells.

Figure 7.81: *Cracking of the Brazil Nut shell*

Using this cracking machine, one person can crack about 200 gram of nuts per hour. It takes a team of four members three days to crack 10kg of nuts.



After cracking the nut shell, nuts will be classified. For the market of Porto Velho, for the current demand, and for the mini factory which is being described, the classification is not important yet. Only after growing further and having national and international customers, it makes sense to classify the nuts.



After classification, nuts will be dried. Because of the high humidity in the area of Sao Carlos and Cunia, the nuts without shell would lose their quality straight away. In order to dry nuts a drying machine has been built (Chapter 7.5).

Figure 7.82: *Drying of nuts without shell*

There are ten shelves per kilogram of nuts inside the dryer and it takes in average two days to dry ten kilogram of nuts. The perfect temperature for drying is about 35° till 45° C. Starting from about 11:00 am the temperature inside the dryer increases over 35° C (Figure 7.83).

04.09.2008

Time	Temp	Weather
11:00	37°	
12:30	47°	
13:10	42.5°	
14:45	41°	
16:20	42.6°	

05.09.2008

Time	Temp	Weather
09:15	36°	
11:00	47.5°	
14:30	51°	
16:15	40°	

Figure 7.83: *Temperature difference inside the dryer during the day*

Through opening or closing of the vents and using or not using of reflectors temperature is regulated inside the dryer.

Dried and unshelled nuts are vacuum packaged straight away (Figure 7.85) because of humidity, otherwise they would lose their value.

A packaging machine is missing at the community. In order to select an appropriate packaging machine success factors should be identified. There are technical, economical, and social factors which are considered while choosing an appropriate machine. Technical factors include the availability of input material (plastic), local availability of the packaging machine, flexible packaging capacity, access to a stable electricity source, and prolonged life cycle under rainforest conditions. Economical factors include low investment costs, easy access to replacement parts, easy access to low cost input materials (plastic), and low maintenance costs. Social factors include low operational complexity and safety.

Name of the packaging machine	*Roved Vacuum Family*	*Orved Eco Vacuum Pro*	*LAVA V100*	*VACUUM SEALER*
				
Website	www.culinaryinnovations.co.uk	www.culinaryinnovations.co.uk	www.lava-europe.com	www.polishop.com.br
Price	£175,- (222,-€)	£150,- (190,35€)	259,-€	R$601.86 (198.44€)
Country of Origin	Great Britain	Great Britain	Germany	Brazil
Technical Factor				
Availability of input material			X	X
Local availability of the packaging machine				X
Economical Factors				
Low investment costs	X	X		
Access to replacement parts			X	X
Access to low cost input materials				X
Low maintenance costs				X
Social Factors				
Low operational complexity	X	X	X	X
Safety	X	X	X	X

Table 7: *Choosing the appropriate packaging machine – Pahl Beitz*

After choosing a packaging machine regarding the success factors only one company which produces domestic vacuum packaging machines in Brazil has been identified. The Vacuum Sealer packaging machine can be ordered from Sao Paulo for a price of 601.86R$ (198.44€). It is the only locally available domestic packaging machine which can seal bags of up to 30x50cm. The packaging machine has a guarantee of two years and a local assistance over phone or internet.

Figure 7.84: *Vacuum Packaging Machine*

The disadvantages of this machine are that its production company is suited in Sao Paulo so that its maintenance gets complicated if there are any problems with the machine and that the plastic bags for the packaging machine have to be from the same brand. Consequently the plastic bags have to be ordered from Sao Paulo.

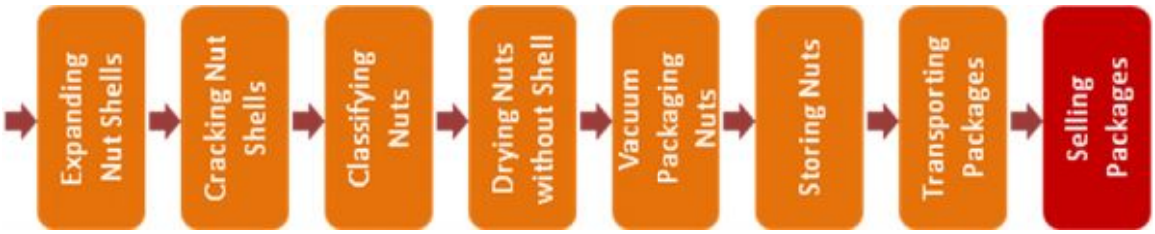
Figure 7.85: *Vacuum packaging of dried nuts*

After choosing a packaging machine the final product as shelled, dried, vacuum packaged Brazil Nuts has been produced (Figure 7.86). Ten packages of 1kg Brazil Nuts have been sealed in order to have the first experience of adding value to the product and at the same time of having the first experience of commercializing it.

Figure 7.86: *Final product as shelled, dried, vacuum packaged nuts*

Because of a very low quantity of final packages of nuts (only ten packages), the nuts could be stored at home of one of the producers. In that case the nuts did not need a special area to be stored since they are vacuum packaged and did not need a special airflow or a specific storage area.

Because of a low quantity of final packages, the 10kg of nuts could be transported in a backpack.



In order to sell the final product, the team visits the Rondônia's capital Porto Velho. The team's goal is to identify the customer's demand and to see how much profit one can receive after adding value to the product inside rainforest communities.
The first market visited in Porto Velho was Cain 'Agua (Figure 7.87) which is located at the harbor of Porto Velho.

Figure 7.87: *Market of Cain 'Agua*

The selling price of the nuts in Cain 'Agua depends on their quality level. The price for the 1st quality level of nuts is 12, - R$ (5,04€), for the 2nd quality level 10, - R$ (4,16€), and for the 3rd quality level 8, - R$ (3,36€). However the price changes constantly depending on the supply and the demand of nuts.
The second market visited was Mercado Central (Figure 7.88). The feedback to dried, vacuum packaged Brazil Nuts from Sao Carlos do Jamari was that there is an extraordinary quality of nuts compared to nuts from Bolivia or Brazilian state Acre but on the other side a too high price. The sales woman bought one package for her own use for 15,-R$/kg (6,24€/kg). The deal is for her to buy packages for the next year's season for 12,-R$/kg (5,04€/kg).
Currently she is receiving packages of 20kg of vacuum packaged Brazil Nuts from Acre for 150,-R$ (63,-€), which is equal to 1kg of nuts for 7,50R$ (3,15€) and is reselling them for 12,-R$/kg (5,04€) while earning 1,89€ per kg of nuts.

Figure 7.88: *Shop – Box in Mercado Central (market)*

A shop "Floresta" which is specialized only on Brazil Nuts and Brazil Nut products has been visited afterwards. The customers of Floresta are supermarkets and nut factories. The selling price of their nuts ranges between 12, -R$ (5,04€) and 16,-R$ (6,72€) per kg depending on the quality and packaging. The existence of a cooperative is important for the commercialization on a big scale and for selling nuts to "Floresta". The sales woman of "Floresta" affirmed the constant demand for Brazil Nuts and big quantities of well dried nuts are easily saleable.

The last market visited was Mercado do Um. The salesman bought three packages of dried, vacuum packaged Brazil Nuts from Sao Carlos do Jamari for a price of 10,-R$/kg (4,16€). His opinion was that smaller packages of 250g and 500g are easier to sell because the consumers mostly demand small packages of nuts.

One kilogram of nuts with shell during the season of Brazil Nuts costs 0,64R$ (0,27€). Three kilograms of nuts with shell (1,92R$; 0,81€) are equal to about one kilogram of nuts without shell.

After adding value to Brazil Nuts through shelling, drying, and vacuum packaging the nuts, one kilogram of nuts costs 12,00R$ or 5,04€ if being sold on the local market of Porto Velho. The winnings for one kilogram of nuts after adding value result in 10,08R$ or 4,23€ per kilogram of nuts.

By having a certificate for commercializing nuts nationally, the selling price increases by ~14.16€ on the local market of Porto Velho and by ~19.83€ on the national market of Sao

Paulo. After receiving a certificate for commercialization internationally, the price rises up to 20.18€.

Figure 7.89 shows the increase of selling price after adding value to the product -Brazil Nuts.

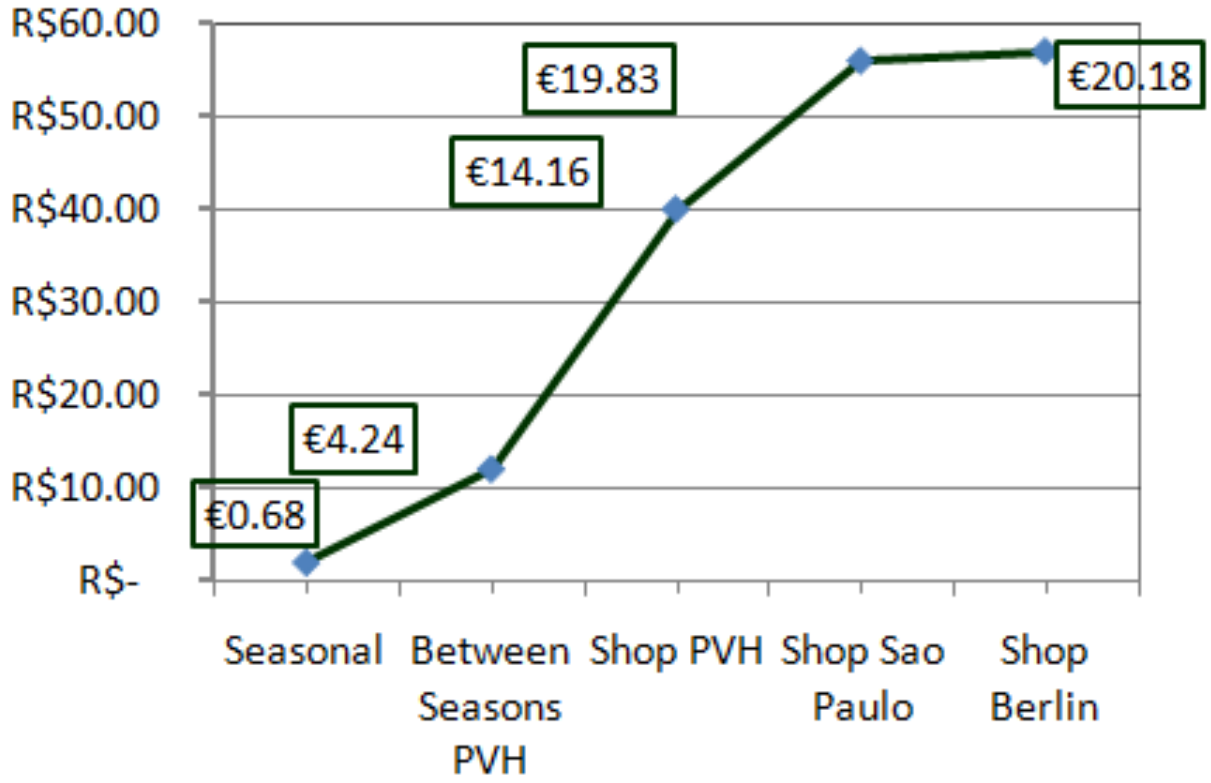


Figure 7.89: *Price difference of 1kg Brazil Nuts*

8 Evaluation of the Project with Producers

1. *Commercialization in Porto Velho:*

Marketing is very important in order to deciding the price, as there is not much experience with selling within the community. A price of 15,-R$ (6,24€) for 1kg of dried packaged nuts seems to be too expensive, but there are significant differences in price depending on the package. It is important to give some nuts to buyers to taste, so that they can see the quality of the product. It has been helpful to compare the quality of nuts from Sao Carlos do Jamari and of nuts from Acre, or Bolivia. The nuts from Sao Carlos do Jamari are of a better quality and tastier than the ones which are currently being sold on the markets in Porto Velho. Some markets in Porto Velho are willing to buy unprocessed nuts in big quantities in order to process them further and sell to other markets. The demand of nuts is high and the supply low. If there would be a sufficient amount of nuts, it would be possible to sell them. The team thinks that it would be good to have nuts in different shops of Porto Velho in order to compare between locations where nuts are sold for different prices or in different ways.

2. *Storage Room:*

There was a discussion of giving 600,-R$ (249,06€) as an initial capital for buying nuts during the Brazil Nut season to producers of Sao Carlos do Jamari. With that money the producers are supposed to collect nuts, to receive an amount of money for the nuts they provide, to store the nuts until their selling price rises, sell them afterwards, and to divide the additional earnings between the producers. The producers liked this idea very much. They decided to collect 33 latas of nuts each and to receive 6,-R$/lata (2,52€/lata). Producers decided that Marcio will get the 600,-R$ and receipts in order to do the book-keeping.

3. *Why was there a lack of motivation to participate in the Brazil Nut project by other members of the community?*

There may be not enough trust in the GET - NAPRA group. Some inhabitants of the community might prefer to work individually rather than as a group. Brazil Nuts are very cheap in price and a lot of people stop working with Brazil Nuts for that reason.
Marcio thinks that it is difficult to do what he, Ademilton and Sr. Manoel are doing. By participating in this project they are planning the future in a way that people in the community do not generally do. Many people in the community live with regard only for the present, while Ademilton, Senhor Manoel, and Marcio are working for the future.
On the other hand it may be better to begin the project with only few participants who will become strong in their knowledge during the start-up period and to let the group grow with the time.

The reason for little motivation may also be the previous Brazil Nut projects which started three years ago, remained without obvious results, and influenced the level of trust of the community's inhabitants.
It may also be difficult for producers to sit, to participate, and to concentrate on lectures and workshops since the producers are not used to studying.
It is to be expected that people who do not understand the reasoning behind the project will not be willing to participate.
The language barrier between the team and the producers caused sometimes longer meetings than the producers would have liked. It would be good to hold shorter meetings in the future.
The team needs to develop better ways to communicate with the producers. Nevertheless, by talking over the same matters again and again each of the producers eventually understands everything what is being communicated.

4. *1st Workshop: Good Handling (6 hours workshop)*

It is better to have one workshop of six hours rather than many short workshops. The exchange between theory and practice during the workshop has been helpful. Until this workshop, the theory for the work with Brazil Nuts has been missing. The producers usually get the transferred knowledge of how to work with Brazil Nuts from their family members only. Harvesters are not used to exchanging their knowledge on how to work with Brazil Nuts between themselves beside family members.

5. *Good Handling*

After having the theory of good handling, the producers will pay closer attention to what exactly they are doing while handling the nuts. At the beginning it will be difficult to change patterns of behavior.
The final product as a package of dried Brazil Nuts is a great motivation and a great success for the producers (Figure 8.90).

Figure 8.90: Final product as dried, vacuum packaged nuts without shell

The final product is an inspiration for the continuation of the project.

6. *Travelling to Manicoré – seeing a Brazil Nut factory*

It was worth going to see the Brazil Nut factory of Manicoré and to understand the whole process. After the trip, Marcio realized that not everything has to be perfect. It was a relief to see that there were mistakes in the processing of nuts in other communities as well. Additionally, he realized that the producers of Manicoré do the same process as the producers in Sao Carlos do Jamari, but with more advanced machinery. In general the producers have a good impression of the Brazil Nut factory of Manicoré.

7. *Choosing which Solar Dryer to build*

It was difficult for the community members to decide which dryer to build because the presentation of the dryers was too short and with only little information about the dryers. If the presentation of the available dryers were better, it would be easier to make a decision about what dryer to build. Though Ademilton knew very little about building a drier at the beginning of the project, he learned a lot during the process. He also had the impression that the team preferred to build the Vertical Solar Dryer rather than the Horizontal Solar Dryer.

Marcio thought that the final product would be better with the Horizontal Dryer but that the Vertical Dryer would be more practical and more secure.

Though Senhor Manoel preferred to construct the Horizontal Dryer, he was satisfied with building a Vertical Dryer because he knew little about both of the dryers, and because the Horizontal dryer would use external energy while the Vertical one would not.

8. *Construction of the Dryer*

The construction of the dryer took longer than supposed but the producers think that it is usual that in praxis it takes longer than in theory. It was good to learn the construction process and to see how the team members are working. Now it is satisfactory to see the result.

9. *Processing the Nuts*

It would be good to have more machines for shell cracking. Now there are only three cracking devices.
In regard to the packaging machine, bags for packaging are needed and it would be good to have different sizes of bags.
It is a sacrifice to work so long in order to get shelled, dried, packaged nuts, but there is a good result and one can see that it is worth it to invest time in this process.

10. *Whole project*

The project happened very immediate and very fast. Producers had obligations but were participating in the project. They had to set priorities.
For Ademilton everything was about building a storage room, not about the dryer. The storage room is still missing. For closing the project, he needs to build a storage room in order to have a basis to begin. He feels responsible for continuing what was started during the project.
It was interesting to see that people, who have never worked with Brazil Nuts, have the knowledge and that language is not the only source for communication.

Figure 8.91: *Project team with the constructed vertical solar dryer and the final product*

9 Conclusion and Outlook

It became unusual for community inhabitants to share their traditional knowledge between persons other than family members. After the quality management workshop and the visit of the Brazil Nuts processing cooperation "COVEMA" in Manicoré, the lack of skills and of knowledge on how to process Brazil Nuts could be dispelled.

During the project, the harvesters had their first experience of Brazil Nuts' quality management. They got to know the Brazil Nuts from a theoretical point of view and got a traditional knowledge input from the practical experience of producers other than their family members. The knowledge on good handling gives the producers the spirit of collaboration within the group in order to exchange the knowledge and to maintain the nuts' quality.

The importance and the advantages of working together in an organized group started to develop. The awareness has been raised that only through increasing the quantity and quality of nuts, will the producers be able to gain negotiation power on the local, national, and international nut markets and overcome the dependency relationship between themselves and intermediaries. An outlook for the follow up project is to identify an adequate form of a business model for the producers like an association or cooperative and to implement this business model into the producers' work with Brazil Nuts because a suitable organizational form for working together with Brazil Nuts is still missing. Through division of tasks and sharing of knowledge, the producers can increase their income, sell Brazil Nuts for a higher price between seasons, manage initial capital, maintain quality of Brazil Nuts, increase trust between producers, gain a higher motivation through collective, and entrepreneurial spirits, and work toward a certification for the trade of Brazil Nuts on the national and international markets. After having a certain form of organization and a division of tasks within, the producers will be able to overcome the obstacle of not having sufficient information about the local, national and international market conditions.

The project's second part of adding value to Brazil Nuts gave the producers the knowledge on how to process Brazil Nuts and experience on how much the price of a product can raise after investing a certain amount of time and work into it. The producers gained the technical knowledge on how to construct a solar dryer for nuts. They have experienced the construction process and have access to construction designs in order to multiply the drying machines. A sample of shelled, dried, vacuum-packaged Brazil Nuts could be developed. This final product was a source of motivation for continuation of work with Brazil Nuts, for adding value to the products, and for working together as a group. After having ten 1kg packages of the final product, the team had the first experience of commercialization. They listened to the opinions of sellers on the market of Porto Velho about their product, understood the importance of the quality and the quantity of the products for setting a selling price.

As a conclusion one can say that the project solved the goal of motivating the inhabitants of Sao Carlos do Jamari and Cunia on improving their work with Brazil Nuts. The more

motivated the harvesters are, and the more time they invest in the work with Brazil Nuts, the more popular the work with Brazil Nuts becomes. As working with Brazil Nuts becomes more popular, more producers will be willing to work with Brazil Nuts. And as more people work with Brazil Nuts the project will be duplicated in other communities. Finally, the more communities that work with Brazil Nuts, the better it is for the forest's protection.

Figure 9.92: *Factors leading to forest protection*

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