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# THE INTRODUCTION OF MORINGA (*Moringa oleifera*) AS A FOOD COMMODITY: A CASE STUDY ON THE VALUE CHAIN FROM OMETEPE ISLAND, NICARAGUA

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## ABSTRACT

The introduction of Moringa (*Moringa oleifera)* as a food commodity for dietary supplements and so-called “superfoods”, especially based on Moringa leaves, is worldwide growing. Thereby, it is also promoted by NGOs as natural nutrition for the tropics and subtropics, coming along with environmental and socio-economic benefits to support a sustainable local development. However, Moringa is still not considered as a food commodity in most of these regions apart from its countries of origin. Therefore, a case study on the local Moringa value chain on Ometepe Island, Nicaragua, was performed, as NGOs are planning to commercialize Moringa for local consumption on the island. The analysis was set up on the Value Chain Analysis Approach provided by the Food and Agriculture Organization (FAO) of the United Nations. Activities, flows and agents necessary to locally introduce Moringa (limited on Moringa leave powder) were analyzed including a study case to physically and monetary account the flows of a pilot project. Concluding this study, Moringa presents a prospective commodity for organic food to respond on malnutrition in the study area. Based on an intercropping cultivation practice for Moringa with a spacing of 2 m by 3 m on 1 ha of land, it is expected that 3,300 kg of fresh Moringa leaves could be harvested in the first year of production and 5,940 kg in the second year. By this a final Moringa leave powder output of 410 kg/ha in the first year could be realized and 740 kg/ha in the second year, resulting in a total value added between 7,500 to 8,000 USD per ha in the first year and between 14,200 and 15,200 USD per ha in the second year. However, negative impacts, bottle necks and barriers were also identified, requiring further NGO involvement and research studies to support a sustainable development of Moringa as a food commodity on Ometepe Island.


**Keywords:** Moringa, Moringa leave powder, food commodity, value chain analysis, Ometepe Island

**RESUMEN**

La introducción de Marango (*Moringa oleifera*) como un producto alimenticio para suplementos dietéticos y los llamados "súper alimentos", especialmente basando en las hojas del Marango, está creciendo rápidamente en todo el mundo. Así también es promovido por las ONG como la nutrición natural de los trópicos y los subtropicales, incluyendo beneficios ambientales y socioeconómicos para apoyar al desarrollo local sustentable. Sin embargo, el Marango todavía no se considera como un producto alimenticio en la mayoría de estas regiones, aparte de sus países de origen. Por lo tanto, se realizó un estudio de caso sobre la cadena de valor local del Marango en la Isla de Ometepe, Nicaragua. Ahí ONG tienen planeado la comercialización de Marango para el consumo local de la isla. El análisis se estableció sobre el concepto del análisis de la cadena de valor proporcionado por la Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). Actividades, flujos y agentes necesarios para introducir Marango (limitado al polvo de las hojas del Marango) a nivel local fueron analizados incluyendo un caso de estudio para contar físicamente y monetariamente los flujos de un proyecto piloto. Como conclusión de este estudio, el Marango presenta un producto alimenticio orgánico prospectivo para responder a la desnutrición en el lugar de estudio. Cultivando 1 ha de tierra en base a una práctica de policultivos con el Marango en una separación de 3 m por 2 m, se espera que 3,300 kg de hojas frescas de Marango podrían ser cosechadas en el primer año de producción y 5,940 kg en el segundo año. Por lo tanto, se puede producir 410 kg por ha de polvo de Marango en el primer año y 740 kg por ha en el segundo año, lo que resulta en un valor añadido total de entre $ 7,500 y $ 8,000 dólares estadounidenses por ha en el primer año y entre $ 14,200 y $ 15,200 dólares estadounidenses por ha en el segundo año. Sin embargo, también se identificaron impactos negativos, límites y barreras, lo que requiere más intervenciones de las ONG e investigaciones científicas para apoyar el desarrollo sustentable de Marango como un producto alimenticio en la Isla de Ometepe.

**Palabras Clave:** Marango, Moringa, polvo de hojas de Marango, producto alimenticio, análisis de cadena de valor, Isla de Ometepe

**ZUSAMMENFASSUNG**

Die Einführung von Moringa (*Moringa oleifera)* als Nahrungsmittelrohstoff für Nahrungsergänzungsmittel und sogenannte "Superfoods", vor allem basierend auf den Blättern des Moringabaums, gewinnt weltweit an Bedeutung. Dabei wird es in den Tropen und Subtropen von Nichtregierungsorganisationen auch als natürliches Nahrungsmittel im Rahmen einer nachhaltigen lokalen Entwicklung gefördert. Dennoch wird Moringa außer in seinen Herkunftsländern überwiegend noch nicht als Nahrungsmittelrohstoff gehandelt. Daher wurde eine Studie der lokalen Moringa Wertschöpfungskette auf der Isla de Ometepe, Nicaragua, durchgeführt, wo Nichtregierungsorganisation die nachhaltige Kommerzialisierung von Moringa für den lokalen Konsum planen. Diese Studie basiert auf dem Konzept der Wertschöpfungskettenanalyse der Ernährungs- und Landwirtschaftsorganisation (FAO) der Vereinten Nationen. Die notwendigen Aktivitäten, Ströme und Akteure, um Moringa (begrenzt auf Moringablattpulver) lokal einzuführen, wurden untersucht und durch eine Fallstudie zur physischen und monetären Bewertung der Ströme eines Pilotvorhabens ergänzt. Daraus schlussfolgernd stellt Moringa im Untersuchungsgebiet einen potentiellen Rohstoff für organische Nahrungsmittel dar. Dabei wird erwartet, dass der Anbau von Moringa auf 1 ha Land in Polykulturen bei einem Pflanzabstand von 2 m x 3 m im ersten Produktionsjahr 3.300 kg frische Moringa Blätter und im zweiten Produktionsjahr 5.940 kg erbringt. Dies entspricht einem Moringablattpulverertrag von 410 kg/ha im ersten Produktionsjahr sowie 740 kg/ha im zweiten Produktionsjahr und dem Potential zu einer Wertschöpfung von 7.500 bis 8.000 USD/ha im ersten Produktionsjahr sowie 14.200 bis 15.200 USD/ha im zweiten Produktionsjahr. Zusätzlich wurden negative Einflüsse, Beschränkungen sowie Hindernisse identifiziert, die ein weiteres Eingreifen der Nichtregierungsorganisationen und zusätzliche wissenschaftliche Studien erfordern, um die nachhaltige Entwicklung von Moringa als Nahrungsmittelrohstoff auf der Isla de Ometepe zu unterstützen.

**Schlüsselwörter:** Moringa, Moringablattpulver, Nahrungsmittelrohstoff, Wertschöpfungskettenanalyse, Isla de Ometepe

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| | |
|---|---|
| APHIS | Animal and Plant Health Inspection Service |
| AMG | Arzneimittelgesetzt (German Medicinal Product Act) |
| ANN | La Asamblea Nacional de la República de Nicaragua |
| AVRDC | Asian Vegetable Research and Development Center |
| BCN | Banco Central de Nicaragua |
| BID | Banco Interamericano de Desarrollo |
| BMF | Bundesministerium der Finanzen (German Federal Ministry of Finance) |
| CBP | U. S. Customs and Border Protection |
| CCA | Commodity Chain Analysis |
| CDC | Center for Disease Control and Prevention |
| CFIA | Canadian Food Inspection Agency |
| CPML | Centro de Producción más limpia de Nicaragua |
| DFE | Dietary Folate Equivalents |
| EN | European Standard |
| EU | European Union |
| EUR | Euro (ISO 4217 code) |
| FAO | Food and Agriculture Organization of the United Nations |
| FAVIR | U. S. Fruit and Vegetable Import Requirements |
| FDA | U. S. Food and Drug Administration |
| FOMIN | Fondo Multilateral de Inversion |
| GDP | Gross Domestic Product |
| GIZ | Deutsche Gesellschaft für internationale Zusammenarbeit GmbH (former GTZ) |
| GP | Gross Profit |
| GTZ | Deutsche Gesellschaft für technische Zusammenarbeit GmbH (now GIZ) |
| HACCP | Hazard Analysis and Critical Control Points |

| | |
|---|---|
| HKND | Hong Kong Nicaragua Development |
| INE | Instituto Nicaragüense de Energía |
| INETER | Instituto Nicaragüense de Estudios Territoriales |
| INIDE | Instituto Nacional de Información de Desarrollo |
| INIFOM | Instituto Nicaragüense de Fomento Municipal |
| INTUR | Instituto Nicaragüense de Turismo |
| IR | Impuesto sobre la Renta |
| ISO | International Organization for Standardization |
| MAGFOR | Ministerio Agropecuario y Forestal de Nicaragua |
| MARENA | Ministerio del Ambiente y los Recursos Naturales |
| MIFIC | Ministerio de Fomento, Industria y Comercio |
| MINSA | Ministerio de Salud de Nicaragua |
| MLP | Moringa Leaf Powder |
| NE | Niacin Equivalents |
| NGO | Non Governmental Organizations |
| NIO | Nicaraguan Córdoba (ISO 4217 code) |
| NP | Net profit |
| NTON | Norma Técnica Obligatoria Nicaragüense |
| RE | Retinol Equivalents |
| SDC | Servicios para el Desarrollo de la competitividad |
| TE | Tocopherol Equivalents |
| UNA | Universidad Nacional Agraria |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNICEF | United Nations Children's Fund |
| UNU | United Nations University |
| U.S. | United States |

| | |
|---|---|
| USA | United States of America |
| USD | United States Dollar (ISO 4217 code) |
| USDA | United States Department of Agriculture |
| VA | Value Added |
| VAT | Value Added Tax |
| VC | Value Chain |
| VCA | Value Chain Analysis |
| WHO | World Health Organization |
| WFP | World Food Programme of the United Nations |
| WRI | World Resources Institute |

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# 1 INTRODUCTION

## 1.1 Background information about Moringa

Moringa, also known as Marango, drumstick tree, horseradish tree, ben oil tree and others, is a highly valued, fast-growing, medium sized and drought-resistant tree widely cultivated and naturalized in tropics and subtropical regions of the world. Originally it comes from the Sub-Himalayan regions of India, Pakistan, Bangladesh and Afghanistan, where it has a traditional use as medical and nutritional plant (Radovich, 2011). The tree belongs to the Moringaceae, a monogenetic family, whereof *Moringa oleifera* Lam. is the most common known and utilized species (Nadkarni, 1976 cited by Farooq *et al.*, 2007; Ramachandran *et al.*, 1980). According to Von Maydell (1986) the tree has a relatively short lifetime of about 20 years (cited by Reyes, 2004). Although, the tree can range in height from 5 to 10 m, it is generally considered a small- to medium-size tree. It further presents a slender softwood tree. Its leaves are tripinnate compounded with 1 to 2 cm big green to dark green leaflets elliptical shaped and with a wild leafy flavor and slight bitter taste. The flower is about 10 to 25 cm big, has a light fragrance and a white to cream color. The fruit of Moringa is a tri-lobed capsule referred to as pod. Immature pods are green which become brown and dry at maturity. Each pod contains about 15 to 20 large seeds with papery wings. Figure 1 presents the botanical description of the parts of Moringa while Figure 2 presents a detail image of the tree.

**Figure 1:** *Moringa oleifera* (botanical)


Source: Planeta Homa (2011:1)

**Figure 2:** Detail image of the Moringa tree

Source: DeLange (2005:1)

The Moringa tree tolerates a wide range of conditions. However, an optimal growth was studied on high average daily temperatures of 25°C to 30°C, a well distributed annual rainfall of 1,000 mm to 2,200 mm, high solar radiation, and well drained soils with a pH of 5.0 to 9.0. Furthermore, altitudes below 600 m are considered to be optimal, but this adaptable tree can grow in tropical regions up to altitudes of 1200 m (Morton, 1991; Palada and Chang, 2003; Radovich, 2011).

Recently the plant has gained much global attention due to its multiple use and benefits. All the parts of Moringa could be used for various purposes e.g. as fertilizer, animal feed stock, food and dietary supplement, medicine, cosmetics, biodiesel feed stock, and for water purification, making Moringa a valued plant for human beings (Fahey, 2005; Radovich, 2011). Various studies amongst others on its nutritional and medical values have been performed. The leaves and fruits as well as the flowers and the immature pods of the tree are consumed as highly nutritive vegetables in many countries. The leaves for example have been reported to be a rich source of β-carotene (vitamin A), proteins, vitamin C, calcium, iron and potassium as well as to act as a good source of natural antioxidants (Dillard and German, 2000; Siddhuraju and Becker, 2003). Thus, Moringa is nowadays considered to have the potential for being an important food commodity. The combination of its traditional use and recent scientific work supporting these traditions has resulted in increased marketing of dietary supplements and so-called “superfoods” based on Moringa, especially on Moringa leaves (Radovich, 2011). Moreover, Moringa is treated as a local and cost-effective response on malnutrition in the world’s tropics and subtropical regions. There it is particularly useful because the leaves appear until the end of the dry season when just a few other sources of green leafy vegetables are still available (Fahey, 2005). Furthermore, Moringa leaves can be kept for a longtime once they are dried requiring low storage and processing costs, and thus being available throughout the year (Kar *et al.*, 2013). Additionally, the costs of production are very low as Moringa is cultivated in hot climate, as it can tolerate poor soil conditions, and the absence of water as well as it is resistant to most pests and diseases (Palada and Chang, 2003; Kar *et al.*, 2013).

Because of this development, Moringa is currently of big interest for Non Governmental Organizations (NGO) acting all over the tropical belt. These NGOs seek to introduce Moringa with its multiple benefits to rural communities for local consumption, including its sustainable local cultivation and commercialization. Main objectives are the improvement of living conditions (including health and nutrition) as well as economic development and poverty reduction.

Thereby the introduction of Moringa as a food commodity directly responds on three United Nation (UN) Millennium Development Goals: goal number 1 – eradicate extreme poverty and hunger; goal number 4 – reduce child mortality; and goal number 5 – improve maternal health. Three NGOs in particular (Trees for Life, Church World Service and Educational Concerns for Hunger Organization) have advised Moringa as *"natural nutrition for the tropics*" (Fahey, 2005:2).

### 1.2 Problem statement

Apart from its countries of origin, usually local people in tropical and subtropical areas do not know about Moringa and/or do not consume it (Radovich, 2011). For example Moyo *et al.* (2011) states that most people in South Africa are not aware of the potential benefits of Moringa. Also in Nicaragua, where Moringa was introduced in the 1920s as an ornamental tree and to use as a kind of live fence (Foidl *et al.*, 2001), Moringa (locally called Marango) is partly known by local people as medical plant and as animal feed stock, but they are not aware about the plants nutritional value and thus they do rarely consume it. As a consequence Moringa is still far away from being a valued food commodity in the study area as well as in other tropical and subtropical countries others than those where Moringa originally comes from.

### 1.3 Justification

Even Moringa is recently intensively studied; there is a gap of integrated economic, environmental and social studies as well as of data about Moringa as a food commodity. These kinds of studies are essential to add value on Moringa aiming to create a sustainable development of local Moringa markets. Just a few studies about local Moringa markets and about Moringa as a source of income generation exist, which is far away from providing enough information about the entire processes from the cultivation of Moringa to the commercialization and consumption of the final products (so called commodity chain or value chain [VC]) to bring its benefits to local communities. This gap should be closed by this investigation for the case of Ometepe Island where the plant is partly known and locally grown but still not consumed. Thereby this investigation will contribute to the sustainable development of Moringa as food commodity in the tropics and subtropics.

Therefore a case study on a project to introduce Moringa in the area of study will be performed based on the concept of value chain analysis (VCA), which has been accepted in recent years as an important tool in development and environmental research (Faße *et al.*, 2011). The investigation aims to combine the environmental perspective with the economic nature of the VCA, because sustainable development requires methods to quantify and compare the environmental impacts of providing goods and services to our societies (Rebitzer *et al.*, 2004). The allocation of value chain activities integrating the environment in value chain analysis became a field of interest in recent years, referred to as “greening the value chain” (Irland, 2007). Value chains cannot be analyzed separated from the environment because all economic activities and particularly the agricultural production of food are based on environmental resources. All inputs and energies are provided by the environment as well as the capacity to dispose emissions and waste depends on the environment.

Ometepe Island was chosen as study case because some NGOs are currently planning to introduce Moringa as a dietary supplement and to create a local market for its consumption. In Balgüe, Municipality Altagracia, a Moringa project will start its activities in July 2014 with a first phase of knowledge and awareness rising. Additionally, a pilot project to commercialize Moringa on the island will start at the end of the year. Therefore, the investigation will support the Moringa project of Balgüe, Ometepe Island. The outcome will provide important insights on the projects way to set up a Moringa value chain which aims to establish a local market, so that the local community will benefit from the tree in multiple ways.

## 1.4 Research objectives

The **general** objective of this investigation is to analyze the organization of the VC of Moringa as a food commodity on Ometepe Island combining a socio-economic and environmental focus.

Furthermore, the following **specific** objectives are considered:

- Identifying all economic agents, all functions and all products within the chain,
- Calculating physical and monetary flows within the chain,
- Identifying the inventory of problems encountered by agents, and conceivable solutions to boost, increase and orient the chain; and
- Identifying requirements and barriers to introduce Moringa as a food commodity.

## 1.5 Thesis structure

This thesis is divided into seven major chapters. Chapter one presents the introduction to the investigation and is followed by the conceptual framework presented in chapter two. It will be focused on basic concepts of nutrition (including malnutrition, undernourishment and dietary supplements), the nutritional properties of Moringa, the concept of a commodity chain analysis (CCA), which is based on the VCA, and the concept of agroecology as applied in this investigation. Then, chapter three presents the study area Ometepe Island, Nicaragua. This chapter ends with a conclusion focusing on Moringa as a food commodity in the study area providing general considerations, which are included in the VCA. Following, within chapter four the methodology (methods of data collection and data analysis) of this investigation is explained. Afterwards, in chapter five the results and discussions of this investigation are presented. This chapter is divided into different sections following the structure of a VCA and an additional section on sustainability considerations. Finally, conclusions and recommendations are stated in chapter six and chapter seven lists the references.

# 2 CONCEPTUAL FRAMEWORK

## 2.1 Nutrition

UNICEF (2014b) states *"Proper nutrition is a powerful good: people who are well nourished are more likely to be healthy, productive and able to learn. Good nutrition benefits families, their communities and the world as a whole."* However, human nutrition is a complex, multifaceted scientific domain. It indicates the processes whereby cellular organelles, cells, tissues, organs, systems, and the body as a whole obtain and use necessary substances obtained from foods (called nutrients) to maintain structural and functional integrity. These nutrients can directly influence human genetic expression, determining the type of ribonucleic acid formed (transcription) and also the proteins synthesized (translation). They further act as substrates and cofactors in all of the metabolic reactions in cells (Vorster, 2009). Nutrients are divided into six main categories, which are presented in Table 1.

**Table 1:** Nutrients classification and use

| Class/Category | Use |
|---|---|
| Carbohydrates (macronutrient) | As fuel for energy for body heat and work |
| Fats (macronutrient) | As fuel for energy and essential fatty acids |
| Minerals (micronutrient) | For developing body tissues and for metabolic processes and protection |
| Proteins (macronutrient) | For growth and repair |
| Vitamins (micronutrient) | For metabolic processes and protection |
| Water | To provide body fluid and to help regulate body temperature |

Source: Own representation based on Voster (2009) and Latham (1997)

Finally, the combination and amounts of nutrients in the consumed foods determine human health (Vorster, 2009). Therefore, general guidelines for a healthy diet are developed by various institutions even though daily nutritional requirements, including those for essential nutrients, vary depending on factors such as age, sex, height, weight, physical activity, and the rate at which the body burns calories, called metabolic rate (Porter, 2009). Thereby, the dietary requirement for a nutrient is defined as "*an intake level which meets specified criteria for ad-*

*equacy, thereby minimizing risk of nutrient deficit or excess*" (FAO and WHO, 2004:1). For the purpose of this investigation the reference intake level as recommended by FAO and WHO will be considered as many countries rely on WHO and FAO to establish and disseminate the information, which they adopt as part of their national dietary allowances (WHO, 2014). These references for proteins, minerals and vitamins are presented in Annex 1.

**Malnutrition**

Malnutrition literally refers to "bad nutrition" and technically includes both over- and undernutrition (CDC and WFP, 2005). According to the WFP malnutrition is defined as: *"A state in which the physical function of an individual is impaired to the point where he or she can no longer maintain natural bodily capacities such as growth, pregnancy, lactation, learning abilities, physical work and resisting and recovering from disease. The term covers a range of problems from being dangerously thin (see Underweight) or too short (see Stunting) for one's age to being deficient in vitamins and minerals or being too fat (obese)."* (WFP, 2014:1)

Literature and also important organizations that work on malnutrition like WHO, UNICEF, FAO and WFP pay more attention to undernutrition than to overnutrition. Maternal and child undernutrition is still prevalent in most developing countries coming along with short and long term implications for these societies (Contreras, 2008). Thus, the reduction of malnutrition is considered to be central to reducing poverty and therefore central to reaching the Millennium Development Goals (The World Bank, 2003). This investigation will follow this trend as it is relevant for the selected area of study.

There are two categories of undernutrition: 1.) Protein-energy malnutrition (growth failure) and 2.) Micronutrient malnutrition or deficiency .The first category protein-energy malnutrition is *"a form of malnutrition measured not by how much food is eaten but by physical measurements of the body - weight or height - and age"* (WFP, 2014:1) and is categorized in stunting, wasting and underweight usually measured for children under 5 years (UNICEF, 2014a; WFP, 2014). These indicators are explained in Table 2.

**Table 2:** Protein-energy malnutrition indicators: Stunting, wasting, underweight

| Indicator | Explanation |
|---|---|
| **Stunting** | • Indicator of chronic malnutrition;<br>• Reflects shortness-for-age; and<br>• Is calculated by comparing the height-for-age of a child with a reference population of well nourished and healthy children |
| **Wasting** | • Indicator of acute malnutrition;<br>• Reflects recent and severe process that has led to substantial weight loss, usually associated with starvation and/or disease;<br>• Is calculated by comparing weight-for-height of a child with a reference population of well nourished and healthy children; and<br>• Is often used to assess the severity of emergencies because it is strongly related to mortality. |
| **Underweight** | • Is measured by comparing the weight-for-age of a child with a reference population of well nourished and healthy children. |

Source: Own representation based on UNICEF (2014a) and WFP (2014)

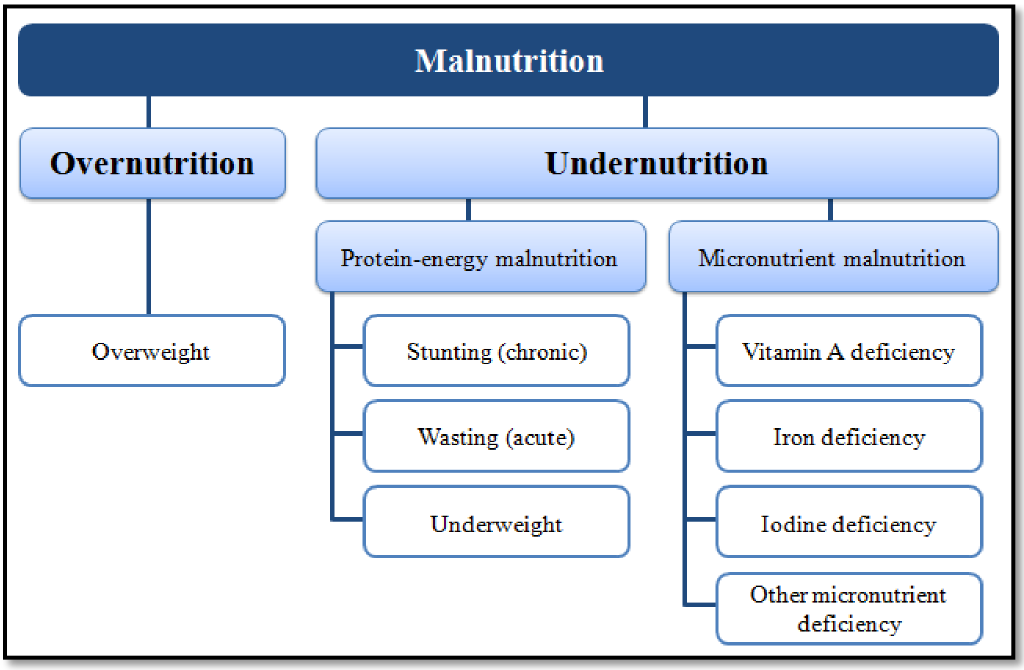
Whereas a micronutrient deficiency occurs when essential vitamins and/or minerals are not present in adequate amounts in the diet of a person. According to CDC and WFP (2005) the most common micronutrient deficiencies are iron (anaemia), vitamin A (xerophthalmia, blindness), and iodine (goiter and cretinism).

Finally, Figure 3 presents a systematical overview of malnutrition.

**Undernourishment**

Another important indicator on nutrition used by institutions is undernourishment, which describes: *"The status of people whose food intake does not include enough calories (energy) to meet minimum physiological needs. The term is a measure of a country's ability to gain access to food and is normally derived from Food Balance Sheets prepared by the FAO."* (WFP, 2014:1)

**Figure 3:** Overview malnutrition




Source: Own representation based on UNICEF (2014a) and WFP (2014)

**Dietary supplements**

For dietary supplements does not exist one general used definition. Different institutions set their own definition regarding their purposes. For example FAO and WHO (2003:44) define vitamin and mineral supplements as *"sources in concentrated forms of those nutrients alone or in combinations, marketed in forms such as capsules, tablets, powders, solutions etc., not in a conventional food form and whose purpose is to supplement the intake of vitamins and/or minerals from the normal diet."* Furthermore, countries set their own definition of dietary supplements by laws and regulations. In Nicaragua the law 693 "Ley de Soberanía y Seguridad Alimentaria[1]" presents the legal framework for nutrition and alimentation. However, it does not provide a definition of dietary supplements (ANN, 2009). A guide on the use of dietary supplements by the national Health Ministry (Ministerio de Salud, MINSA) at least defines nutrient supplementation as *"the administration of additional nutrients to those provided by foods, generally in pharmacological doses"* (MINSA, 2012; Own translation).

[1] Law of sovereignty and food security (own translation)

## 2.2 Nutritional properties of Moringa

Even though all parts of the Moringa tree could be eaten, it is especially the leaves (and partly the seeds) being promoted as food commodity. Thus this investigation is also focused on the leaves. The nutrients properties of Moringa are clear indications that the plants leaves are rich in nutrients and that they have the potential to be utilized as a food additive with multiple purposes. This includes serving as a protein (including all the essential amino acids[2]), fatty acid, mineral and vitamin resource for animal and human nutrition (Foidl *et al.*, 2001; Moyo *et al.*, 2011). In dried leaves the content of various nutrients is even much higher as drying the leaves assists to concentrate these nutrients. Drying further facilitate conservation and consumption (Moyo *et al.*, 2011). Additionally, the leaves' medical properties are supporting Moringa's value as a food resource. Due to its antibacterial and anti-inflammatory action it can be used as a treating agent for diarrhoea, urinary disorder and gastric ulcer. Furthermore, they can successfully purify blood along with lowering of blood glucose and cholesterol level (Ramachandran *et al.*, 1980); they increase breast milk production among young mothers and they can be a good source of natural antioxidants (Pari *et al.*, 2007). For all these benefits especially the dried Moringa leaf powder (MLP) is used as dietary supplement (Yaméogo *et al.*, 2011).

Several case studies on the nutrition value of fresh and dried Moringa leaves have been performed in different countries (Foidl *et al*., 2001; Olson, 2001; Fahey, 2005; and Yang *et al.*, 2006). However, these values vary depending on factors like method of analysis, genetic background, and environmental conditions as well as on cultivation and processing methods (Babu, 2000). For the purpose of this investigation the nutrition value of fresh leaves and MLP as reported by the company Moringa Delight will be taken in account as they grow Moringa in Leon, Nicaragua, presenting close growing conditions to those of the study area. The analysis of the Moringa nutrition content as reported by Moringa Delight (2013) is presented in Table 3. However, these numbers are equal to those presented by Fuglie (1999).

[2] An essential amino acid (or indispensable amino acid) is an amino acid that cannot be synthesized by the organism being considered, and therefore must be supplied in its diet. The amino acids regarded as indispensable for humans are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine, and histidine (WHO, FAO and UNU, 2007), whereby histidine is often considered to be semi-essential.

**Table 3:** Nutrition content of Moringa fresh leaves and MLP (as per 100 g)

| Indicator | Fresh Leaves | MLP |
|---|---|---|
| Moisture [%] | 75.0 | 7.5 |
| Calories | 92.0 | 205.0 |
| Protein [g] | 6.7 | 27.1 |
| Fat [g] | 1.7 | 2.3 |
| Carbohydrate [g] | 13.4 | 38.2 |
| Fiber [g] | 0.9 | 19.2 |
| Calcium [mg] | 440.0 | 2,003.0 |
| Magnesium [mg] | 24.0 | 368 |
| Phosphorous [mg] | 70.0 | 204.0 |
| Potassium [mg] | 259.0 | 1,324.0 |
| Copper [mg] | 1.1 | 0.6 |
| Iron [mg] | 0.7 | 28.2 |
| Sulphur [mg] | 137.0 | 870.0 |
| Oxalic Acid [mg] | 101.0 | n. d. |
| Vitamin A –β-Carotene [mg] | 6.8 | 16.3 |
| Vitamin B – Choline [mg] | 423.0 | n. d. |
| Vitamin B1 – Thiamin [mg] | 0.21 | 2.64 |
| Vitamin B2 – Riboflavin [mg] | 0.05 | 20.5 |
| Vitamin B3 – Nicotinic Acid [mg] | 0.8 | 8.2 |
| Vitamin C – Ascorbic Acid [mg] | 220.0 | 17.3 |
| Vitamin E – Tocopherol Acetate [mg] | n. d. | 113.0 |

Source: Moringa Delight (2013)

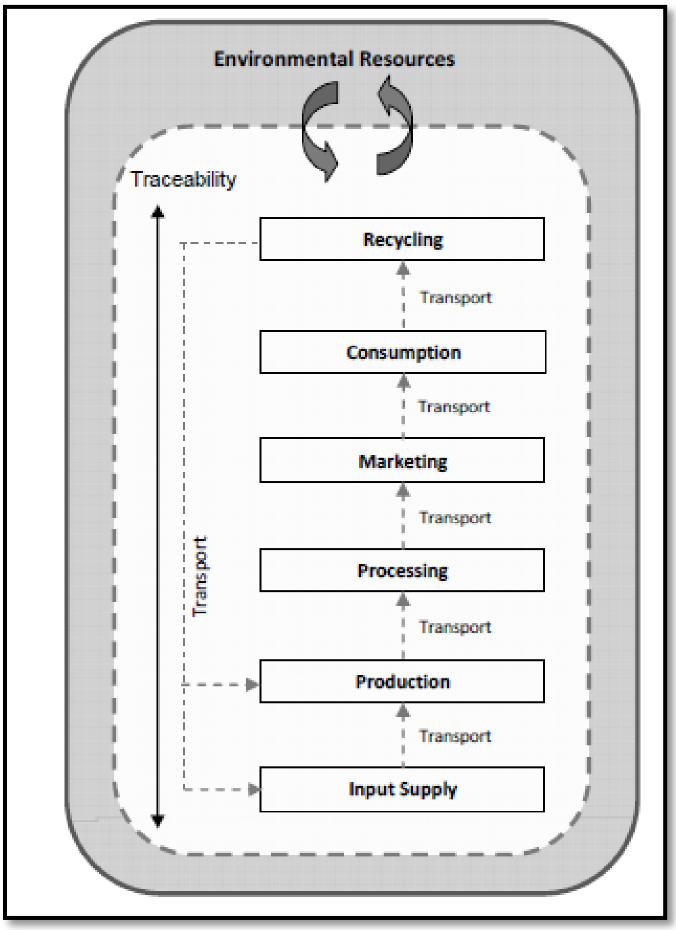
According to the results of different studies on Moringa for human nutrition which results were presented at a workshop in Ghana 2006 (Moringanews, 2006a and 2006b) 10 to 30 g of MLP per day or 50 to 150 g fresh leaves are recommended to prevent or cure malnutrition depending on the patient’s profile. Furthermore, for medicinal use, they recommend a daily use of 1 to 4 tablespoons (whereby one tablespoon is equal to 8 g).

## 2.3 Commodity Chain Analysis

### 2.3.1 Value Chain

Commodity chains could be analyzed by different methodologies, which are widely found in literature based on value chain approaches (FAO, 2005a). The origin of the value chain goes back on two different traditions: the French ‘filière concept’ and Wallerstein’s concept of a commodity chain (Raikes *et al.*, 2000; Bair, 2005). Based on both concepts a few variations have emerged. Thereof Porter's concept of the value chain, Gereffi's global commodity chain, and Humphrey's world economic triangle (the last two were joined to the concept of the global value chain), have to be mentioned as most important concepts (Faße, *et al.*, 2009). A generally accepted definition of value chain was developed by Kaplinsky and Morris (2002:4): *"The value chain describes the full range of activities, which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), to delivery to final consumers, and final disposal after use"*. Based on this definition, a value chain consists of six steps: 1. Input Supply, 2. Production, 3. Processing, 4. Marketing, 5. Consumption, and 6. Recycling/Disposal. The steps are connected via physical and monetary flows and the entire chain is linked to the environment through environmental resources and services (Faße, *et al.*, 2009).

**Figure 4:** Value Chain Model




Source: Faße *et al.*, (2009:7)

For an agricultural product, the definition of a commodity chain usually starts with the grown raw material and is then divided into a system of “sub-chains”, representing the different uses and processes involving the product after the harvest (FAO, 2005a).

### 2.3.2 Value Chain Analysis

Based on concept of value chain different approaches of analyzing a value chain have been developed. Amongst others, the Food and Agricultural Organization of the United Nations (FAO) (2005a) provides a set of modules, which presents a systematic approach to conduct financial (on individual level) and/or economic (on an overall economic level) VCA for agricultural commodities. According to FAO (2005c) the VCA furthermore combines the following parts: 1.) Functional analysis (channels, agents, and flows), 2.) Marketing analysis, 3.) Processing analysis (for the record), 4.) Analysis of the stocking function (for the record), 5.) Financial analysis (costs analysis and value added), and 6.) Policy analysis and analysis using shadow prices. However, each VCA could be limited to one or more of these parts (FAO, 2005c). For the purpose of this investigation the FAO’s concept will be applied as a financial analysis on the level of different economic actors involving the six before mentioned parts of a VCA. This approach consists of two main parts: 1. Mapping, and 2. Flow accounting. The first part represents a functional and institutional analysis which starts with generating a ‘preliminary map’ of a particular value chain to provide an overview of all chain actors (institutional analysis) and the type of interaction between them (functional analysis). The results can be presented either in a table or in a flow chart. Once the mapping has been developed, the involved flows are quantified physically and monetary (flow accounting), (FAO, 2005b). However, According to Faße *et al.* (2011) the VCA of the FAO as presented above does usually not include environmental indicators. Therefore it is important to complete the economic accounting nature of the VCA by either environmental accounts or further analysis on environmental and social impacts of the chain.

### 2.3.3 Economic agent, value added, gross profit and net profit

According to FAO (2013:3), for the purpose of a VCA an **economic agent** is defined as *“the subject carrying out a set of integrated operations of economic relevance, aimed at producing a given output.”* Thereby, each agent within the value chain presents a customer of an upstream agent and at the same time a supplier of a downstream one. The agent can be an individual person such as a farmer, or a legal entity, for example a firm, an authority, a development organization. Usually in a VCA, the term “agent” refers to the “representative agent” of a group of individuals sharing common characteristics, or the group itself (Ibid.).

According to FAO (2005a) a typical agro-food commodity chain includes the following elements and agents:

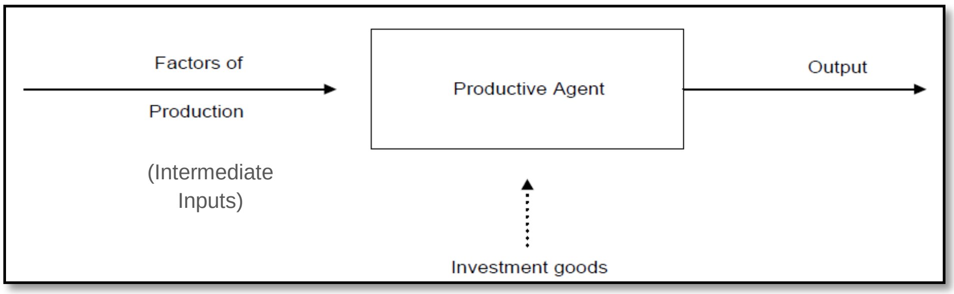
- *“The upstream or input supply chain: seed production, research, agro-chemical production, agricultural machinery, agricultural equipment, initial development and animal feedstuffs;*
- *agriculture and the livestock rearing process, which produces commodities;*
- *processing, wholesaling, transport and retail industries;*
- *packaging industries;*
- *non-agricultural food chains;*
- *industries handling the processing, transport, trade and distribution of industrial and energy products originating in agriculture;*
- *financial services;*
- *research and extension services, credit services;*
- *consumers;*
- *catering trade.“* FAO (2005a:9)

Transfers of goods, services or funds (money or any other economic rights) made between the agents are referred to as "flows". From any other agent’s point of view, each productive agent is rather like a “black box” within which the production of goods and services occurs. The productive agent or enterprise needs factors of production (Input) to create a new product or service (Output) (FAO, 2005a). Implicit in the notion of a “flow” is a period of time (in this context often referred to as the accounting period) which is usually taken to be a year. This enables to divide the inputs of the production process into two groups:

- *Factors of production which are totally transformed or consumed during the accounting period, intermediate inputs;*
- *Factors of production which are only partially used during the accounting period, where they provide inputs to the production process over a number of years before being fully depleted, investments goods.* (FAO, 2005b:3)

This could be presented as per Figure 5.

**Figure 5:** Productive Agent




Source: FAO (2005b), modified

Now, considering that **X** is the value of intermediate inputs used (factors of production) and **Y** is the value of the output, then the difference, Y-X, represents the value which the agent has added during the accounting period to the value of the inputs in the process of production or processing. Thus, the **Value Added** (VA) is defined by the equation (Ibid.):

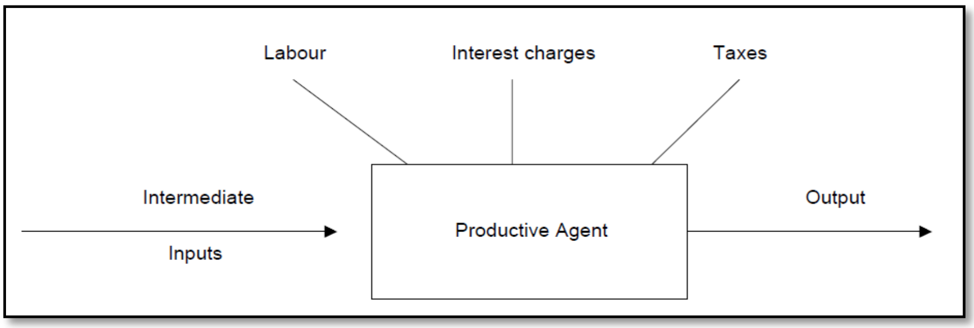
$$\mathbf{VA = Y - X}$$

Furthermore, the incorporation of the cost of labor embodied in the productive process, the expenses on the financial services, such as investment loans and working capital, which facilitate the process of production, and the various taxes and duties levied during the production process will lead to the **gross profit** (GP). The GP presents the difference between VA and expenditure on labor, interest charges and taxes as defined by the following equation (Ibid.):

$$\mathbf{GP = VA - (wages\ and\ salaries + interest\ charges + taxes)}$$

In other words, the GP represents the return to cultivation, once the costs of production, intermediate inputs, labor costs, interest charges and taxes have been deducted. Figure 6 presents a diagram of the items defining the GP (Ibid.).

**Figure 6:** Gross profit

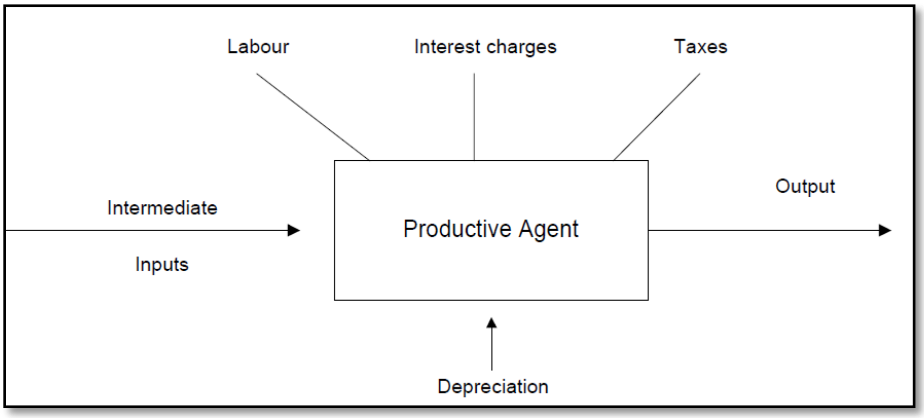



Source: FAO (2005b:4)

Finally the consideration of the investment goods, which is often realized prior to production but continues to provide services over a period of time, and is to some extent consumed in the year in consideration, will lead to the **Net Profit** (NP). A theoretical value must be attributed as a cost to production corresponding to the use of the investment, a value known as depreciation. As this is a measure of the consumption of a factor of production, depreciation is an element in the value Y, but it is not a financial flow in the year being analyzed. When depreciation is subtracted from the Gross Profit, the balance is termed the NP (Ibid.):

**Net Profit = Gross Profit – Depreciation**

**Figure 7:** Net profit




Source: FAO (2005b:5)

Whereas the NP measures the increase in wealth of the individual agent, value added measures the increase in wealth for the whole scale of the chain (e.g. regional or national), as represented by the sum of remuneration to labor, interest charges and taxes in addition to the net margin of the entrepreneur (Ibid.).

One of the major problems within a VCA according to FAO (2005b) is the valuation of agricultural production when production has not yet entered into monetary exchange (such as own consumption of subsistence farmers) or where there is poor information on the volume and price of transactions. The first problem could generally be solved by multiplying known physical estimates of flows by existing market prices. The second problem is more complex and can only be treated on a case by case basis, coming along with uncertainty and imprecision in the estimation process. However, this difficulty is not specific to VCA: it is common to all estimates and macro-economic analyses relating to agricultural and/or informal sectors and value chains which are dependent on "peasant accounting" (FAO, 2005b). Both of the above mentioned problems are present in the case of Moringa on Ometepe Island. As the commercialization of Moringa has not taken place so far, there is no existing monetary flow and also information on volume and prices of interaction will be evaluated within this investigation for the first time. Therefore the results will automatically include uncertainty and imprecision in the estimation process.

## 2.4 Agroecology

As the analysis of a food commodity starts with the plant cultivation it is further important to apply a concept for sustainable agriculture while investigating on a sustainable food commodity. To meet the research goal the concept of Agroecology is applied as it combines social, economic and environmental aspects. This concept as illustrated by Altieri and Nicholls, (2005) presents a sustainable alternative to conventional agricultural practices and seeks to empower small and medium-size farms by diversification and revitalization of these farms as well as the restructuring of the agricultural policy and food system to make it economically viable for farmers and consumers. Nowadays, there exist different movements in the world which are seeking to establish ecologically sensitive farming systems from a variety of perspectives. Some are focused on the production of organic products for lucrative markets; others emphasize land stewardship, while others pursuing to improve the empowerment of peasant communities. In general, however, they have common goals: to secure food self-sufficiency, to preserve the natural resource base, and to ensure social equity and economic viability (Ibid.). This concept will be applied as Altieri is known as pioneer researcher and one of the most outstanding proponents and leaders of agroecology, particularly in the Latin American and Caribbean region, later followed by Nicholls (Ibid.).

Agroecology has emerged as a discipline that provides the basic ecological concepts for this investigation: design and management of agroecosystems that are both productive and natural resource conserving, while also being culturally sensitive, socially just and economically viable (Altieri, 1995). Altieri and Nicholls (2005) present the following ecological principles, which have to be implied to the design of such a system according to Reinjntjes *et al.*, (1992):

- "*Enhance recycling of biomass and optimizing nutrient availability and balancing nutrient flow.*
- *Securing favorable soil conditions for plant growth, particularly by managing organic matter and enhancing soil biotic activity.*

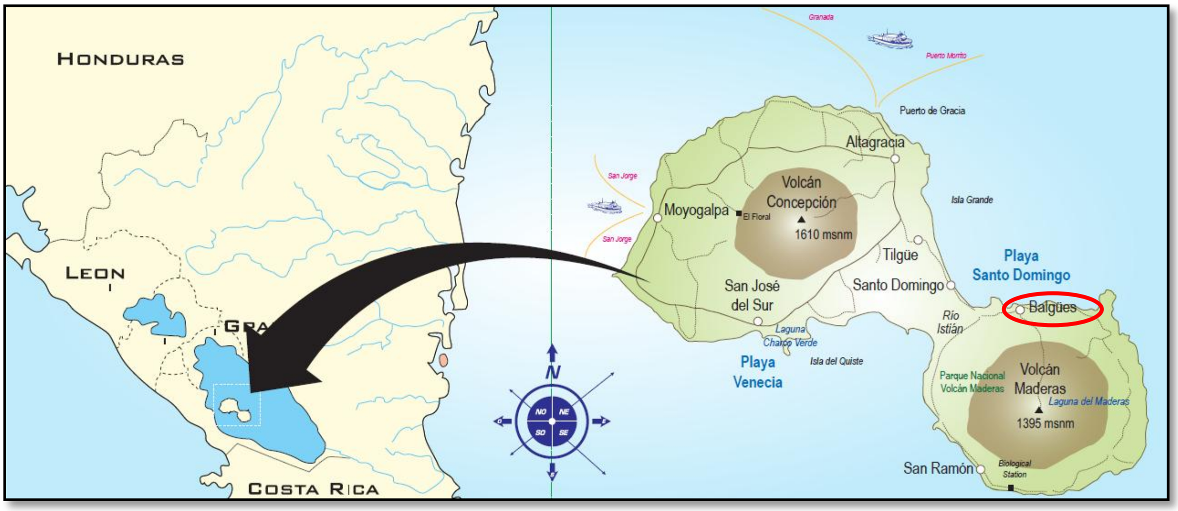
- *Minimizing losses due to flows of solar radiation, air and water by way of microclimate management, water harvesting and soil management through increased soil cover.*
- *Species and genetic diversification of the agroecosystem in time and space.*
- *Enhance beneficial biological interactions and synergisms among agrobiodiversity components thus resulting in the promotion of key ecological processes and services.''* (Altieri and Nicholls, 2005:32)

# 3 STUDY AREA

## 3.1 Geophysical and biological description

The area of study is limited to Ometepe Island, located in the Lake Nicaragua[3] (or Lake Cocibolca) in the south of Nicaragua (see Figure 8). This lake is part of an elongated tectonic depression extending in the middle of Central America, covering an area about 500 km long from the Gulf of Fonseca in the Pacific Ocean to the alluvial valley of the Rio San Juan in the Caribbean Sea. The lake covers an area of 8,264 km² and scatters approximately 310 islands and islets whereof Ometepe Island is the biggest one (MARENA, 2010).

**Figure 8:** Map of Ometepe Island




Source: Ometepetravel (2013:1), modified

The island is formed by two volcanoes: Concepción about 1,610 m.a.s.l. in the northwest (latitude 11°538' N and longitude 85°623' W) and Maderas about 1,395 m.a.s.l. in the south-east which belong to the Central American Volcanic Arc. The town Balgüe, where the Moringa project is settled, is located in the north of Maderas volcano (see Figure 8).

The island with its extension of 276 km² and a superficies of 53,860 ha (equal to 76,460 manzana [Nicaragua][4]) is characterized by a dramatic range of altitude, topography and climate, which create various habitats representing the majority of the country's ecosystems.

[3] Currently the government of Nicaragua is planning to construct a canal which shall connect the Pacific and the Atlantic Ocean. In June 2013 Nicaragua's legislature passed the legislate on granting the concession to realize this project to a newly founded Hong Kong–based company (HKND Group, 2014). In January 2014 a statement was published that the construction work of the canal will start in December 2014 (Ortega and Jing, 2014). At the end of March 2014 the exact route has still not been public. However, the canal, if realized as announced, would cross the Lake Nicaragua coming along with unforeseeable consequences for the lake and Ometepe Island.

[4] 1 ha ≈ 1.4196 manzana [Nicaragua] (Converterin, 2014)

Therefore Ometepe Island has been an UNESCO Biosphere Reserve since June 2010. This Biosphere Reserve is composed by three protected areas: 1.) Maderas Volcano National Park, 2.) Wildlife Refuge Peña Inculta – Humedal Istián, and 3.) Concepción Volcano Natural Reserve. The limits (by coordinates) of these parts are defined in the law called "Ley que declara y define los límites de la reserve de biósfera a la Isla de Ometepe[5]" (ANN, 2013). The distribution of plant species on the island reflects the existence of at least six types of natural vegetation and the anthropic areas. The natural forest formations correspond to cloud forest, rainforest, transition from rain to dry forest, dry forest, coulee of volcanic material and wetlands. Each of these types of formations presents substantial changes in the abundances of plant species (Díaz and Díaz, 2008; MARENA, n.d.).

Due to its insularity and geographical position the island is an area of transition between the dry Pacific region and the wet Atlantic region of Nicaragua. The climate on Ometepe Island presents characteristic tropical wet and dry climate with rainfalls in winter from May to October (Aw climate according to the climate classification system of Köppen). The minimum temperature of 26.1°C is recognized in January and the maximum of 28.9°C in May (MARENA, n.d.). According to the Nicaraguan Institute for Territorial Studies (Instituto Nicaragüense de Estudios Territoriales, INETER, 2006) the average annual precipitation is between 1,400 mm and 1,800 mm. The average annual evaporation is about 2,044.8 mm exceeding the average annual precipitation and thus indicating a humidity deficit. The dry month of March and April are the month with the maximum of evaporation (479.1 mm and 518.0 mm) according to the presence of wind, high temperatures, the minimum of precipitation and a low relative humidity. The average monthly relative humidity gets up to 73.9 % in May and the average velocity of wind is about 2.9 m/s, while the maximum is measured in January and February (4 m/s). Furthermore, the maximum solar radiation is measured in March (519.4 cal/cm$^2$ per day) and April (518.0 cal/cm$^2$ per day) and the minimum in December with about 378.4 cal/cm$^2$ per day (MARENA, n.d.).

The history of land use on Ometepe Island (as well as in entire Nicaragua) has taken more dynamic and generated large changes in use since the process of land reform and titling that existed in the 80s and 90s when many lands were given to landless farmers and cooperatives (MARENA, n.d.). According to National Institute of Information for Development (Instituto Nacional de Información de Desarrollo, INIDE) and the Ministry of Agriculture and Forestry

[5] Law which declares and defines the limits of the Biosphere Reserve of the Ometepe Island (own translation)

(Ministerio Agropecuario y Forestal, MAGFOR, 2013) 19,300 manzana [Nicaragua] (equal to 13,595 ha) have been determined for agricultural use on the entire island. These areas are located all around the two volcanoes mainly up to 400 m.a.s.l. Just the cacao cultivation (agro forestry) on volcano Maderas reach up to 600 m.a.s.l. (MARENA, n.d.). The land use as of 2010/2011 is presented in Table 4.

**Table 4:** Use of agricultural land (2010/2011)

| Land use | Area | | |
|---|---|---|---|
| | in manzanas [Nicaragua] | in ha | in % |
| Annual and temporal crops | 5,449 | 3,838 | 28.2 |
| Permanent and semi permanent crops | 5,121 | 3,607 | 26.5 |
| Agroforestry | 2,657 | 1,872 | 13.8 |
| Natural pastures | 2,287 | 1,611 | 11.8 |
| Cultivated pastures | 2,035 | 1,433 | 10.5 |
| Fallow land | 1,558 | 1,097 | 8.1 |
| Installations and infrastructure | 193 | 136 | 1.0 |
| **Total area for agriculture** | **19,300** | **13,595** | **100** |

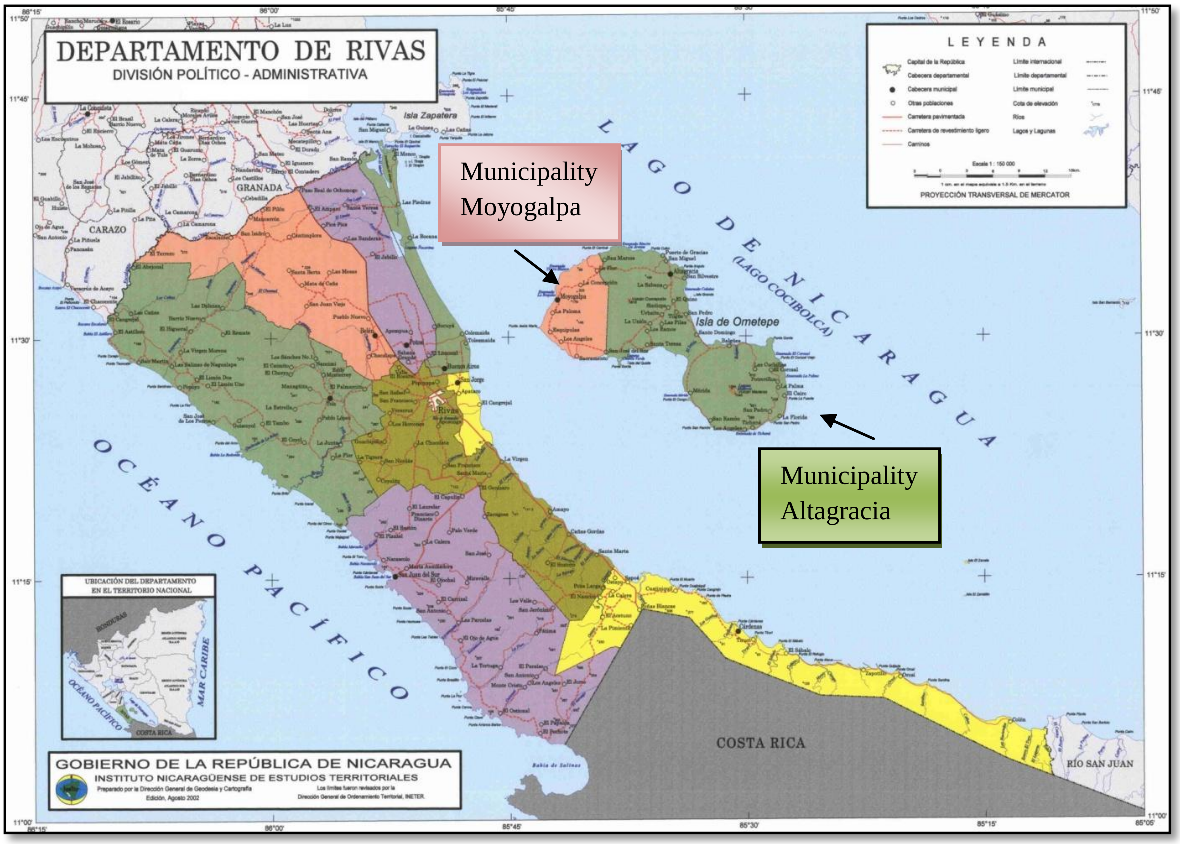
Source: Own calculation based on INIDE-MAGFOR (2013)

Apart from the Lake Nicaragua, the “Laguna Maderas”, located in the crater of the Maderas volcano, some natural water springs and three main rivers have to be mentioned as water resources for human activities. The “Laguna Maderas” stores all rainfall water of the area during the year. It has an area of 4 hectares and an elevation of 1,180 m. Furthermore, the rivers Balgüe and Tichana with a deepness of 0.3 to 0.8 m and a cross section of 2 to 4 m (presenting an average flow of 0.13 $m^3/s$) as well as the river Istiam (0.5 to 1.0 m deep and 3 to 7 m cross section) are used as drinking water and for agricultural water irrigation. Other Lagoons and rivers have bad water quality and are thus not used for human activities (INIFOM, 2014a; INIFOM 2014b).

## 3.2 Political division

Ometepe Island politically belongs to the Rivas department of Nicaragua[6]. Furthermore, the island is divided into two municipalities: Altagracia and Moyogalpa. Figure 9 shows the political division of the Rivas department and of Ometepe Island. The town Balgüe belongs to the municipality Altagracia.

**Figure 9:** Political division of the Rivas department and Ometepe Island




Source: INETER (2013), modified

The municipality of Altagracia (with its capital city also called Altagracia) is about 213 km², whereas the municipality of Moyogalpa (with its capital city also called Moyogalpa) counts 63 km². Corresponding, around $^{2}/_{3}$ of Ometepe's total population is living in the municipality of Altagracia (MARENA, n.d.).

## 3.3 Socio-economic description

Due to the World Bank's country classification Nicaragua is the second poorest[7] country of Latin America and the Caribbean (The World Bank, 2014a). However, its economy has per-

[6] In total the unitary republic of Nicaragua is divided for administrative purposes into fifteen departments and two autonomous regions (INETER, 2000).

[7] It has to be emphasized that the classification "poor" limited to a pure economic evaluation.

formed a steady growth within the last years. For the years of 2010 to 2012 the gross domestic product (GDP) was about 8,586.7 million USD in 2010, 9,636.2 million USD in 2011 and 10,507.7 million USD in 2012. This presents a per capita GDP of 1,476.5 USD in 2010, 1,636.3 in 2011 and 1,730.8 in 2012 (BCN, 2013)[8]. At Ometepe Island agriculture and cattle-breeding present the main economic activities followed by trade and services. Additionally tourism presents a great potential to economic development of the island (INIFORM, 2014a; INIFORM 2014b; Díaz and Díaz, 2008).

Furthermore, it has to be mentioned that within Central America, Ometepe Island is one of the important archaeological and cultural areas to preserve pre-Columbian relicts (petro-glyphs, statuary, ceramics) which are scattered throughout the territory of the island (MARENA, 2010). Due to its historical and cultural wealth the island is recognized by the state of Nicaragua as an area of the nation's cultural heritage and thus conservation and resto-ration of this heritage are reinforced (MARENA, n.d.).

**Population and Infrastructure**

The population of Ometepe Island is currently reported to be about 31.079 inhabitants pre-senting a population density of 112.6 inhabitants per km². Thereof just 4,816 people live in areas considered to be urban (the cities Altagracia and Moyogalpa) and the majority of 26,263 people live in rural areas, which are distributed all around the two volcanoes (INIFOM 2014a; INIFOM 2014b). According to INIDE the latest available figures about housing are available for 2005 (INIDE, 2014). In this year there were 6,220 residential houses on Ometepe Island, presenting an index of 4.77 inhabitants per residential house, based on the total population of 29,684 inhabitants in 2005 (INIDE cited in CPML and BID/FOMIN 2012).

The Infrastructure for transportation on the island is divided into the aquatic and terrestrial system. For land transportation, there are mainly nine routes all around the island available. These transportation services are performed by small private companies. For the aquatic transportation, the island counts with three ports, finding one in poor condition and only one working with a fleet of vessels (INIFOM, 2014b).

Electricity on the island is provided via a plant, which acts independent from the National Interconnected System. The plant is currently working with Diesel and has six machines, two in service, one emergency and three as reserves (INIFORM, 2014a). A part from the local

[8] Nicaragua's total population was reported to be about 5,923.1 thousand inhabitants in 2010, 5,996.6 thou-sand inhabitants in 2011 and 6,071.0 thousand inhabitants in 2012 (BCN, 2013).

industry just 50 % of the population are currently connected to this plant, meaning that another 50 % of the island's population is still lacking access to electricity. However, there is a project installed which aims to provide additional wind power in the short-term future, responding on the energy capacity deficit and the increasing energy demand (Quintero, 2012b; confirmed by observation and interview at the construction area).

**Agriculture and Cattle-breeding**

The farmers of Ometepe Island have historically been dedicated to the cultivation of basic grains, mostly rice, beans and maize, and besides cultivating banana, sesame and coffee; the latter concentrated on the slopes of Volcano Maderas. Those products which are not dedicated for own consumption, are mainly sold in Managua, Granada, Rivas and San Carlos. Furthermore, the island has been recognized by growing watermelon. However, the island has not much importance as fruit producer. The fruit production (mainly citrus, avocados and others) has basically been sufficient for own consumption. Likewise, it has not had history of producing vegetables and therefore the local consumption of these has been low (SDC, 2009; MARENA, n.d.). Cattle-breeding activities are of traditional character with low technical support. Meat and milk production are for the island's own consumption and partly for exportation (MARENA, n.d.).

According to INIDE-MAGFOR (2013) there exited 3,245 agricultural production units as of 2010/2011 on Ometepe Island (2,309 in the municipality of Altagracia; 936 in the municipality of Moyogalpa). Thereof 3,231 units were presented by individual farmers (2,299 in the municipality of Altagracia; 932 in the municipality of Moyogalpa). Regarding the cultivated area it is reported that 24 % of these individual farmers were cultivating a land area of 1 to 2.5 manzanas [Nicaragua] (equal 0.7044 to 1.761 ha), whereby the majority does not use machinery, neither they have irrigation systems. Furthermore, 73.4 % were male farmers and 306 of all the individual farmers belonged to an organization. There existed eleven cooperatives and one family group. Additionally, it has to be mentioned that there were just 66 agricultural production units with certified organic agricultural production (Ibid.).

**Tourism**

The latest available statistics states that 36,797 non-national tourist had visit Ometepe Island in 2010 and 38,900 in 2011. Considering that the elevation of this data is done manually the real figure might be about 40,000 in 2011 (Rodriguez cited by Quintero, 2012a). According to Rodriguez (cited by Quintero 2012a) January, March and August are the month in which most tourists came to visit the island in 2011 (4,793 in January; 4,164 in March; 3,876 in August). Most of them came from the USA (11,460 tourist), Canada (3,692 tourist) and Germany (3,446 tourists). According to the mentioned increase of tourists per year, also the available infrastructure is steadily increasing. In 2011 there were about 455 officially registered rooms available at the island, presenting 890 beds (Ibid.). The official number is estimated to be higher, especially considering that a lot of local families offer informal home stay possibilities to tourists.

For further information about tourist, the official numbers according to Nicaraguan Institute for Tourism (Instituto Nicaragüense de Turismo, INTUR) available for entire Nicaragua have to be considered. The numbers of tourist that have visited Nicaragua are as presented in Table 5.

**Table 5:** Number of tourists visiting Nicaragua

| Year | Number of tourists | Increase per year [tourists] | Increase per year [%] |
|---|---|---|---|
| **2008** | 857,901 | 74,003 | 8,63 % |
| **2009** | 931,904 | 79,347 | 8,51 % |
| **2010** | 1,011,251 | 48,780 | 4,82 % |
| **2011** | 1,060,031 | 119,550 | 11,28 % |
| **2012** | 1,179,581 | 74,003 | 8,63 % |

Source: Own representation based on INTUR (2013)

In 2012 71.4 % of the tourists in Nicaragua were male and 28.6 % female. The majority (61.5 %) was between 26 and 40 years old, 14.2 % had less than 26 years and 24.3 % more than 40 years (BCN cited in INTUR, 2013).

**Health care and malnutrition**

There are two clinical centers in the urban areas of the island; one in the city Altagracia and the other in the city Moyogalpa. Furthermore, there are seven medical stations in different rural communities available and in total fifteen doctors are working within this health care installations. A hospital is still missing on the island. For any surgery people have to go to the hospital on the mainland (INIFOM 2014a; INIFOM 2014b).

According to health care and the nutrition situation on Ometepe Island there are currently no further numbers available, but malnutrition and undernourishment present still a serious problem in Nicaragua. According to The World Bank (2014b) the prevalence of undernourishment in Nicaragua has been as follows:

**Table 6:** Prevalence of undernourishment

| | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| **Prevalence of undernourishment (% of population)** | 24.7 % | 23.9 % | 22.7 % | 21.5 % | 20.0 % |

Source: Own representation based on The World Bank (2014b)

Furthermore, UNICEF (2013) states the following indicators on nutrition of children under 5 years in Nicaragua as of 2012:

**Table 7:** Nutrition indicators Nicaragua 2012

| Indicator[9] | Amount [%] |
|---|---|
| Low birth weight (< 2,500 g) | 7.6 |
| Underweight, moderate & severe[10] | 6.0 |
| Underweight, severe[11] | 0.8 |
| Stunting, moderate & severe[12] | 22.0 |
| Wasting, moderate & severe[13] | 1.0 |
| Overweight, moderate & severe[14] | 6.2 |

Source: Own representation based on UNICEF, 2013

Interviews performed with medicals at the two clinical centers during the fieldwork confirmed that stunting is a present problem of children on Ometepe Island. Furthermore these medicals stated, that parasites, kidney problems and micronutrients deficits such as iron, phosphor and calcium present health problems based on malnutrition within both children and adults.

## 3.4 Moringa in the area of study

There is almost no literature about Moringa, or Marango as locally called, in the study area available. However, according to observations by the author performed during the fieldwork for this investigation, single ornamental trees are located all around the island which is confirmed by one study from literature. This study, performed by Conrado and Jiminez (2008),

[9] Further details about the meaning of these indicators are provided in section 2.1.
[10] Refers to: below minus two standard deviations from median weight for age of reference population.
[11] Refers to: below minus three standard deviations from median weight for age of reference population.
[12] Refers to: below minus two standard deviations from median height for age of reference population.
[13] Refers to: below minus two standard deviations from median weight for height of reference population.
[14] Refers to: over two standard deviations from median weight for age of reference population.

counted 21 trees of Moringa along the main street between El Quino, Santa Cruz and Merida (13.8 km). Amongst others, Moringa was established on the island by reforestation programs such as by the German Development Cooperation GIZ, former GTZ (Guerrero, n.d.). Another reforestation program bringing Moringa to the island was performed in Balgüe, Volcano Maderas, as mentioned during the interviews. According to the interviewed person this program was performed by an organization called Decosur. Additional information about Moringa in the sudy area cannot be gathered by literature. Thus, further information is presented with chapter 5 as result and discussion of this investigation.

### 3.5 Conclusion

Considering the climate conditions and the very fertile soils of volcanic origin, Moringa growing conditions are optimal on Ometepe Island. Based on the existing agricultural practices and the overall socio-economic situation, a sustainable Moringa commercialization should be set up on a small scale farming concept and a low technology processing to incorporate local capacities adequately.

As malnutrition is a serious problem on Ometepe Island, Moringa has the potential to become a valued food commodity, especially when addressing malnutrition. According to its nutrition values (see section 2.2) Moringa has the potential to respond on the protein-energy malnutrition and also on the micronutrient malnutrition as named by the interviewed medicals. Thus, the promotion of MLP as dietary supplement will be focused within the following analysis. Furthermore, it seems to be more effective to promote the MLP considering that local people do not have the tradition of cultivation and eating vegetables. The promotion of the fresh leaves as a vegetable would require a big change in local eating culture.

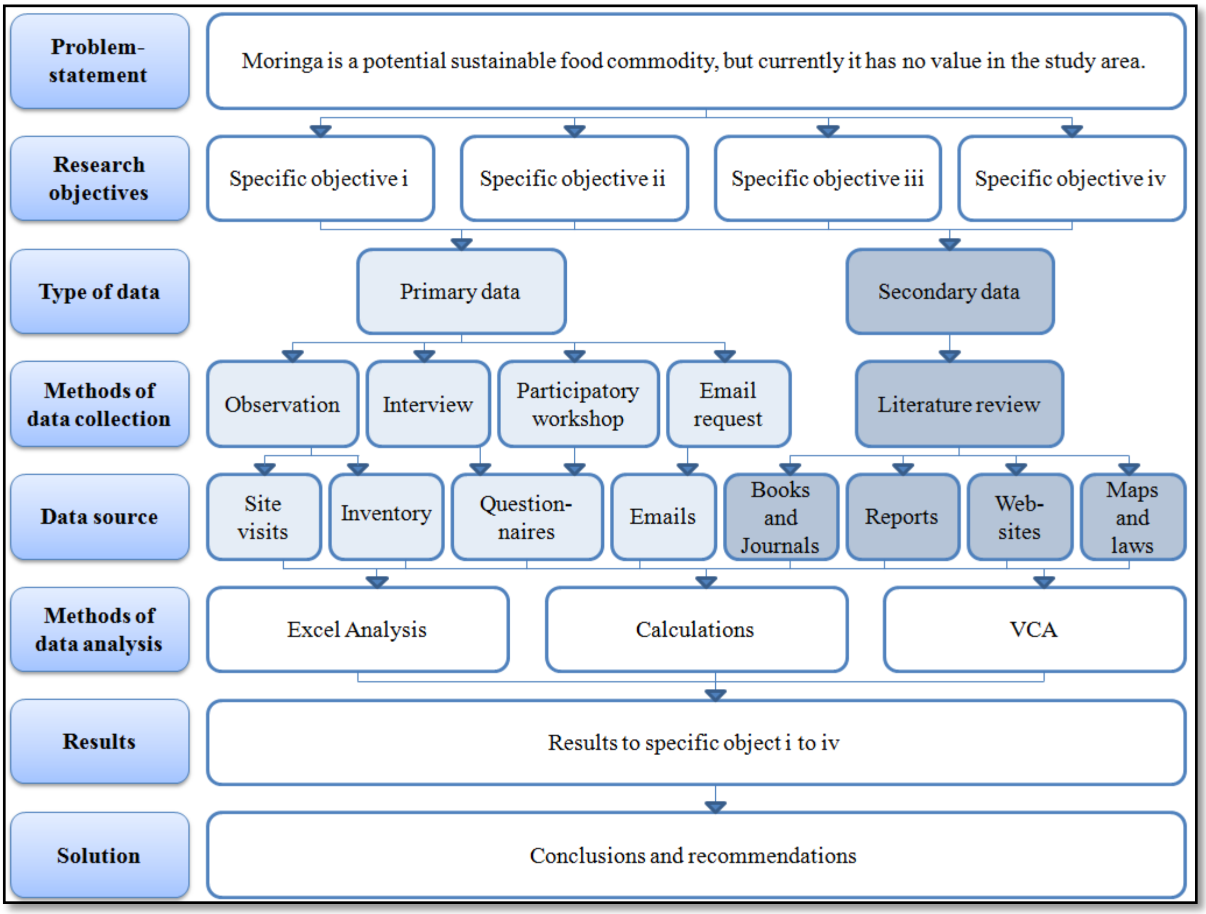
Apart from local people, tourists present another core group for Moringa products in the area of study. The number of tourists visiting the island per year is already higher than the total population of the island. Tourist usually buy local products to bring back home as a souvenir or a gift for family and friends. Thus, tourists have to be considered as potential clients and need to be included in the VCA.

# 4 METHODOLOGY

## 4.1 Overview

The cognitive interest of this thesis was achieved by a combination of different methods. The research conducted an analysis on activities, agents, and flows necessary to introduce Moringa as a sustainable food commodity applying the FAO's value chain approach. Figure 10 provides an overview over the methodology of this investigation.

**Figure 10:** Overview methodology




Source: Own representation

## 4.2 Data collection

### 4.2.1 Type of data to collect

Based on the concept of VCA as presented by the FAO (see section 2.3.2) different data had to be collected to successfully perform a VCA. Considering the different levels of analysis according to FAO (2005c), Table 8 presents an overview of main data that was collected for the purpose of this investigation. Data to collect was of both characters, quantitative and qualitative.

**Table 8:** Overview type of data to collect

| Level of Analysis | Data required |
|---|---|
| **Functional** | Relationships between the agent, the upstream chain (who the product is bought from), the downstream chain (to whom the product is sold), quantity, |
| **Processing** | Volumes, ratio, losses, time, and costs |
| **Stocks** | Volume, costs |
| **Marketing** | Selling price, required quality, supply regularity, kind and payment conditions, logistic, institutions |
| **Costs** | Agent costs: purchase of inputs, tools, rents, maintenance, services, transport, sundry expenses, taxes, staff |
| **Policies** | Current policies impacting the chain |

Source: Own representation based on FAO (2005c)

### 4.2.2 Data sources and data collection methods

#### 4.2.2.1 Secondary sources

The investigation started with a literature review that was concentrated on the Moringa cultivation, processing and commercialization in the world and especially in Nicaragua. Through it the different steps of the Moringa VC in general were identified and descript in detail. The results are the basic fundament on which the secondary data was then entering in the VCA. Secondary sources such as scientific publications (books and journals), scientific and institutional reports, and other literature resources available were taken into account. Furthermore maps of Ometepe Island and applicable national, regional and local laws were used to understand the study area and incorporate its specific circumstances. Online resources such as websites of economic agents of the Moringa VC in the area of study and other areas were also included.

#### 4.2.2.2 Primary sources

The fieldwork for this investigation was performed during three month, March till May 2014, on Ometepe Island in Nicaragua and whenever necessary on the mainland of the country. In general data from the entire island was elevated; just for specific details the data was reduced on the town Balgüe, where the Moringa project is located. Thereby, the main primary sources are questionnaires, site visits, inventory and email. Different data collecting methods were used to collect this primary data.

**Interviews**

Within the fieldwork the following face-to-face interviews were performed:

- 300 interviews in Spanish language with local adult people about their knowledge on Moringa and their general attitude on plant consumption and the intake of dietary supplements: Thereof it was pre-determinate to include 150 female and 150 male people. The interviews were performed within a 6-days journey all around the island. People of each category (female and male) who were randomly encountered on the street were interviewed. By this it was assured that person from each community along the main road around the island were included in the survey. An example of such a questionnaire is provided within Annex 2. However, the interviews were not strictly followed this questions. The interviews were always adapted to the answers given by the interviewee.
- 100 interviews in English language with tourist about their knowledge on Moringa and their general behavior on buying local products from Nicaragua to take back home: These interviews were perform at five different touristic hot spots on the island (Moyogalpa, Ojo de Agua, Playa Santo Domingo y Santa Cruz, Balgüe and Merida), whereby each of this places was visited two or three times to perform the interviews. The interviewees were chosen randomly without any pre-determination like sex or origin. The interview consisted of four parts: Part A, which covered general information about the interviewee ending with the question if the person knows Moringa. If this question was answered with Yes, the interview went on with part B, covering the interviewee's Moringa knowledge, consumption behavior and the general behavior of buying local products in Nicaragua. If the person did not know about Moringa, a short explanation on the plant and its usage, especially as a food commodity, was given (part C) and then the interview went on with part D, covering question about their interest in buying Moringa on Ometepe Island and the general behavior of buying local products. An example of such a questionnaire (which was always adapted to the specific course of each interview) is provided within Annex 3.
- Interviews with medicals at the two clinical centers in Moyogalpa and Altagracia and also with four pharmacies, two located in Altagracia and two in Moyogalpa were performed: These interviews were focused on malnutrition and the consumption of dietary supplements on the island and also about Moringa.

- Interviews at sales points such as hotels, restaurants, souvenir shops and local stores (so called “pulperias”) to identify Moringa sales channels.
- An interview with the president of the local Drinking Water Committee (Comité de Agua Potable) of Balgüe was performed to understand the situation of water irrigation.
- Interviews with governmental institutions of the municipality of Altagracia and the Rivas department.
- Further interviews were performed during the site visits (see under observation) with key actors at the places visited.

Interviewing was chosen as it presents a technique to understand the underlying reasons and motivations for people’s attitudes, preferences or behaviors (Evidence Base, 2006). In all the interviews performed, semi-structured questionnaires open-ended were used because they allow the respondents to express themselves in more detail and by this they provide more qualitative data (University of Surrey, 2014). Other advantages of interviews are the possibility to ask follow-up in-depth questions and that the interviewer has control over the interview and might assist the interviewees if they do not understand a question. Furthermore, interviews give a possibility of investigating the motives and feelings of the respondents and also they allow the production of record for future reference. However, the method of interviewing has the disadvantage of being time consuming due to the necessity of setting up the interviews, travelling, recording, transcribing, etc. Some other shortcomings of this methods are the limited geographical coverage (in this case reduced to the main road along the island), that it is expensive, that bias of the respondents, especially if they want to impress, create false impression or end the interview quickly (Evidence Base, 2006).

According to the time limitation of this investigation it was not possible to record and transcript the interviews. Manually notes were taken during and directly after each interview to capture data.

**Observation**

The following two site visits were performed during the fieldwork:

- A Moringa plantation in Leon, Nicaragua, was visited on the 4$^{th}$ of April 2014. At this farm Moringa is produced on 72 ha for the company Moringa Delight. The Moringa products are exclusively determined for exportation in the USA as there is no local Moringa market in Leon neither in Nicaragua. The observation was focused on the agricultural production of Moringa and the processing of MLP, coming along with the production of orgnic compost. Different employees further explained the processes observed and gave additionally interviews.

- A site visit of a permaculture farm in Balgüe was also part of the methodology. This farm presents an agricultural unit producing Moringa on Ometepe Island. There are about 2,000 trees growing, but the farm does not commercialize Moringa. The use is limited on the farm. Observations were done on Moringa production, completed by explanation of one of the farm's owners.

Observation of these places was chosen as it allows the investigator to obtain more reliable information about certain circumstances. It also serves as a technique for verifying or nullifying information provided in interviews. Furthermore, when observing the environment, it can provide valuable background information that may bring insights on other aspects of the research (University of Surrey, 2014).

**Inventory**

The following inventories were accomplished:

- Identification of sales points for local products which address especially tourists: Therefore another 3-days journey around the island was conducted. All sales points like hotels, hostels, restaurant, souvenir shops, and tourist attractions accessible from the main street were visited and an inventory of those that sale local products to tourists was prepared.
- Identification of dietary supplements sold at the pharmacies in Moyogalpa and Altagracia: An inventory was prepared based on the information given by the employees of the pharmacies and on the product description presented on the packaging material of the observed products.
- Identification of germinated trees within two trials to determine the germination rate: Therefore two small trials were performed during the field work within the Moringa project in Balgüe. Seeds were obtained from five different wild growing trees in Balgüe and seeding was performed one day after the pod's harvest.

**Participatory workshop**

A participatory workshop with two local farmers and one local project manager was carried out at the end of the field work (mid of May). The participating people will be involved in the Balgüe Moringa project and were therefore available to participate in the workshop. The aim of the workshop was to evaluate the farming activities (especially considering time and costs). Therefore the whole structure of the VC activities including inputs and outputs (already physically accounted) was presented to the participants. Each step of the VC was then discussed by the group which was guided by a moderator (the author).

**Email requests**

Email requests were used to capture specific data from identified economic agents of the Moringa VC. For this, personal emails that included a structured questionnaire were sent directly to the contact person of an economic agent.

## 4.3 Data analysis

Data was analyzed both, qualitative and quantitative. Thereby qualitative analysis was done whenever the interviewee's answers allowed to incorporate qualitative results to the VCA. To quantitatively analyze the elevated data, three different methods were applied. First, the data collection was documented in Excel and thus the analysis of the elevated data was performed with functions provided by Excel (formulas, data analysis and diagrams). As the statistically analysis of the interviews was reduced on descriptive parameters like the absolute and relative frequency of answers, Excel was sufficient and no further statistic program (as SPSS for example) was needed. Second, mathematic calculations were performed and third, the method of VCA was applied. This part presents the main method of data analysis and was divided into the mapping and the flow accounting.

It has to be emphasized that this study does not present a typical VCA, which is usually applied on an existing VC. In this investigation the VCA method was used to identify and quantify the steps of a VC to introduce Moringa as a valued food commodity in the area of study. Therefore the VCA was applied in form of a projection. The VCA started with a detailed description of activities, flows and agents, based on secondary and primary data. This description was part of the VCA mapping and it presented the basis to further account the flows. The flow accounting did further require the identification of policies to incorporate additional monetary items like taxes. The flow accounting in this case study also presents a projection and was set up on the pilot project as planned by the Moringa Project of Balgüe.

**VCA: Mapping**

This part of the research combines a functional and institutional analysis of the value chain, which includes the following essential aspects to develop a preliminary map:

- Institutional Analysis:

- the identification of activities and flows within the VC, and
- the identification of economic agents.

- Functional Analysis: (to show the interactions of activities and agents identified):
  - The principal functions of each stage in the VC,
  - the agents carrying out these functions, and
  - the principal inputs and outputs for each agent in the chain and their various forms into which they are transformed along the entire chain (FAO 2005b).

Thereby, the functional analysis presents both a construct for ensuring analytical clarity and a useful presentation tool for ongoing analysis (Ibid.). The VCA started with the identification and detailed description of activities and flows in the VC, starting from the primary activity of agricultural production of Moringa on Ometepe Island. Subsequently, it followed on the one hand the product downstream through various marketing and processing channels necessary to bring the final product to the market. On the other hand an upstream analysis was performed, analyzing the different required input activities. Based on that, the economic agents were identified and finally the functional analysis was carried out. The results are presented in flow charts and tables, according to the VCA concept provided by FAO (2005a).

**VCA: Identification of policies**

Identified policies were analyzed qualitatively with the goal of identifying further monetary items that needs to enter in the flow accounting. Different issues were analyzed and mentioned in the results even though not all issues analyzed delivered further data that flows into the flow accounting.

**VCA: Flow accounting**

Based on the mapping, a physical and monetary flow accounting was performed presenting a financial input-output analysis. The financial input-output analysis is characterized as being a linear and static accounting model. Therefore, outputs for example are typically assumed to scale linearly related to the product flows (Rebitzer *et al.*, 2004; Faße *et al.*, 2009). The flow accounting was performed for a study case. This study case presents the planned commercialization of Moringa as by the Balgüe Moringa project. The entire flow accounting was performed on an overall VC level. As in this case study a VC for Moringa is not established in the study area, there exist no constellation of economic agents, activities and relations to allow an analysis on the level of each economic agent. Furthermore, prices for the output of each agent are not available on thus the value added by each agent cannot be calculated. The necessary estimations to do so would require further research, which is not possible to do according to the time limit of this investigation. Rather, the flow accounting presents one case study for which different assumption were set.

The accounting was set up on the available land area for realizing the Balgüe Moringa project and a fixed plant density, which is a recommendation based on the functional and institutional analysis of the Moringa VC on Ometepe Island. Both present the dependent output variable for the accounting procedures. The estimated final outcome of the accounting procedures is the value that might be added on Moringa in the study area. However, as the VCA was performed on VC level the investigation does not deliver any information on a possible distribution of this value added within the different economic agents. Amongst others, the following main indicators as presented in table 5 were used to account the flows.

**Table 9:** Overview accounting indicators

| Classification | Indicator |
|---|---|
| Physically | Total Material Input |
| | Total Product Output |
| | Total Labor Time |
| Monetary | Net profit |
| | Gross profit |
| | Value added |

Source: Own representation

Thereby it is considered, that this study represents what future Moringa farmers in the study area anticipate in terms of costs and yield. However, due to some underlying basic assumptions used in gathering the data for this study case, the final results as reported in this study might be different when compared with particular individual operations.

The monetary flow accounting was done both in local currency Nicaraguan Cordoba (NIO) and United States Dollars (USD). Thereby, 25 NIO are 1 USD, based on the currency exchange rate of 25:1, which presents the exchange rate locally in use during the time of the fieldwork for this study. Numbers were rounded for presentation purposes.

**VCA: Sustainability considerations**

Finally, as part of the VCA, a verbal analysis on the sustainability of the commercialization of Moringa in the study area was performed. Thereby environmental, social, economic and political factors were incorporated, as they present the four domains of sustainable development. By this the economic nature of the VCA is further completed.

# 5 RESULTS AND DISCUSSION

## 5.1 VCA Mapping: Institutional analysis

### 5.1.1 Identification of activities and flows

#### 5.1.1.1 Production

In general there exist three different forms of Moringa cultivation. First, Moringa could be grown for intensive leaf production with a minimum spacing of 10 cm by 10 cm, resulting to a maximum of one million plants in one ha. These plants are than always cut at a high of 1 m to 1.5 m. This technique comes along with various disadvantages e.g. requires a permanent irrigation, high seed input, makes the trees more prone to pest outbreaks and it does further not allow the pod and seed production of the tree. This method presents an annual leaf vegetable production and not a tree cultivation (Palada and Chang, 2003; Radovich, 2011; observed at field visit in Leon). The second method includes the full development of the tree and is thus often called as pod producing method which also allows leaf production but in lower quantities. Therefore plants are spaced with a minimum of 2.5 m by 2.5 m (Palada and Chang, 2003; Radovich, 2011). This method was also observed during the field visit in Leon. Furthermore, Moringa could be grown within polycultures requiring a minimum spacing of 2 m per 3 m (Radovich, 2011). Such a cultivation system was visited at the permaculture farm in Balgüe. Finally, all Moringa production activities depend on the applied cultivation technique.

Several studies on Moringa cultivations, some of them resulting in practical guidelines, were identified, most of them focused on high plant densities. For example, in Nicaragua, BIOMASA, an agricultrual research program located in Nicaragua, which studied different aspects of Moringa, in cooperation with the “Departamento de Biomasa de la Universidad Nacional de Ingeniería”, and also the Universidad Nacional Agraria (UNA) are investigating on Moringa cultivation. The leaf production system studied by BIOMASA is focused on optimum yields, thus presenting an industrial monoculture production system with one million plants per hectare, using high amounts of fertilizers and sub-soiling with a deep plugging unit (Foidl et. al., 2001; Fuglie, 2008). Such a cultivation system was visited and observed in Leon, Nicaragua, where MLP is produced on 72 ha for the company Moringa Delight. Based on the literature as well as on the observation and the information given in interviews performed during this field visit, the system is not considered to be a sustainable solution for the local market of Ometepe Island. First, it does not fit the traditional agricultural practices and local capacities. Second, it does not respect the ecological principals of the concept of Agroecology as provided by Altieri and Nicholls (2005). Such a cultivation system presents an input intensive monoculture production coming along with high production costs and negative environmental impact.

Furthermore, different studies of the UNA Nicaragua exist, which considered middle to high plant densities. However, studies by Radovich (2011) performed in Hawaii, USA, and Palanda and Chang (2003) performed at the Asian Vegetable Research and Development Center (AVRDC) in the Taiwan lowlands present the most adequate results from the literature review as they also consider small-scale applications. Further studies on small scale Moringa farming project exist, especially performed in Africa.

**Soil preparation**

Palanda and Chang (2003) argue that Moringa requires accurate land preparation and also a well-prepared seedbed. According to their studies performed at the AVRDC, they recommend to plant Moringa on 30 cm high raised beds to facilitate drainage. The bed widths as tested at the center vary from 60 to 200 cm. Furthermore, Reyes (2004) recommends starting the soil preparation at the end of the dry season and finishing at the beginning of the rainy season. According to him it is further recommended to leave the ground loosely with a slightly rough surface, but not very dusty, to prevent that the seeds are put too deep or are washed by rain.

**Planting**

Moringa could be planted either by direct seeding, transplanting or by cuttings for propagations (Palada and Chang, 2003; Radovich, 2011). Palada and Chang (2003) recommend the direct seeding when the adequate amount of seeds is available and labor is a limiting factor, whereas cuttings should be used when seeds are limited but adequate labor available. Transplanting allows flexibility, but requires extra cost for material and additional manpower. Thus, transplanting does not present an alternative for the small-scale farming on Ometepe Island, but direct seeding and the use of cuttings do.

Radovich (2011) recommends a 10 cm by 10 cm planting for home gardens but a 0.75 m by 1 m planting on field bigger than 0.5 ha coming along with the advantage to allow seed production. However, the planting of Moringa in polycultures is an agroecological alternative for Ometepe Island as crop cultivation on the island is usually performed during rainy season because most of the farmers do not apply additional irrigation systems. Thus, the Moringa cultivation would not require additional land and farmers could optimize their outcome as

Moringa will continue to grow during dry season once the plants were established during rainy season. However, outcome of Moringa leaf production per unit area will be lower.

**Fertilization**

According to Palada and Chang (2003) Moringa grows well in most soils without the use of additional fertilizer. They state that once the Moringa plants are established, their extensive and deep root system is efficient to assimilate nutrients from the soil. Just for optimum growth and yields they recommend the use of fertilizers at planting time, whereby compost or well-rotted farmyard manure at the rate of 1–2 kg/tree are considered to be the most sustainable methods, making industrialized fertilizer unnecessary (Ibid.). Radovich (2011) further states that 0.5 kg of manure might be enough. On the other hand, both above mentioned studies from the UNA by Reyes *et al.* (2006) and Mendieta-Araica *et al.* (2013) applied the fertilization of synthetic N, P und K. However, the visited plantation in Leon and the permaculture farm on Ometepe Island apply just compost, whereby the plantation in Leon confirms that even large-scale industrial production do not require the addition of industrialized fertilizer. Furthermore, a small scale case study on Moringa cultivation performed by Ogoudadja and Saint Sauveur (2006) also just applied manure at planting time.

Within the study area the application of compost is not a common agricultural tradition of local farmers, while the use of manure as organic fertilizer is already applied at least within organic coffee production. Thus, adding of manure will be considered within the ongoing analysis.

**Pest management**

According to Palada and Chang (2003), Reyes (2004) and Radovich (2011) Moringa is resistant to most pest and diseases, but outbreaks may occur under specific conditions. However, Palada and Chang (2003) and Radovich (2011) state that the plant usually will recovers during warm weather and thus they do not recommend the use of pesticides. Furthermore, Reyes (2004) states that efficient pest control could be done by manual practices e.g. by eliminating the pest with a machete. Moreover, Moringa Delight (2013) states that the variety grown in Nicaragua is known as very resistant to pests based on studies by L. Fuglie. Furthermore, a Moringa experienced farm on Ometepe Island (10 years of growing moringa within a polyculture system) never had experienced problems with pests. Additionally, a study performed in Managua, Nicaragua, by the UNA on the intensive biomass production of Moringa also states that pest and disease incidence was not observed during their experiment, performed from July 2001 till November 2003 (Reyes *et al.*, 2006). However, on the contrary during another study from the UNA also performed on intensive biomass production of Moringa in Managua but from June 2007 till October 2009, a termites attack occurred resulting in a mortality of 0.13 % (Mendieta-Araica *et al.*, 2013). Thus, the authors of the mentioned study emphasize to be aware that pest outbreaks may occur even literature promotes Moringa as being pest resistant.

Following the argumentation of Palada and Chang (2003) and Radovich (2011) and taking in account the always warm weather conditions on the island and the small-scale agricultural production traditions, pesticides are not considered to be necessary within the Moring production on Ometepe. However, additional manpower to manually work against a possible pest should be considered as stated by Reyes (2004) considering that pest outbreaks may occur like experienced by Mendieta-Araica (2013).

Moreover, it is important to protect the plants from cattle and pigs as they will be attracted to eat the young plants (Palada and Chang, 2003). This requires the installation of fences as especially pigs are widespread on Ometepe Island and not kept enclosed.

As part of pest management, weeding has to be considered. This should be done regularly to avoid any competition for nutrients, especially nitrogen. In the case of improper weeding, the trees produce fewer leaves and the leaves at the base of the plant begin to yellow. When the plants are young, weeding must be done more frequently to allow light to reach the soil. Furthermore, an adult plantation should be weeded at least 4 times a year, with a higher frequency during rain seasons (Saint Sauveur and Broin, 2010).

**Irrigation**

According to Palada and Chang (2003) newly transplanted or seeded trees need to be irrigated immediately after transplanting or seeding to promote early root development. They recommend irrigating regularly for the first two months. Once established, Moringa rarely needs watering as the well-rooted tree are drought resistant and irrigation is needed only if persistent wilting is evident. A permanent irrigation system is only required, if an intensive leaf production is aspired and therefore a high planting density is used and the trees are completely cut regularly, as for example observed in Leon and also as studied by BIOMASA.

Within the study area, irrigation systems rarely exist (see section 3.3). According to the information given by the president of the Drinking Water Committee of Balgüe a view farmers, which cultivates land that is directly located at the coast, do use water irrigation systems.

They take up the water from the lake with a small pump. However, most of the agricultural land in Balgüe, has no access to the lake and thus famers are working without irrigation systems. The Drinking Water Committee of Balgüe does not permit to connect the agricultural lands with the local drinking water supply system. The fresh water springs deliver enough water for domestic use (45 l water per person per day are calculated), but not enough for agricultural usage. Hence, the cultivation of Moringa in the study area, especially in Balgüe where the Moringa project is located, should be adapted to conditions without a water irrigation system. Thereby, a sustainable Moringa production at Ometepe Island could make use of the rainy season. Seedling could be performed when rainy season starts providing enough water for the young plants. Later on when the dry season starts, trees will be established and do not require further irrigation. This could be applied in polyculture production and also in single crop production which aims the development of the entire tree making an irrigation system unnecessary.

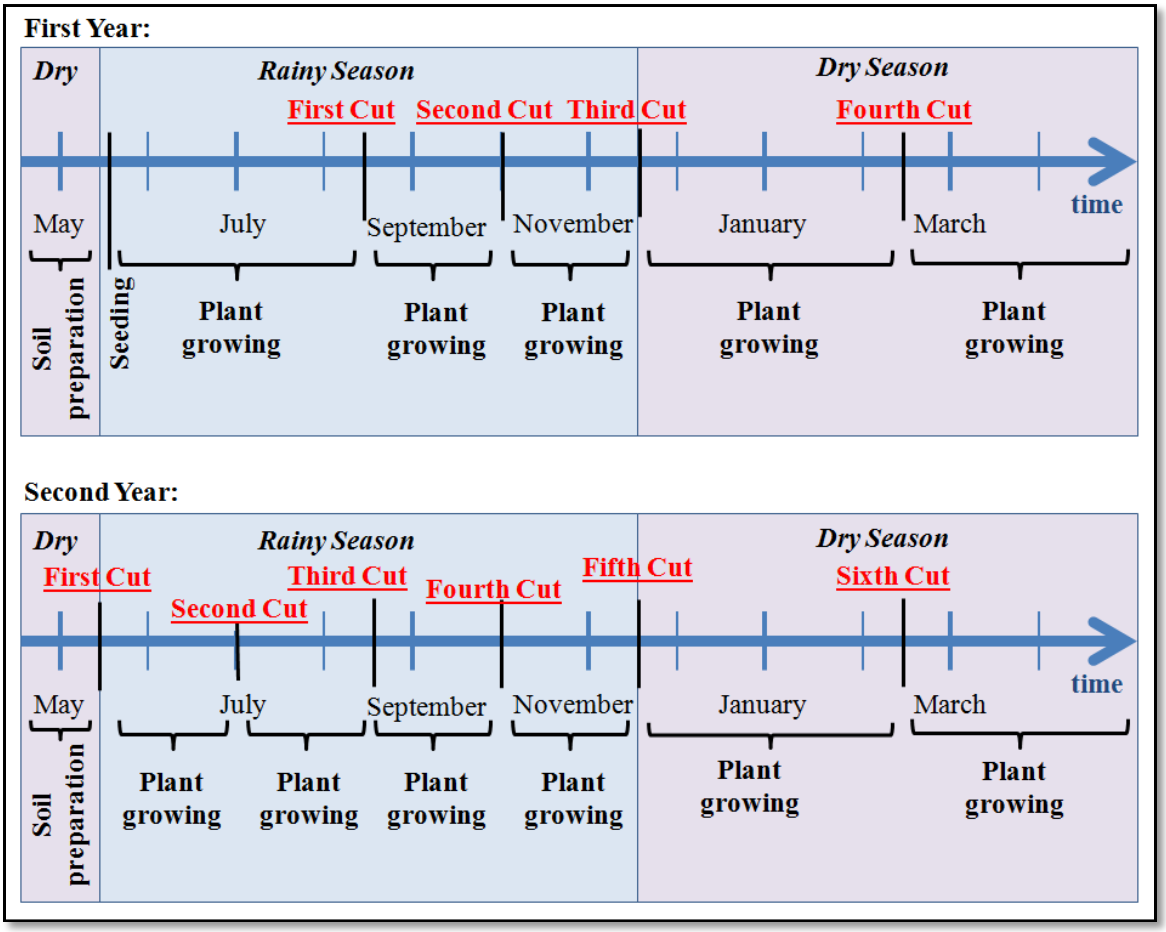
**Harvesting**

To harvest Moringa a machete and manpower are used for the cutting. Apart from the environmental aspects and crop management the biomass production also depends on the cutting frequencies (Reyes *et al.*, 2006 and Mendieta-Araica *et al.*, 2013). For the optimum leaf harvest, the entire tree is cut back to a height of 1-2 m (Doerr and Cameron, 2005). In Leon, the tree was even cut back to about 15 cm. Three month after seeding, the tree is cut first time and then a fixed cutting frequency is usually followed. In Leon a cutting density of 45 days, which was also studied by BIOMASA (Foidl *et al.*, 2001), is used. Reyes *et al.* (2006), who studied the biomass production of Moringa depending on the cutting density, present the highest yields rate at a cutting density of 75 days. However, ongoing investigations at the UNA used also a cutting frequency of 45 days (Mendieta-Araica *et al.*, 2013). Therefore, this investigation will also consider a cutting frequency of 45 days to calculate the possible cuts within one period.

On Ometepe Island cutting would be limited to the rainy season according to the lack of irrigation systems. There is almost no literature available on Moringa leaf cultivation with a few cuttings during the rainy season. Just one study, performed in Benin by Ogoudadja and Saint Sauveur (2006), was identified, using limited cuttings during the rainy season. Al other studies performed, do either consider no cuttings or permanent cuttings during one year. Considering a rainy season of six month on Ometepe Island and a cutting density of 45 days, it would be possible to cut the trees three times during rainy season in the first year (first cut three month after seeding) and four times in the following years. Ogoudadja and Saint Sauveur (2006) state that another cut during the dry season might be performed, but with a lower leaf yield. In the second year the trees are than cut back first time when rainy season starts, also resulting in a lower leaf yield. Figure 11 shows a possible calendar of Moringa cultivation for the first and the following years (harvest schedule). However, the harvest period for one cut needs to be adapted later to optimize the ongoing processing (see section 5.4.2.1).

For the production of MLP, both young and old leaves are suited. As Moringa leaves can easily lose moisture after harvesting, it is recommended to harvest early in the morning and complete the initial phase of processing in the same day, if possible. Diseased and damaged leaves are discarded manually just after the collection of fresh leaves (Mishra *et al.*, 2012).

**Figure 11:** Harvest schedule




Source: Own representation

**Storage**

The leaves are particularly perishable and therefore Radovich (2011) recommends storing them under cool temperature and high humidity to avoid excessive wilting and leaflet abscission. For processing MLP this would come along with intensive use of technology which is not considered to be sustainable taking in account local conditions. Therefore, fresh plants should be processed within the same day, which is also recommended by Mishra *et al.* (2012).

**Transport**

Transportation is necessary to get the fresh leaves to the place of processing and also to get the organic waste that is produced during processing. On Ometepe Island transportation of agricultural yield are usually done by bike, motorbike, horse or donkey, with a transporter or a heavy goods vehicle depending on the amount. Also the roof of a public transport bus is used for this purpose. The final choice depends on distance, availability and the load that has to be transported.

#### 5.1.1.2 Upstream analysis: Input supply

**Land**

The Moringa VC requires land for Moringa cultivation as an input supply. Agricultural land on Ometepe Island is available all around the island on the slopes of the two volcanoes. The current land use is described in section 3.1.

**Seeds**

Considering the low-input cultivation of Moringa, labor cost presents the main cost factor and thus labor presents a limiting factor. Therefore, the direct planting by seeds will be considered within this analysis and thus seeds are required as an important input to the Moringa VC. Seeds might be purchased from resellers or manually obtained from the mature pods.

**Fertilizer**

For the purpose of this study fertilization by adding manure and mulching with organic waste will be applied. This method allows the nutrients circulation by reusing organic waste. Thus, additional synthetic fertilizer is not necessary. Manure might be collected within the study area from horses and cattle as local farmers usually do not reuse this manure. However, this practice is just performed by the observed permaculture farm but not by local farmers.

**Pesticides**

For the purpose of this study pesticides are not considered to be necessary.

**Water**

According to the limited access to irrigation water in the study area, water as an input supply is not considered. Plant watering will be reduced to the rainy season.

#### 5.1.1.3 Processing

There is just limited literature available on how to produce MLP. Also scientifically studies to evaluate methods of MLP production are rare. Thus, this investigation follows the recommendations of different practical guidelines considering scientific studies whenever possible.

In general it is important to emphasize that the processing of MLP influences the quality of the final product. This might be important when quality standards have to be met, for example according to a national law, or for certification purposes (see section 5.3). The main goal is to obtain healthy and pure MLP free of microbes, dust and other parts of the plant than leaves for example.

**Washing**

First, the collected leaves should be washed in running tap water to remove dirt (Mishra *et al.*, 2012). After this, Mishra *et al.* (2012) and Saint Sauveur and Broin (2010) recommend to soak the leaves in 1 % saline solution (NaCl) for 3-5 minutes to remove microbes followed by another washing. This step plays a substantial role in removal of dust, pathogens as well as microbes that might be present on the leave surface. After washing, leaves are usually drained before starting the drying process (Mishra *et al.*, 2012)

Prabhu *et al.* (2011) were studying further preservation techniques whereby the following treatments were applied for washing: salt solution, germicide treatment[15], germicide and salt treatment, and turmeric and salt treatment. They performed different microbiological analysis on the dried leaves samples and the results did not vary significantly. Thus, the use of salt treatment presents an alternative for Ometepe Island, as it is easy to prepare. Scientific studies performed on the use of MLP did further apply the following washing techniques: Kar *et al.* (2013) were using potassium permanganate solution and Nadeem *et al.* (2012) only used water. Finally the applied technology will have an effect on the product quality and might be

[15] For this a 25 % glutaraldehyde was used.

influenced by different quality standards or laws. However, the recommended use of saline solution will be applied within this study.

**Stripping**

There exist different methods for stripping the leaves from the stems. Doerr and Cameron (2005) recommend the stripping directly after harvesting and before drying. On the contrary, Olsson and Willgert (2007) as well as Mishra *et al.* (2012) do not strip before drying as stem separation might be done after drying and during milling and sieving.

**Drying**

According to the Moringa Association of Ghana (cited by Miracle Trees, 2014) they are tree possible methods of drying Moringa leaves: room drying, mechanical drying and solar drying. Direct sun drying is not recommended as it destroys nutrients like proteins and 60 – 80 % of vitamin A (Doerr and Cameron, 2005; Olsson and Willgert, 2007; Price, 2007). Other authors also name open-air-shade-drying as applicable to produce MLP e.g. Ollson and Willgert (2007) and Mishra *et al.* (2012). However, shade drying at open air requires more area when drying large volumes of leaves and it is also more difficult to control; wind and rain have to be considered as well. Moreover, the material could also be negatively affected by insects and dirt when leaves are dried under free air conditions (Olsson and Willgert, 2007). Thus, shade trying will not be considered as an alternative to dry MLP.

**Room drying** is performed under shady conditions in a well-ventilated room (Moringa Association of Ghana cited by Miracle Trees, 2014). Thereby different methods of laying out the material during the drying process could be applied. Olsson and Willgert (2007) tested three methods: 1.) drying on black plastic on the ground, 2.) drying on trays, and 3.) hanging in bunches. Thereby the first two methods delivered the same results whereas hanging the material in bunches did result in lower dry matter contents. Though, room-dried leaves cannot be guaranteed mould-free with the maximum recommended moisture content and is thus not recommended for commercial purposes (Saint Sauveur and Broin, 2010).

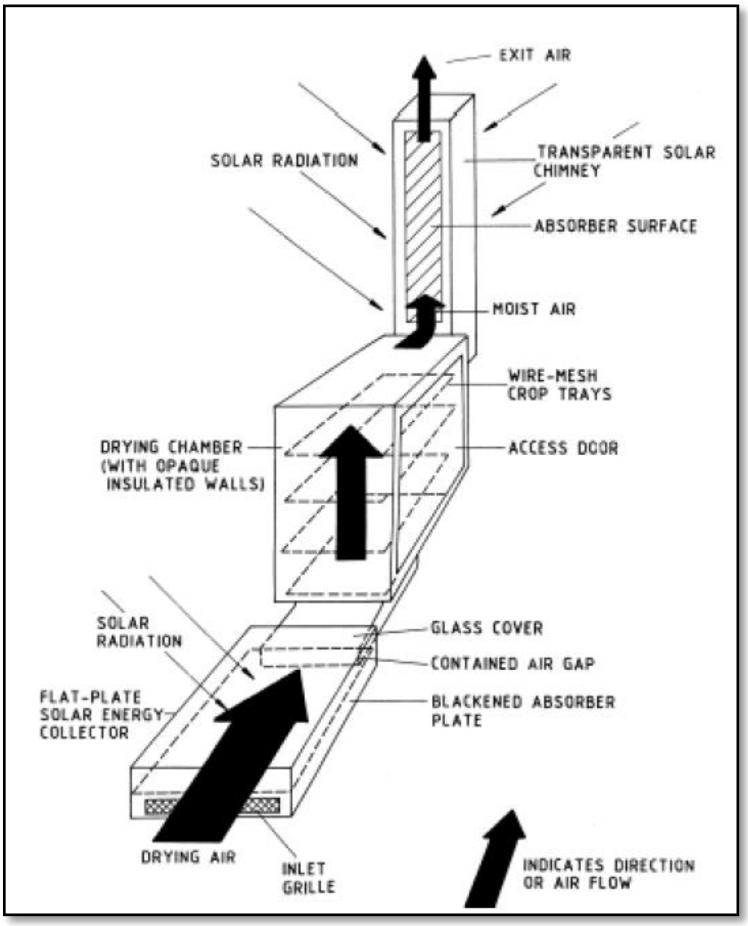
**Mechanical drying** is based on the use of electric or gas hot-air dryers. Thereby, the loading density should not exceed 2.5 kg/m². The Moringa Association of Ghana as cited by Miracle Trees (2014) recommends this method for large scale leaf processing as this ensures year around production. However, the use of electricity in Ometepe Island might be a limiting factor of commercial production. As stated within section 3.3 not all communities have access to electricity. Furthermore, power failures (possibly up to 24 hours) are practiced almost every day. Thus, the commercialization of MLP should not rely on electricity for the drying process, as the drying process should start directly after the harvest. Also a gas dryer should be avoided as it increases the input and those the production costs. Therefore, the use of mechanical drying for the study case is opposed.

**Solar-drying** uses collected sun-heated air, that flows in a chamber containing material and by natural convection the material gets dry (Olsson and Willgert, 2007). Thereby the air intake should be filtered to keep out dust. The loading density should not exceed 2kg/m². (Moringa Association of Ghana cited by Miracle Trees, 2014). Such a dryer was observed at the permaculture farm on Ometepe Island, which was the only agricultural unit producing Moringa identified during field work. They use the dryer to dry fruits and leaves for own consumption. However, they have no experience in drying large amounts of Moringa leaves by now. Saint Sauveur and Broin (2010) recommend solar drying for both small and large scale processing, especially in rural communities where electricity is not available. This case study will follow this recommendation and apply the use of a solar dryer.

In general when drying materials, the drying rate is influenced by many factors, e.g. the amount to be dried and the way of treatment. Thereby, the drying environment has a crucial influence. The main factors are: precipitation, solar radiation, air temperature, wind and humidity (Wright *et al*., 2000). Thereby, especially the air temperature and the relative humidity of the air play a key role (Weiss and Buchinger, n.d.). According to temperature Mishra *et al.* (2012) state that most nutrients were retained by drying at 50°C according AVRDC research. The Moringa Association of Ghana (cited by Miracle Trees, 2014) emphasizes to use a maximum temperature of 55°C. Leaves should be dried until their moisture content is below 10 % (Moringa Association of Ghana cited by Miracle Trees, 2014). Mishra *et al.* (2012) state a maximum of 4 days to get the Moringa leaves completely dry. However, this time is less when using a dryer or any other mechanical device. Weiss and Buchinger (n.d.) states, that a solar dryer in general reduces trying time to 1/3 of the time needed by sun drying. According to Saint Sauveur and Broin (2010) it takes about 4 hours (under sunny conditions) to dry Moringa leaves with a dryer and a loading capacity of 2 kg/m² (neglecting the relative humidity).

Nowadays, there are many types of solar dryer available (Weiss and Buchinger n.d.; Janjai, 2012). Though, not every solar dryer is adequate for the study case considering a high relative humidity of the air, a maximum processing temperature of 55°C, the exposure of the Moringa leaves from sunlight during drying, and the poor electricity supply on Ometepe Island. Weiss and Buchinger (n.d.) as well as Visavale (2012) present a classification of available solar dryers, whereof just indirect dryers are suitable for the study purpose as indirect dryers allow drying not under direct sunlight. Further, indirect solar dryer are available in different designs, whereby the selection of a design type is determined by the quantity, character, and designation of the material to be dried. Typically these solar dryers are either in a cabinet or channel design. Additionally, the dryers might be differentiated by the way the heated air is used as active or passive, whereby just passive dryers operate without electricity input (Ibid.). Thus, for the study purpose just an indirect passive solar dryer is suitable. Furthermore, this kind of dryer has the advantage that it is cheap to build based on local materials. By applying various drying layers the surface area of the dryer is increased (Ibid.). Figure 12 presents the design of a typical indirect passive solar dryer.

**Figure 12:** Design of an indirect passive solar dryer




Source: Ekechukwu and Nortan (1999) cited by Visavale (2012:22)

**Milling or Grinding**

Dried leaves can be transformed into powder by using a simple mortar and pestle, local grain grinders, burr mills (hand crank or motor driven), or merely by rubbing the dried leaves against a fine screen (Doerr and Cameron 2005; Mishra *et al.*, 2012). Finally this method depends on the scale of production. Saint Sauveur and Broin (2010) recommend the use of a burr mill or a hammer mill for commercial purposes. Thereby, recommended particle sizes are: coarse (1.0-1.5 mm), fine (0.5-1.0 mm) and very fine (0.2-0.5 mm). For the milling process the use of electronic devices is possible. Once the leaves are dried they might be stored for a few days before going on with milling. That enables the use of milling even if an electricity failure of 24 hours will appear.

**Sieving**

Once the powder has been produced, it should be sifted to remove any remaining stems. This could be done manually by using a fine strainer (Doerr and Cameron, 2005). According to Mishra *et al.* (2012) it is common to use a 0.5–1.0 mm pore size screen. If the milling is performed with a mill for commercial purposes, no further sieving is necessary (Ibid.).

**Packaging and Storage**

According to Doerr and Cameron (2005) and Mishra *et al.* (2012) MLP can be stored for up to 6 months under the following conditions: the powder has to be clean and dry, it has to be protected from light and humidity, and kept below 24°C. On the websites of different Moringa retailers in Germany and the USA even longer date-of-expiry of MLP are stated. However, considering lower quality standards in Nicaragua, for the purpose of this study 6 month will be considered. Typical materials used to store MLP are plastics, glass or aluminum bags. However, using glass cannot guarantee the protection from sunlight and is thus not considered within this case study.

**Transport**

To get the final product to the sales points public transport system might be used. If the sales point is not directly along the main street, a private motorcycle or car presents the most common alternative.

#### 5.1.1.4 Marketing

According to Kotler, one of the leading scientists on Marketing, and Keller (2012:5) the American Marketing Association offers the following formal definition of Marketing: *"Marketing is the activity, set of institution, and process for creating communicating, delivering, and exchanging offerings that have value for costumers, clients, partners, and society at large."* Based on this definition Kotler and Keller (2012:5) understand marketing management as *"the art and science of choosing target markets and getting, keeping and growing customers through creating, delivering, and communicating superior customer value."* Thus, selling (including sales channels) is just a small part of Marketing. Moreover, it includes the understanding of the costumers and the design of the product in a way that it fits the costumer perfectly (Kotler and Keller, 2012). In the case of MLP on Ometepe Island, there is a good, more specific a dietary supplement, which has to become a value to meet costumers. While the costumers are analysed separately within the VCA, the marketing section is limited to the final product, the sales channels, and advertising. However, this part of the investigation does not present a complete marketing study. Rather, it presents an analysis of marketing activities identified during the fieldwork performed on Ometepe Island.

During the fieldwork two existing marketing activities on Moringa as a food commodity were identified: Worth-by-mouth propaganda (by locals and foreigners) and promotion by NGOs. Both present advertising activities. Sales activities of Moringa were not identified on the island. Therefore, it could be concluded that these activities are not enough to promote Moringa on the island. Further activities that should be performed to commercialize Moringa on Ometepe Island were identified during the interviews and observations performed. The results are presented as follows.

**The final product**

The design of the final product has to be considered coming along with additional attention when selling MLP to tourist. As they have to carry the product while travelling, the package material needs to be robust but not heavy and the product size should be adequate. Apart from these physical properties of the product design, the properties of the MLP itself have to be analysed to understand the final presentation (graphic design) of the product.

The nutrition value of MLP and its potential of being a dietary supplement are considered to be an important factor to base marketing on. Both tourists and locals mentioned health properties (medical and nutritional) as an important issue. Tourist mentioned the health properties of MLP as a reason for them to buy it. Local people might become interested in the product for its healthy aspects, considering that local people do take dietary supplements. According to Babu (2000) it is therefore useful to compare the cost of nutrients from various sources with that of Moringa to see the economic benefits in recommending Moringa as a dietary supplement or any other form of nutrition intervention. However, there is no data available for this purpose in the study area.

By interviews and observations performed at four pharmacies (two in Moyogalpa and two in Altagracia) more than 20 dietary supplement products that are sold on the Island were identified, mainly Vitamin B12 and multivitamin products. The following tables present the comparison of the nutrient values of the 9 most sold products according to the interviewed persons with those of MLP. Thereby 20 g of MLP were chosen following the average of the daily intake recommendation for dietary purposes as presented at the mentioned workshop in Ghana 2006 (see section 2.2).

**Table 10:** Nutrient values of available dietary supplements and of MLP (part I)

| Product / Nutrient | IVK Vitamin C (1 tablet) | Macrovitamin (5ml) | Nutrison (5ml) | Intrafer TF 500 (5ml) | MLP (20g) |
|---|---|---|---|---|---|
| Ca [mg] | - | 25 | 1.908 | - | 400.6 |
| Mg [mg] | - | - | - | - | 73.6 |
| P [mg] | - | - | 1.965 | - | 40.8 |
| K [mg] | - | - | - | - | 264.8 |
| Fe [mg] | - | - | 4.3 | 30 | 5.6 |
| S [mg] | - | - | - | - | 174.0 |
| Vitamin A –β-Carotene [mg] | - | - | - | - | 3.2 |
| Vitamin B1 – Thiamin [mg] | - | 3.0 | 1.0 | - | 0.6 |
| Vitamin B2 – Riboflavin [mg] | - | - | 1.0 | - | 4.2 |
| Vitamin B5 – Phanthenol [mg] | - | - | - | - | n.d. |
| Vitamin B3 – Nicotinic Acid [mg] | - | - | 5.0 | - | 1.6 |
| Vitamin B6 – Pyridoxine [mg] | - | 2.0 | 0.5 | - | n.d. |
| Vitamin B12 – Cobalamin [mcg] | - | 5.0 | 1.5 | - | n.d. |
| Vitamin C – Ascorbic Acid [mg] | 500 | - | - | - | 3.4 |
| Vitamin D3 – Cholecalciferol [UI] | - | 400 | - | - | n.d. |
| Vitamin E – Tocopherol Acetate [mg] | - | - | - | - | 22.6 |

Source: Own representation

**Table 11:** Nutrient values of available dietary supplements and of MLP (part II)

| Nutrient \ Product | Forti-Ferro (5ml) | Ferridoce 2 (5ml) | Cabalex (1ml) | Fortiplex (2ml) | MLP (20g) |
|---|---|---|---|---|---|
| **Ca [mg]** | - | - | - | - | 400.6 |
| **Mg [mg]** | - | - | - | - | 73.6 |
| **P [mg]** | - | - | - | - | 40.8 |
| **K [mg]** | - | - | - | - | 264.8 |
| **Fe [mg]** | 143 | 2.0 | - | - | 5.6 |
| **S [mg]** | - | - | - | - | 174.0 |
| **Vitamin A –β-Carotene [mg]** | - | - | - | - | 3.2 |
| **Vitamin B1 – Thiamin [mg]** | 2.0 | 0.77 | - | 40.0 | 0.6 |
| **Vitamin B2 – Riboflavin [mg]** | 2.0 | 0.57 | - | 4.0 | 4.2 |
| **Vitamin B5 – Phanthenol [mg]** | - | 3.33 | - | 4.0 | n.d. |
| **Vitamin B3 – Nicotinic Acid [mg]** | 10.0 | 10.0 | - | 200.0 | 1.6 |
| **Vitamin B6 – Pyridoxine [mg]** | 1.0 | 1.0 | - | 4.0 | n.d. |
| **Vitamin B12 – Cobalamin [mcg]** | 5.0 | 3.0 | 1.0 | 40.0 | -. |
| **Vitamin C – Ascorbic Acid [mg]** | - | - | - | - | 3.4 |
| **Vitamin D3 – Cholecalciferol [UI]** | - | - | - | - | n.d. |
| **Vitamin E – Tocopherol Acetate [mg]** | - | - | - | - | 22.6 |

Source: Own representation

This analysis shows that the most sold dietary supplements in the study area mainly provide vitamins of the B group. Moringa as a plant cannot compete with vitamin B12 products, but it can deliver other B vitamins. Nevertheless, the comparison illustrates that 20 g of MLP just provides more Vitamin B2 than all other supplement products do. All other nutrients provided by the analyzed products are provided in higher amounts by other supplement products compared to MLP. However, the advantage of MLP presents the combination of all nutrition together including proteins, especially all the essential amino acids. MLP is considered to be a more complete product. Furthermore, other properties of local produced MLP present advantages compared to the analyzed dietary supplements from the pharmacy. For example the advantage that it is locally grown on a low input basis, that it is a natural product and that Moringa comes further along with other medical properties present important values of MLP to drive marketing on and make local people consuming MLP.

Apart from the medical and nutritional properties of MLP, tourists stated the following characteristics of the final product as a reason to buy it:

- It is local and organic grown.
- It supports local economic by creating further jobs and providing additional income to farmers.
- It has less impact on the environment when buying directly on the island by reducing further emission and resources for exportation.
- It is cheaper on the island than back home according to reduced transportation and sales costs.

These characteristics should be emphasized by marketing to reach more clients and to increase the quantity of sales. Additionally, tourists stated that the final product needs a proper name and logo as this gives them usually more confidence in a local product.

**Sales channels**

MLP might be sold as a dietary supplement or as a so called superfood (Radovich, 2011). Dietary supplements on Ometepe Island are sold without medical recipes in pharmacies or local stores ("pulperias"). As a superfood MLP might be sold as local organic product, which is especially valued by tourists. A few organic food products are sold to tourists on the island, e.g. coffee, honey, marmalades, teas and cereals. Usually these products are sold by hotels, restaurants or at other touristic places. Direct sales from the producer to the tourists are rare, resulting, that the higher prices tourist often are willing to pay, benefit more the tourist infrastructure than the farmers itself.

**Advertising and promotion**

According to the qualitative analysis of the interviews performed (both with tourists and locals) the following advertising activities might be considered to promote Moringa:

- Word-of-mouth advertising,
- Workshops by NGOs,
- Print on packaging material,
- Flyers and poster at the sales points, and

- Online marketing.

Furthermore, the interviewed medicals and the representative of MINSA, stated the promotion of dietary supplements by the national government, specially for children and pregnant woman. Thus, the cooperation with the MINSA in promoting MLP should be taken into account.

#### 5.1.1.5 Consumption

MLP is consumed directly by adding it to foods and drinks, or in form of capsules. Nutrient and Moringa intake level recommendations are described in section 2.1 and 2.2. The production of capsules requires further proceeding and material input. Because of this capsules are usually more expensive and thus it does not present a solution for Ometepe Island, where people’s income is low. Furthermore, MLP might flow into other VC of food commodities. In this case MLP would be used to increase the nutritional value of food. For example Nadeem *et al.* (2012) studied the adding of MLP to buttermilk and Manaois *et al.* (2013) applied MLP to produce rice crackers. However, this would present another VC and is therefore not part of this study. Consumption in this case is limited to direct consumption of MLP; both by tourists and locals.

#### 5.1.1.6 Recycling

After the consumption of the final product, recycling is limited on the packaging material. This recycling activity would be performed partly out of the study area considering that tourist would buy the product to take back home. Further recycling activities are identified during the VC within production (working materials, organic waste), processing (organic waste, working materials and investment goods after they reach their useful life) and marketing (advertising materials). All these recycling activities will take place within the study area. The organic waste should be completely reused for mulching within the Moringa cultivation. By this the nutrient cycles will be closed as intended by agroecology.

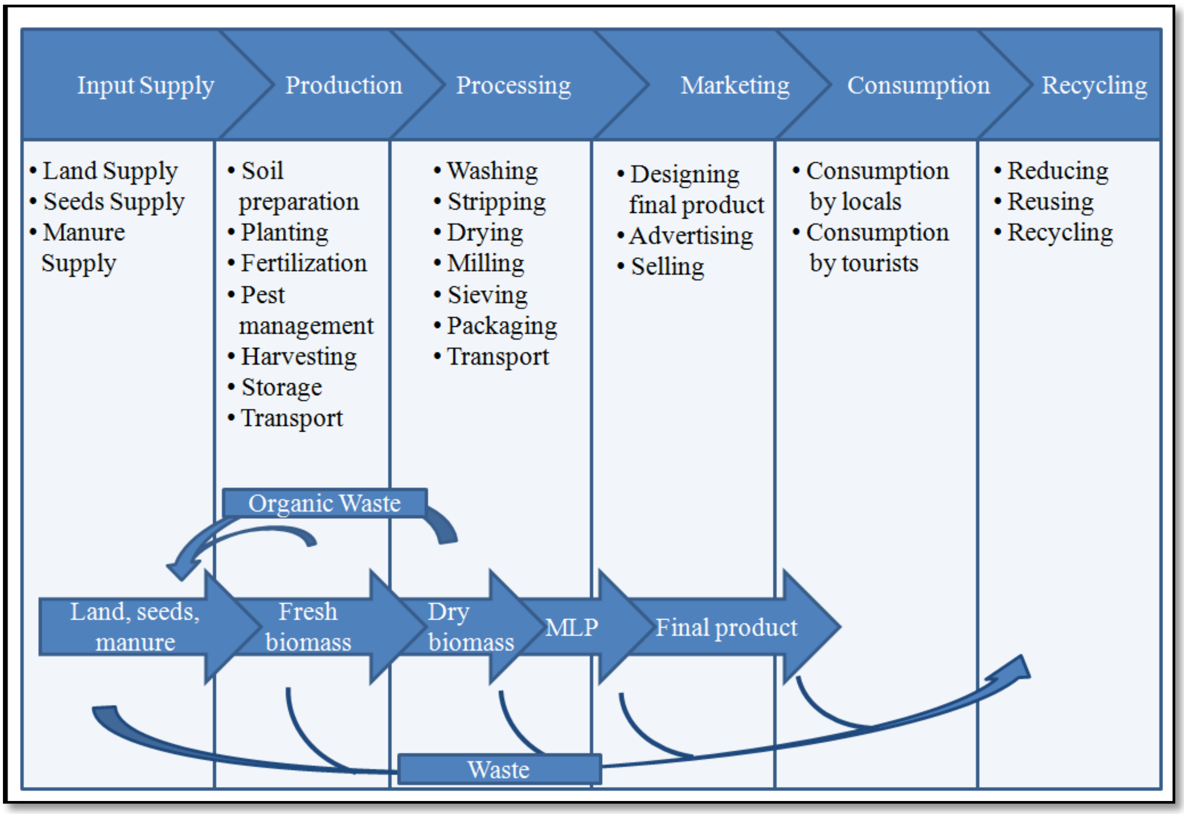
Waste management in the study area is very poor. There is no all embracing waste management system existent. Only close to Altagracia a small landfill is run by the local government. However, this landfill does not present a sustainable solution for local waste. Moreover most parts of the island are not connected to this landfill. Additionally, recycling is limited to wood, metal, glass and plastic bottles. Therefore, local people usually burn the rest of their waste which presents both a social and an environmental risk. Therefore, the following considerations on recycling should be incorporated in the Moringa VC:

- Reduce the material input and thus the amount of waste outcome. For example a bigger package size for the MLP reduces the required package material per volume. Using posters for marketing require less material input and thus less waste output than individual flyers.
- Use materials that might be reused. For example choosing a robust package material with a zipper, could be reused for other package purposes.
- Prefer recyclable materials especially for equipment and investment goods.

#### 5.1.1.7 Summary

To summarize at this point of the institutional analysis, the identified activities and flows, which are necessary to introduce MLP in the study area, are mapped as illustrated by Figure 13.

**Figure 13:** Mapping Moringa VC: Activities and flows




Source: Own representation

### 5.1.2 Identification of economic agents

#### 5.1.2.1 Farmers

According to observations and all the interviews performed during the field work on Ometepe Island just one agricultural unit that cultivates Moringa was identified. However, this unit is a permaculture farm run by foreigners, where Moringa is cultivated (about 2,000 trees) for own consumption and usage on the farm based on a modern permaculture design concept which is not representative for the islands agricultural activities. Apart from this farm, twelve other farms were identified during the interviews, two run by locals, ten run by foreigners, that have between ten to 40 trees for own consumption. Thus, Moringa production for sales purposes was not identified. However, any farmer on Ometepe Island might produce Moringa in a future when a market for the plant will exist. Further information of farmers is presented within section 3.3.

#### 5.1.2.2 Input Suppliers

As analyzed before, the input supply is reduced to land, seeds and manure. Agricultural **land** on Ometepe Island is either owned privately, by a farmers’ cooperative or by the state. As input into the Moringa value chain land might thus be owned privately by the farmer or rented by the farmer from any of the other mentioned land owners.

In Nicaragua large amounts of **seeds** might be obtained from the Moringa Delight farm in Leon and from the UNA Managua, which is studying on Moringa. Moringa Delight is promising that the seeds they sale for planting are picked from the best producing trees in their plantation. They are fresh and guaranteed to have a germination rate of over 95 % (Moringa Delight, 2013). However, it is recommendable to use seeds from local trees as they are most adapted to local conditions (Radovich 2011). Furthermore, it would be less cost intensive. For example in El Peru, about 20 Moringa trees with pod production were observed and according to the owners, the just use the tree as a fence and thus they would give away the seeds for free, requiring just the manpower to harvest the pods and peel them off to get the seeds as well as transportation costs. Accoring to Radovich (2011) one tree produces about 230 pods, each containing 15-20 seeds. Thus just in El Peru it would be possible to get about 69,000 seeds (considering 20 trees with 230 pods each and 15 seeds each pod) from private persons.

The **manure** input in the study area might be supplied by the farmers themselves or bought externally. Within the study area one commercial supplier of manure was identified. This manure is from chicken and certified by Bio Latina[16] as organic fertilizer. The manure from cattle or horses on the island is not sold; however it might be collected manually as the already mentioned permaculture farm in Balgüe does.

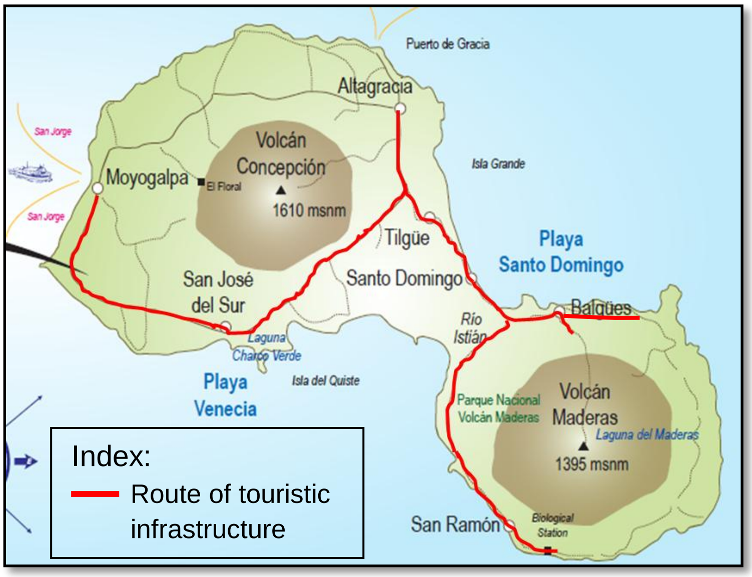
#### 5.1.2.3 Processors

During the field work no industrial processors on Ometepe Island where identified. Small-scale processing of food commodities is done by the producer itself, or in the case of coffee there exist processing infrastructure within the cooperatives. The same could imply for MLP production.

#### 5.1.2.4 Sales points

Dietary supplements are sold in the pharmacies (located in Moyogalpa and Altagracia) and local stores which are available in every small community all around the island. Foods and vegetables in general are sold directly by the producer, in local stores or on the street. Local agricultural products are further sold especially to tourist in hotels, restaurants, at tourist attractions and souvenir shops were also handicrafts and souvenirs are sold. An identification of the distribution of the general touristic infrastructure all around the island as well as of those stores which sell the above mentioned product to tourist was performed during the fieldwork. Figure 14 shows where the overall touristic infrastructure is distributed on the island, indicated by the red line. On the other parts of the island no touristic infrastructure was identified.

**Figure 14:** Touristic infrastructure on Ometepe Island




Source: Map by Ometepetravel (2013), Indication by the author

[16] Bio Latina is a Latin-American company leading in certification of agricultural production system. It meets the ISO 065 (EN 45011) and is recognized in the EU and in the U.S. (Bio Latina, 2014).

Furthermore, Table 12 presents the result of sales point identification which especially addresses tourist. In total all around the island 29 main sales points offering local products such as souvenirs, handicrafts and/or agricultural commodities to tourists were identified during the fieldwork. These sales points are distributed all along the way from Moyogalpa to Atagracia and Altagracia to Balgüe with a higher concentration of 9 sales points in Moyogalpa. Just the southern route of Volcano Maderas, getting down to Merida and San Ramos does not offer official fixed sales point addressing tourists with local products. Out of these 29 identified sales points 12 are already selling agricultural commodities. Furthermore 5 hotels are planning to open a store or a sales corner. These sales points have the potential to sale MLP to tourists. However, it was not possible to capture quantitative data on how many tourists for examples are addressed by these sales points or how many products they sell. An adequate data management system for this purpose is not used by these sales points.

**Table 12:** Sales points addressing local products to tourists

| Category | Total number | thereof selling also agricultural commodities |
|---|---|---|
| Hotels and hostels[17] | 18 | 9 |
| Restaurants | 3 | 1 |
| Tourist attractions | 5 | 1 |
| Souvenir shop | 3 | 1 |
| **TOTAL** | **29** | **12** |

Source: Own representation

#### 5.1.2.5 Advertising institutions

According to the qualitative analysis of the interviewed performed with local people the following advertising agents are identified in the study are:

- Word-of-mouth advertising is considered to be the most source of local knowledge about Moringa. This knowledge is provided by locals (limited to the traditional medical use of the tree) and foreigners (especially about the nutritional values).
- Workshops performed by local acting NGOs were also mentioned as Moringa knowledge source.

[17] Hotels and hostels with restaurants are just captures within this category and not again under restaurants.

- Medical's and pharmacy's recommendation play a key role on nutrition, especially on dietary supplements knowing that local people do not have the tradition of eating healthy vegetables.
- Advertising at local stores leads people to buy unknown products.
- MINSA and MAGFOR as governmental institutions: MINSA contributes to health and nutrition knowledge and MAGFOR to agricultural and environmental practices.

Furthermore, the interviewed foreign tourist and other foreigners mentioned the following advertising agents that should be involved when selling MLP to tourists:

- Hotels, restaurants, souvenir shops and local stores as sales channels,
- Operators of websites about Ometepe Island,
- NGOs, and
- Moringa promoters back in their home countries to generally increase the knowledge about Moringa.

As a result it is concluded that not all necessary marketing agents are directly involved in the local MLP VC. Especially NGOs and governmental institution do not deal directly with the final product MLP. Rather they deal with people's awareness and knowledge while promoting Moringa. Therefore, these agents are not included in the VCA flow accounting according to FAO (2005a). Nevertheless, their involvement to introduce Moringa as a food commodity in the study area is highly recommended.

#### 5.1.2.6 Consumers

The consumer population of Ometepe Island for local Moringa consumption is composed by two major groups: 1.) Local people and 2.) Tourist and foreigners. Another group could presents national tourists, but according to time limitations for the fieldwork and the way interviewees were chosen, they could not be included in the analysis. The term "tourist" within this investigation does therefore refer exclusively to foreign tourist.

**Local people**

The local consumer population as of 2013 is about 31.079 according to INIFOM (2014a; 2014b). Both, adults and children present potential costumers of Moringa product. However, finally the decision of buying the product belongs to the adults. Therefore it is important that people know about Moringa and its benefits. The current situation about local people's knowledge about Moringa was analysed within the fieldwork. Out of 300 randomly chosen local adults (thereof 150 male and 150 female) interviewed all around the island, 143 (47.7 %) stated that they know the tree Moringa (by its local name Marango). Table 13 presents an overview over local people interviewed grouped by age and the ratio of people knowing Moringa.

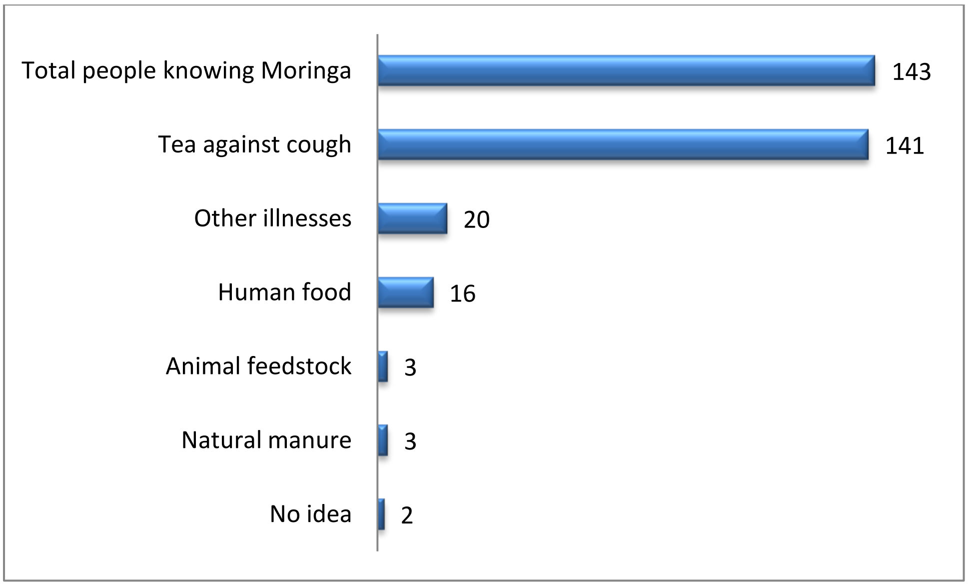
**Table 13:** Local people interviewed about their knowledge on Moringa; grouped by age

| Age | Number of people interviewed | Number of people interviewed by sex | | People knowing Moringa | | | |
|---|---|---|---|---|---|---|---|
| | | male | female | yes | | no | |
| | | | | absolute | % | absolute | % |
| > 25 | 45 | 27 | 18 | 5 | 11.1 | 40 | 88.9 |
| 25-34 | 80 | 44 | 36 | 36 | 45.0 | 44 | 55.0 |
| 35-44 | 58 | 29 | 29 | 26 | 44.8 | 32 | 55.2 |
| 45-54 | 53 | 26 | 27 | 26 | 49.1 | 27 | 50.9 |
| 55-64 | 33 | 13 | 20 | 24 | 72.7 | 9 | 27.3 |
| > 64 | 31 | 11 | 20 | 26 | 83.9 | 5 | 16.1 |
| **Total** | **300** | **150** | **150** | **143** | **47.7** | **157** | **52.3** |

Source: Own representation

Thereby, it results that the ratio of people knowing Moringa increases with increasing age. Usually local people knowing the tree do not know about its nutritional properties but about its medical properties. The people that know Moringa, where asked for what the tree is used and only 16 people (presenting 5.3 % of the total sample size of 300) mentioned that Moringa is eaten because of high nutrition values while 141 mentioned that the flower of Moringa is locally used to make a tea when people suffer cough, 20 people also mentioned that Moringa helps to treat other illnesses, 3 mentioned the use as compost, further 3 knew about its use as animal feedstock and just 2 of the 143 people knowing the tree, did not know for what the tree is used. Figure 15 presents the different usages of Moringa as known by local people and the number of people who know it.

**Figure 15:** Local knowledge about the use of Moringa and number of people knowing it (out of 300 people that where asked)




Source: Own representation

Furthermore, those people were asked if they consume Moringa and even there are 16 people who know about the nutritional properties just 5 of them (presenting 1.7 % of the total sample size and 31.25 % of those people knowing that Moringa presents a human food) consume it regularly in form of fresh leaves or seeds. Out of those 141 people, who know about the flower used for tea against cough, 75 people further stated that they consume the tea when they or any familiar suffers cough (presenting 53.2 % of those who know about the flower tea and 25.0 % of the total sample size). These numbers confirm that knowing about the value does not automatically bring people to consume Moringa. Further awareness on nutrition is necessary.

Furthermore, 122 person (40.7 %) of the 300 interviewed person answered that the regularly take a nutrition supplement, mostly multivitamins and vitamin B12 products. Additional interviews with the medicals at the two clinical centres and the main pharmacies in Altagracia and Moyogalpa confirmed that local people consume nutrition supplements, especially vitamin B12, multivitamin and calcium supplements. However, it was not possible to evaluate quantitative data on the consumption of these products, as the pharmacies and the medicals do not have a data management system.

### Tourists and other foreigners

Tourist and other foreigners living on Ometepe Island present a second consumer group of the study area. Tourists buy local products to bring back home as a souvenir or gift to friends and family. Thus, they present another core group for selling MLP. The following table presents origin and sex of the 100 interviewed tourists. Furthermore, 51 % were between 25 and 34 years old; 27 % were younger than 25 years, 20 % between 35 and 44 years, and 2 % were older than 44. Most of these people (80) were in Nicaragua for tourism, while 8 people were volunteering, 7 were working (thereof 5 works and travel) and 1 was visiting friends and 4 permanently living in Nicaragua. Therefore, 51 % of the interviewed tourist stayed up to 4 weeks in Nicaragua, 41 % stayed longer than 4 weeks but less than one year, 4 % one year or longer (but not permanently) and 4 % permanently.

**Table 14:** Origin and sex of the interviewed tourists

| Nationality | Number of people interviewed | Number of people interviewed by sex | |
|---|---|---|---|
| | | male | female |
| USA | 28 | 17 | 11 |
| Germany | 23 | 11 | 12 |
| Canada | 14 | 9 | 5 |
| Europe, others | 23 | 13 | 10 |
| Latin America | 12 | 8 | 4 |
| Total | **100** | **58** | **42** |

Source: Own representation

Out of these 100 people, 19 stated that they know Moringa (10 of them were male and 9 female). Thereof, 11 people also stated that they consume Moringa. However, it has to be mentioned that 3 of them do permanently live in Nicaragua and 2 in Costa Rica, and thus they refered to the consumption of fresh Moringa parts. The other 6 tourist consume Moringa back home in form of powder, capsules or liquid in Juice spending between 10 and 40 USD per month on it.

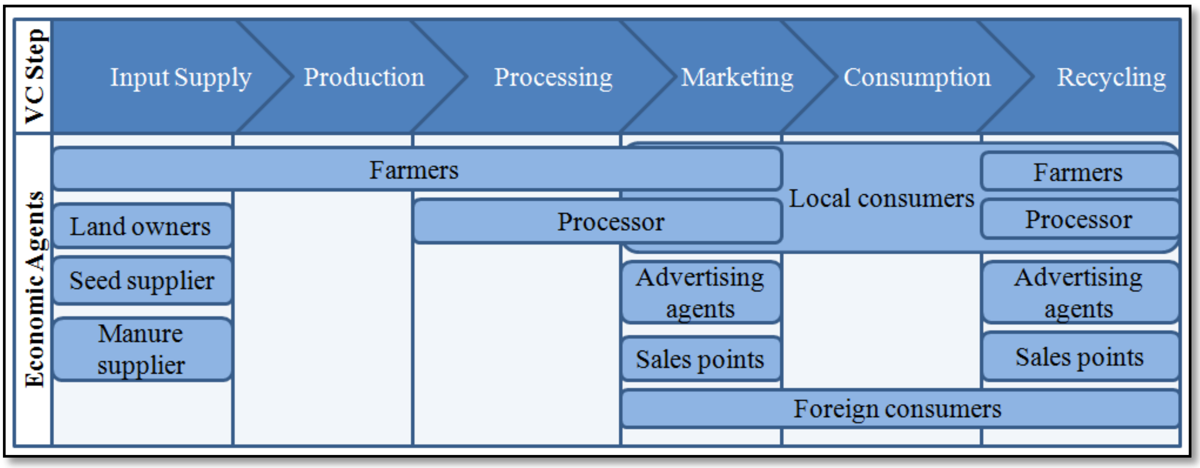
Finally, after talking about Moringa to the interviewees, all of them were asked if they would buy MLP during their stay in Nicaragua. Thereof, 55 % expressed their interest by answering yes, 12 % answered maybe or probably and 33 % said that they would not buy it.

Those 77 % answering yes, maybe or probably, present the core group for selling MLP on the island to foreigners. However, considering that just 19 % of all tourists and foreigners interviewed knew about Moringa, it requires intensive and adequate marketing activities to reach this kind of client.

#### 5.1.2.7 Summary

To sum up at this point, Figure 16 presents an overview of all identified economic agents within the local Moringa VC as necessary to introduce MLP as a food commodity.

**Figure 16:** Mapping Moringa VC: Economic agents




Source: Own representation

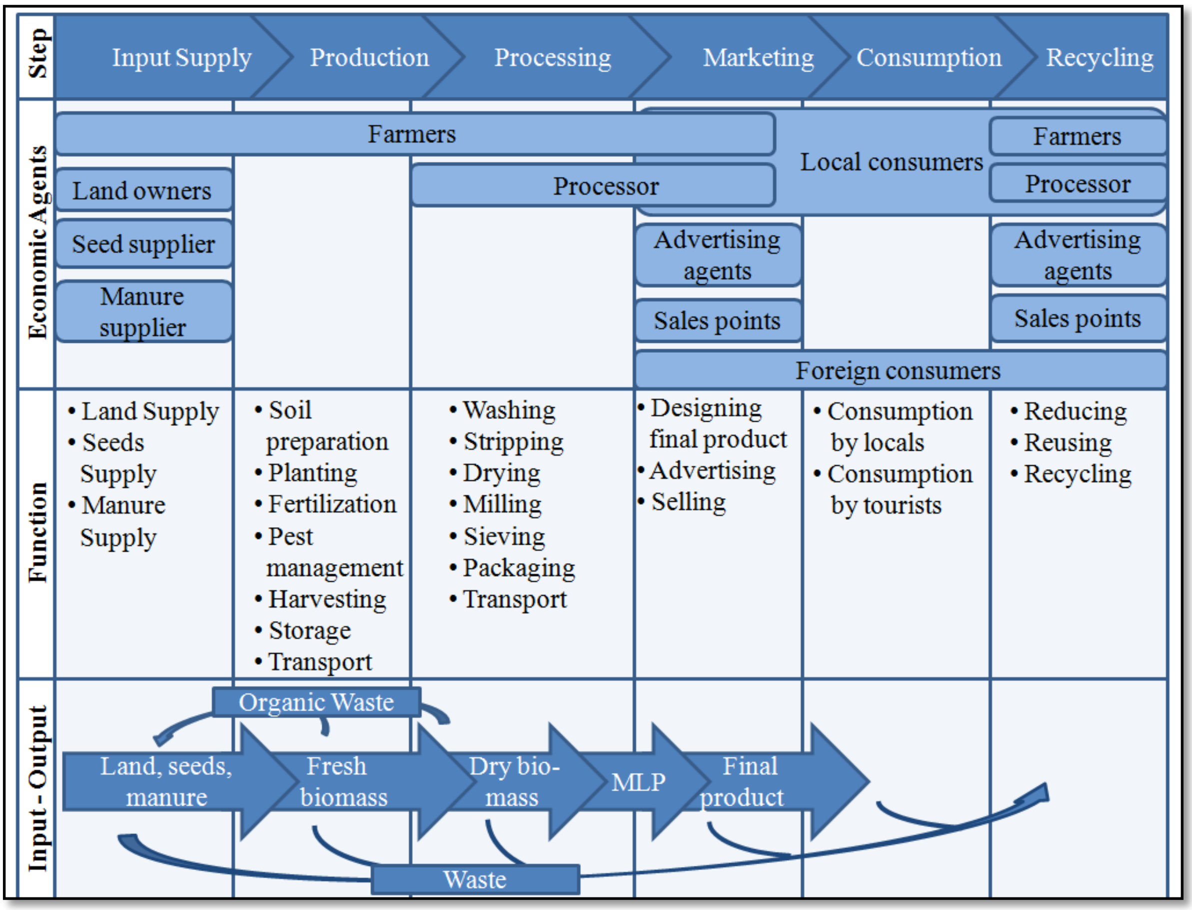
Analysing this figure it has to be emphasized that the farmers present the economic agent which could be involved in most of the VC steps. The entire VC is presented by farmers, considering that farmers are local consumers as well. Thus, it is especially the farmers, which might benefit from the introduction of Moringa as a food commodity on Ometepe Island. Farmers might organize the value chain in a way that does not require any other economic agent for processing, further they might reduce the need for external input suppliers and they might involve themselves into marketing activities to increase the sales of MLP.

Furthermore, the VC step were most of the economic agents are involved presents the Marketing. To introduce Moringa as a valuable food commodity intensive marketing activities are required. Thereby it needs agents of all VC steps accept the input suppliers that are not farmers. Those, special attention has to put on marketing when introducing Moringa as a food commodity.

## 5.2 VCA Mapping: Functional analysis

Based on the preceding institutional analysis the functional analysis of the Moringa VC in the study area could be presented as per Figure 17 and Table 15.

**Figure 17:** Functional Analysis of the Moringa VC on Ometepe Island




Source: Own representation

**Table 15:** Overview functional analysis

| Step of the VC | Function | Agent | Input | Output |
|---|---|---|---|---|
| **Input Supply** | Land supply | Farmers and other land suppliers | n. a.<br><br>(this step presents upstream agents, which are not active part of the Moringa VC) | Land |
| | Seed supply | Seeds supplier | | Seeds |
| | Manure supply | Farmers or external manure supplier | | Manure |
| **Production** | Soil preparation | Farmers | Land, Seeds, Manure | Fresh biomass |
| | Planting | | | |
| | Fertilization | | | |
| | Pest management | | | |
| | Harvesting | | | |
| | Storage | | | |
| | Transportation | | | |
| **Processing** | Washing, Stripping, Drying | Farmer or processers | Fresh biomass | Dry biomass |
| | Milling, Sieving, Packaging | | Dry biomass, | MLP |
| | Transport | | MLP | MLP |
| **Marketing** | Designing final product | Farmer or processers | MLP | Final product MLP |
| | Advertising | Advertising agents | Knowledge | Knowledge |
| | Sales | Hotels, restaurants, souvenir shops, local stores | Final product MLP | Final product MLP |
| **Consumption** | Consumption | Local people | Final product MLP | Waste: packaging material |
| | | Tourists and other foreigners | | |
| **Recycling** | Reusing and recycling of packaging materials | Local people | Waste | Reused or recycled waste |
| | | Tourists and other foreigners | | |
| | Reducing, reusing and recycling cycling of factors of production and investment goods | Farmers, Processers, Marketing agents | Waste | Reused or recycled waste |
| | Reuse of organic matter | Farmers | Organic matter | Organic matter |

Source: Own representation

## 5.3 VCA: Identification of policies

According to the limited time for this investigation, it was not possible to make a complete literature review on laws and other policies that exist and that have to be met within the VC of Moringa. Information considered within this analysis was therefore mainly captured by interviewing the most important responsible governmental institutions like the MINSA, the city hall of Altagracia (Alcáldia de Altagracia), the Drinking Water Committee (Comité de Agua Potable) of Balgüe and the MAGFOR in Moyogalpa as well as additional literature to respond on specific requirements. Therefore, the result does not present a complete analysis of policies rather an identification of applicable regulations based on interviews. Further details were captured if possible to be incorporated in the following flow accounting.

**Performing economic activities (taxes)**

In general to set up any form of economic agent (to perform economic activity), it is necessary to register the entity or private person performing the economic activities at the city hall of the corresponding municipality, Moyogalpa or Altagracia, in the public mercantile register (registro publico mercantile). As the Balgüe Moringa Project would locate the cultivation and processing activities in (or close to) Balgüe, the requirements of the corresponding municipality Altagracia are taken into account. Thereby the minimum requirements are considered, considering the small-scale business within the Moringa VC in the study case.

According to the interviews performed at the city hall in Altagracia, the registration of an economic agent is regulated by the arbitrary municipality plan (Plan de Arbitrios Municipal) which is based on law 40 (“Ley de Municipios de Nicaragua”), and the law 822 (“Ley de Concertación Tributaria y su Reglamento”). The inscription costs 400 NIO per year. Furthermore, a monthly business tax of 200 NIO becomes due. For the sale of a food commodity this process requires amongst others a hygiene certification which is issued gratis by the MINSA.

The agricultural production of a food commodity for sale further requires the registration of the land according to the decree 3-95 (Impuesto sobre Bienes Inmuebles). This is done at the land registry in Altagracia. This institution will levy a tax on the registered land, which is based on an evaluation performed by the institution. The farmer has then to pay an annual fixed tax rate. As this rate vary, the responsible employee stated that for 1 ha of agricultural land the average annual tax rate is about 600 NIO. Nevertheless, the agricultural production at Ometepe Island is still informal organized. So far, local farmers usually do not register their land and thus also not their economic activities.

Furthermore, income taxes in Nicaragua (Impuesto sobre la Renta, IR) are regulated by the decree 662 (Ley del Impuesto sobre la Renta). Regarding this law, the IR has to be paid by natural persons whose gross income is more than 50,000 NIO per year and all corporate bodies independently of their income if not exempted of the IR. According to § 25 section b Decree 622, these corporate bodies have to pay IR of 30 % of the annual income. For natural persons the tax rate varies from 0 % to 25 % depending on the gross income (see Table 16).

**Table 16:** Income tax rate Nicaragua

| Gross income [NIO] | IR |
|---|---|
| **≤ 50,000** | 0 % |
| **50.001 – 100,000** | 10 % |
| **100,001 – 200,000** | 15 % |
| **200,001 – 300,000** | 20 % |
| **≥ 300,001** | 25 % |

Source: § 25, section a Decree 662

Furthermore, the value added tax (VAT) in Nicaragua is currently 15 % in general. The VAT for electricity is about 7 %. However, agricultural products produced in the country are not subject of VAT.

Besides, the social insurance as per decree 974 (Ley Orgánica de Seguridad Social de Nicaragua) was mentioned during the interviews at the city hall of Altagracia. If the economic activity requires employment, the employee has to pay a varying percentage of the employer's salary for social insurance as defined per decree 39-2013 (De Reforma al Decreto No. 975 "Reglamento General a la Ley de Seguridad Social"). For calculation purposes an average of 16.25 % was mentioned by the interviewed person. Though, within the informal agricultural sector of the study area this is not common. Agricultural activities are run by private persons and engaged farmers are paid in cash without any formal registration.

Additionally it might be considered to register a brand for the final MLP product in the register of intellectual property (Registro de la propiedad intelectual) at the Ministry of Promotion, Industry and Trade (Ministerio de Fomento, Industria y Comercio, MIFIC) in Managua. However, it is not common in Nicaragua to register a brand for a local product aimed for the local market.

**Quality standards**

The only existing quality standards for Moringa leaf production and consumption are delivered by Saint Sauveur and Broin (2010). These standards are also published by the Ghana Standard Board. Within this study this standards were met. Furthermore, national and international regulations on food and dietary supplements might set a general framework. In Nicaragua, technical norms (both, national and international) are provided by the Comité Nicaragüense del Codex Alimentarius and published by the MIFIC (MIFIC, 2014). Thereof, especially the "Guidelines for vitamins and mineral food supplements" by the Codex Alimentarius Commission (2005) of FAO and WHO, should be followed within the Moringa VC. It delivers demands for the product itself, the packaging, and the labelling.

**Agricultural activities**

According to the interview performed with the MAGFOR in Moyogalpa, general standards on agricultural practices are provided by this institution even the agricultural sector in the study area is organized informal. Though, MAGFOR has promoted the implementation of a system of Hazard Analysis and Critical Control Points (HACCP) to improve and ensure the safety of products and by-products of plant origin. The HACCP system is based on the implementation of prerequisite programs within which good agricultural practices are developed. The HACCP is constituted by law 291 (Ley Básica de Salud Animal y Sanidad Vegetal) and by the norm NTON-11004-02 (Norma Técnica Obligatoria Nicaragüense sobre Requisitos Básicos para la Inocuidad de Productos y Subproductos de Origen Vegetal).

Furthermore, the norm NTON-11010-07 (Norma Técnica Obligatoria Nicaragüense de Agricultura Ecológica) provides the requirements for organic products. Considering the Moringa cultivation activities, the MLP might be sold as an organic product and thus meet the mentioned norm to get certified as such a product.

**Customs regulations**

Considering that most of the tourists on Ometepe Island are from the USA, Canada and Germany, the national import regulations of at least these countries should be taken into account for the sales to tourists. They might present barriers or limitations to the sale of MLP as a local product addressed to tourists.

In Germany the regulations on private imports of food and forage (in the study case when returning from a non-EU-country) are covered by the German customs regulations. On this basis it is generally allowed to import food for private consumption. Though, the import of some food commodities might be forbidden by further specific regulations. In the case of MLP, it is important to consider national Medicinal Product Act (Arzneimittelgesetzt, AMG). Accordingly dietary supplements or vitamin preparations which are aimed to cure human diseases are treated as a medicinal product (§ 1 AMG) and are therefore covered by the mentioned act. Under special circumstances the import of such a medical product is forbidden. However, medical products for private consumption up to 90 days are allowed to import. Furthermore, it is forbidden to import living plants and products made of protected endangered species (BMF, 2014).

In Canada regulations in the case of importing MLP from Nicaragua are similar. It is generally allowed to import herbs, spices, tea, coffee and condiments as well as 20 kg of dried fruits and vegetables (CFIA, 2014). Furthermore, the Food and Drugs Act presents requirements related to the importation of all health products as defined by the Food and Drugs Act and its Regulations. However, if a drug or a natural health product is aimed for personal consumption it is allowed to import one treatment or the quantity for a supply of 90 days (Health Canada, 2010).

In the USA, the import regulations by the U. S. Customs and Border Protection (CBP) are more specific (CBP, 2014). Besides, the U. S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) develops the policies that determine what agricultural products can be imported into the country and what products pose a risk and should be kept out. Thereby, for fruits and vegetables it depends on the kind and the country of origin whether it is allowed to import or not. However, the U. S. Fruit and Vegetable Requirements (FAVIR) Database does not include Moringa (USDA APHIS, 2014). Thus it was not possible to check whether it is allowed to import Moringa. Nevertheless, in general most of dried species (except parts of some citrus fruits) are allowed to import as well as some dried fruits. Interestingly is also, that powder drinks might be imported just if the ingredients on the original package are disclaimed in English (CBP, 2014). Furthermore, it is also possible to bring medication into the U.S. for personal use only. Non-prescription medicines, vitamins, and supplement products fall under the jurisdiction of the Food and Drug Administration (FDA). In general the FDA will not be object to the personal importation of those products, as long as the traveler is carrying the products in their possession (or in their luggage); and the amount being carried is an amount reasonably considered for personal use (U.S. Embassy, 2014).

## 5.4 VCA: Flow accounting

### 5.4.1 Study case description

The Balgüe Moringa Project is planning a pilot project on the commercialization of MLP for 2015, based on the cultivation of 1 ha land. This project might than easily extended once the product could be launched successfully. However, there exists no cultivation plan for the pilot project yet. Thus, this investigation will set up the following assumptions based on the VCA mapping performed above:

- establishing a polyculture cultivation using a spacing of 2 m by 3 m at 1 ha land, resulting in a plant density of 1,650 trees per ha;
- thereby, the land has no access to the coast, so no irrigation system is applied;
- using direct seeding with locally collected seeds;
- using manure and mulching for fertilization;
- manually performed pest management just in case of any pest outbreak;
- three cuts during rainy season and another one in dry season during the first year;
- five cuts during rainy season and another one in dry season during the second year; and
- horse transportation for fresh leaves and organic waste.

Furthermore, for the processing the use of an indirect passive solar dryer as well as an electronic mill will be assumed. For the sales of MLP, the Balgüe Moringa Project considers to start cooperating with 15 sales points addressing mainly local people (local stores and pharmacies) in 10 communities and further 15 sales points addressing exclusively tourists. For transportation of the final product to the sales point an external service by motorbike will be used. Therefore, the transportation costs will be added to the analysis as a service fee, including fuels, time and the wear of the motorbike.

The financing of this project is based on donations and founds as acquired by the NGO. Therefore no debt financing is necessary and thus no interest charges on debt capital have to be included into the analysis. The accounting period is one year, starting in May of the first year of production. As agricultural products produced in Nicaragua are not subject of VAT, the entire VCA calculation is performed on gross prices.

### 5.4.2 Physically flows

#### 5.4.2.1 Fresh biomass

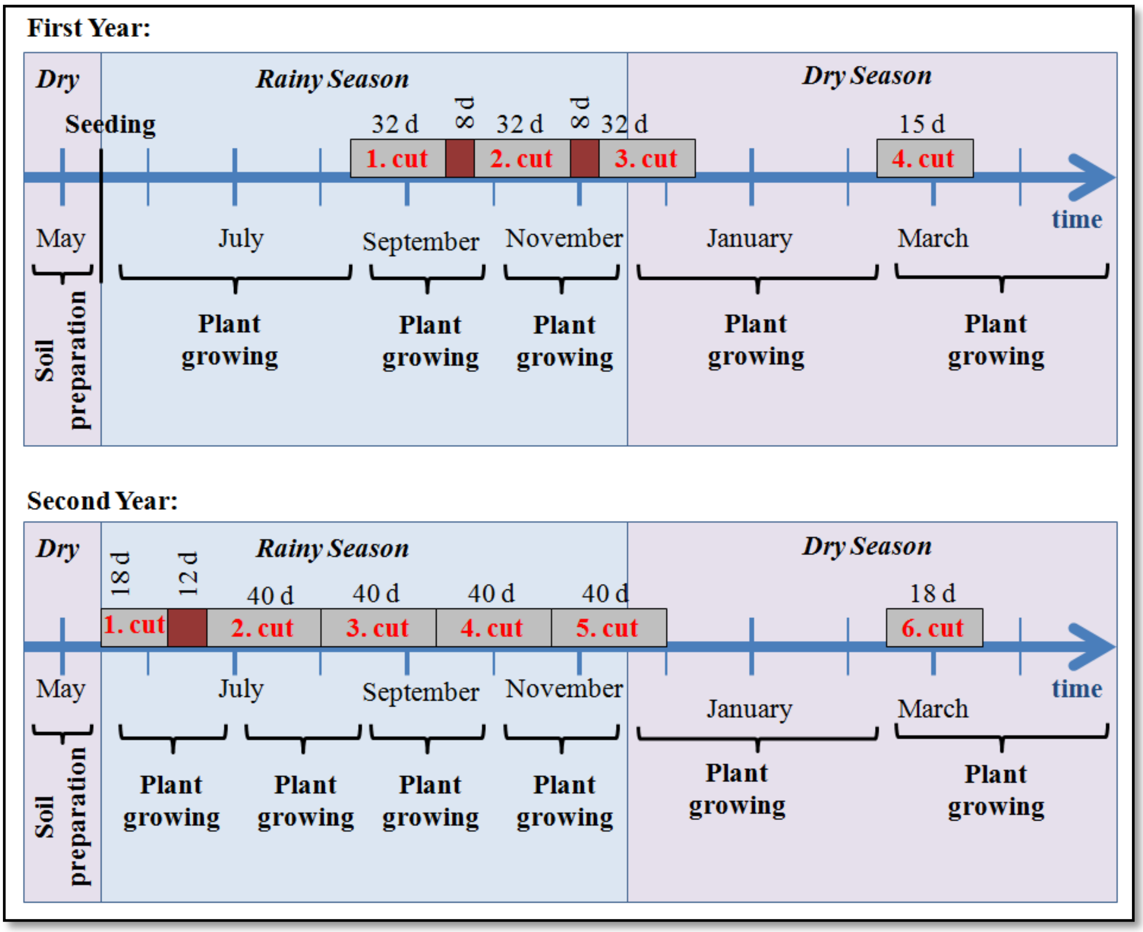
The biomass production of Moringa finally depends on different factors such as environmental conditions, crop management (e.g. plant density, irrigation, fertilization) and cutting frequencies. Different values are available for different conditions. Some studies performed are cited by Animashaun and Toye (2013), but thereof is just one study on polyculture cultivation, which was performed in Benin by Ogoudadja and Saint Sauveur (2006). They studied a cultivation system of 500 plant per ha without an irrigation system and with frequent harvest every 25-40 days limited to rainy season. Thereby they report a leaf yield outcome of 980 kg/ha/year for the first year, which means about 2 kg per tree per year. This rate was about 84 % higher in the second year resulting in 3.6 kg fresh leave production per tree per year within the second year. Radovich (2011) also states that one tree produces 1 to 5 kg fresh leaves per year depending on environmental conditions and crop management, but when not cut during the period and for spacing of 1 m by 1 m. Studies on fresh biomass yield results performed in Nicaragua, as for example by Foidl *et al.* (2001), Reyes *et al.* (2006) or Mendieta-Araica *et al.* (2013), do not separate between leaves, stems and petioles. Thus their reported values are not adequate for MLP production. Therefore, the calculation of the total fresh leaf yield in this case study will be based on 2 kg fresh leaves per tree in the first year and 3,6 kg fresh leaves per tree per year for the following years. However, this is just an assumption by the author based on the reviewed literature. Further research on the Moringa biomass production within the study areas is still necessary.

Consequently, 1,650 plants producing 3,6 kg fresh leaves each per year (2 kg in the first year) will result in a total of 5.940 kg/ha/a of fresh leaves (3,300 kg/ha/a in the first year), plus additional biomass available for mulching the cultivation area (stems and petioles). Thereby, it is important to know the yield per cut for the ongoing calculations within the further transformation process. According to Ogoudadja and Saint Sauveur (2006) the yield outcome of one cut during the dry season presents 46 % of the yield outcome of one cut during rainy season. Furthermore, in the first year it has to be considered that the biomass production will increase with every cut as the tree will develop more stems with each cut. However, in the second year when the trees are established the biomass production is about the same quantity after each cut (Ibid.). As there is no exact data about biomass production per cut in the first year available, the increase of biomass production in the first year will not be taken into account. The impact of this neglect will be considered in the ongoing analysis whenever necessary.

Thus, the 3,300 kg/ha/a of fresh biomass in the first year are obtained by 3 cuts in the rainy season of 954 kg/ha yield per cut (based on an equal distribution of biomass production per cut) and 1 further cut in the dry season of 438 kg/ha yield. In the second year the 5,940 kg/ha/a of fresh biomass are obtained by 4 cuts in the rainy season of 1,207 kg/ha yield per cut and 2 cuts in the dry season of 556 kg/ha yield per cut.

To optimize the ongoing processing, an optimal cutting density has to be chosen. Following Ogoudadja and Saint Sauveur (2006) the harvest period for 1 cut in the rainy season of the second year (where the maximum yield outcome is realized) will be 40 days for optimizing the processing. This means, that 1,207 kg/ha fresh biomass yield per cut presents round about 30 kg fresh biomass per day, which will determine the size of the dryer and the cutting capacity per day. Consequently, the first cut in the second year of 556 kg/ha fresh biomass yield per cut, has to be realized within 18-19 days considering the capacity of the dryer of 30 kg fresh biomass per day. After this a break of 11 or 12 days might be considered to enable a growing time of 30 days for each tree till the next cut. In this way the harvesting periods of the cuts are optimal distributed within the rainy season of 6 month. Following, in the first year, the 954 kg/ha fresh biomass yield per cut might be cut within 32 days followed by 8 days break to enable 40 days of grow for each tree till the next cut. If the increase of biomass production after each cut in the first year would be considered exactly, the harvesting periods will be shifted. Nevertheless, as the capacity of the dryer is calculated on the maximum yield outcome of the second year, any possible biomass yield outcome per cut in the first year would still be able to process. Thus, the neglect of increasing biomass production per cut in the first year is acceptable for calculation purposes. Finally, for the cut during the dry season in the first year a harvest period of 15 days is necessary. By this an overall cutting density of 30-45 will be applied. Thus, in the first year 111 days of harvesting about 30 kg fresh biomass per day are necessary and days in the second year 196 days. The following figure presents the adopted harvest schedule for the study case.

**Figure 18:** Optimized harvest schedule




Source: Own representation

The necessary time for all Moringa cultivation activities as estimated within a participatory workshop is presented in the following tables. Thereby Table 17 presents the total labor time in the first year and Table 18 the total labor time in the second year.

**Table 17:** Labor time for Moringa cultivation in the first year

| Activity | Time [man-hour/year] |
|---|---|
| **Soil preparation** | 40 |
| **Planting** | |
| Seeding | 12 |
| Adding manure | 20 |
| **Weeding** | |
| 5 times during six month of rainy season | 160 |
| 1 time after 1 month of the dry season | 32 |
| **Mulching** | 56 |
| **Pest management** | 30 |
| **Harvesting** | |
| (about 30 kg fresh leaves in 1 day) | (1) |
| total in 111 days | 111 |
| **Transportation** | |
| fresh leaves in 111 days | 56 |
| organic matter (mulch) in 111 days | 56 |
| **TOTAL** | **573** |

Source: Own representation

**Table 18:** Labor time for Moringa cultivation in the second year

| Activity | Time [man-hour/year] |
|---|---|
| **Weeding** | |
| 5 times during six month of rainy season | 160 |
| 2 times (at the beginning and the end) of the dry season | 64 |
| **Mulching** | 98 |
| **Pest management** | 60 |
| **Harvesting** | |
| (about 30 kg fresh leaves in 1 day) | (1) |
| total in 196 days | 196 |
| **Transportation** | |
| fresh leaves in 196 days | 98 |
| organic matter (mulch) in 196 days | 98 |
| **TOTAL** | **774** |

Source: Own representation

#### 5.4.2.2 Seeds input

Even Moringa Delight (2013) guarantees a germination rate of 95 % a germination rate of the local seeds will be considered for ongoing calculations. Therefore an inventory of two trials was prepared and analyzed. Within the first trial, performed in March 2014, 50 seeds were seeded and 44 germinated, presenting a germination rate of 88 %. The second trial was performed in April 2014 and this time 90 seeds were seeded in total and 82 germinated, which presents a germination rate of 91 %. For the following analysis a germination rate of 90 % for local seeds will be taken in account. Thus, to plant 1,650 trees on 1 ha of land 1,833 seeds are necessary. This seeds could be easily collect by one person within 2 hours. Furthermore, it was observed that germination in both cases occurred five to seven days after seeding.

#### 5.4.2.3 Manure input

For the first year of cultivation manure input has to be considered before the seeding of the plants. As Radovich (2011) states that adding 0.5 kg/tree of manure at planting might be enough for Moringa fertilization, this investigation will calculate with this minimum of 0.5 kg manure per tree. Taken into account the very fertile soil conditions in the study area and the aim of reducing production costs, it is adequate to calculate with the minimum value. Thus, a total of 825 kg manure has to be added to the 1,650 planned trees. Therefore, 19 bags of 43.56 kg each are necessary.

After the first year, fertilization will be reduced to mulching by using the organic waste from the Moringa processing and weed control. No further manure input is required.

#### 5.4.2.4 Dry biomass and MLP

According to Animashaun and Toye (2013) the rate of dry biomass out of fresh leaves is about 12.5 to 15 %. Thereof the lower value of 12.5 % is equal to 8 kg fresh leaves resulting in 1 kg dry biomass as used by Sogbo *et al.* (n.d.) in a case study on Moring Powder production. Thus, this value will be considered within the calculation of this investigation. Thus, the 1,650 plants will produce about 740 kg of dry biomass available of MLP production within one year, accepted in the first year. In the first year, the expected dry leaf biomass outcome is about 410 kg. Thereby, the 30 kg of fresh leaves per day of harvest present about 3.75 kg of dried leaves, which will be further transformed in 3.75 kg of MLP. Additional flows within the processing are accounted by following the single processing activities.

**Washing**

In a study case on MLP production performed in Senagal presented by Olivier (n.d.) produced 100 kg of MLP per week and for this they needed 100 l per day of water for washing. In the study case from Ometepe Island, in one week of production about 210 kg fresh leaves (30 kg each day in 7 days) are processed resulting in 26 kg of MLP. This would present a daily water use of 26 l per day of production for washing. Additionally, water for cleaning the workshop and personal hygiene is required. The entire water consumption as estimated in the participatory workshop is about 40 l per day. According to the president of the Drinking Water Committee of Balgüe this amount of water could be provided and does thus not present a limitation of production. Hence, in the first year 4,440 l of water are considered and in the second year 7,840 l are necessary. Furthermore, the use of 1 % saline solution will be applied in the study case. Therefore, the washing process requires 3 steps (clean water, saline solution, clean water), so that for each step 8.7 l[18] are necessary. Thus, for 8.7 l of 1 % saline solution 87 g of NaCl are required. Whereby, it is considered that the solution will be changed once a week, but as soon as it is visibly contaminated. Simplified it will be calculated with 2 kg NaCl input in the first year and 3 kg in the second year.

**Stripping**

After stripping the final weight of the fresh leave biomass of about 30 kg per day of harvesting (3,300 kg/ha in the first year, 5,940 kg/ha in the second year) is reached because steams and petioles are finally removed producing organic waste. An evaluation of this organic waste outcome is not possible. Adequate numbers for calculations were not identified during the reviewed literature. However, it might be resumed, that all organic waste will be reused for mulching on the cultivation area, to optimize fresh biomass yield outcome.

**Drying**

The following indicators have to be taken into account to calculate the design and capacity of the dryer as well as the processing time for drying within this study case:

- Maximum yield of fresh biomass per cut is 1,207 kg/ha in 40 days, presenting 30 kg per day.
- Drying time is about 4 hours of sun. The average sunshine hours per day are between 4.7 and 6.2 in the month of the rainy season and 6.3 and 8.1 in the month of

[18] This value was obtained by dividing the 26 l per day by 3.

the dry season[19]. Thus, it is considered that the drying is possible within one entire day. That means that the loading of the dryer is performed late afternoon/early evening when one entire day was needed to dry the harvest from the day before.

- Furthermore, the relative humidity influences the drying time for air temperature below 50°C (Román and Hensel, 2011). However, as a temperature within the dryer of about 50°C is aspired, the high relative humidity in the study area could be neglected.
- Maximum loading capacity of the dryer is 2 kg/m².
- Thus, a surface area of about 15 m² would be necessary. However, it is recommended to install a higher surface area to ensure that drying could also be finished in the case that one day is not enough. By this, the harvesting frequency might be adopted to the availability of the dryer coming along with reduced days of harvesting and higher fresh biomass yield per day.

**Milling**

The 3.75 kg of dried leaves that resulted from the fresh leave outcome of one day of harvest, should present the minimum capacity of the mill per day. However, the most adequate mill as identified as available in Managua, Nicaragua, during the field work consumes 1,600 W of electricity per hour and the salesman stated that within 0.5 hours the aimed 3.75 kg per day of production might easily produced, already including a second milling process. Thereby, for small-scale purposes the only other alternative identified presents a manual mill. However, as this possibility is excluded within the Balgüe Moringa Project this possibility will not be included in ongoing calculations.

Taken into account 0.5 hours of using the mill per day of production and the 1,600 W of the mill's energy consumption a total energy input of 89 kWh in the first year and 141 kWh in the second year are necessary.

**Packaging**

Typically size of MLP products as sold in Germany and the USA are 200 g and 500 g or 1 lb[20]. According to a MLP reseller request to 5 reseller in Germany and 5 in the USA a 200 g package of MLP is equal to 0.774 l, which is important to know when ordering the packaging

[19] The most adequate figures available were considered. These figures are for the Rivas Department for the time period form 1961-1990 provided by the Hong Kong Observatory (2012).

[20] 1 lb is equal to 453,59237 g

material. Correspondingly 1 lb of MLP is equal to 1.755 l. For the purpose of this study case a 200 g package is considered to be adequate: for tourists it still presents a convenient size to transport the package and for local people it presents a size to introduce the product. Once the product is launched successfully and people are convinced the package size for local people might be increased to reduce packaging material input and the sales price of the final product.

For the pilot project it means that 410 kg MLP produced in the first year are packed into 2,050 packages of 200 g MLP each. In the second year 3,700 packages of 200 g MLP are filled with the 740 kg MLP produced. Based on an email request to three companies in Managua that sell packaging material for industrial purposes, a metalized bag with a zipper that is closed manually during the packaging process was chosen for the purpose of the study. This type of bag is often used to sale MLP in Germany and the USA; it is not heavy but robust and it ensures that the MLP could be stored lightproof and airtight. Furthermore, the bag might be reused and thus reduce waste outcome.

The work time required for packaging depends on the size of the bags used: packaging in small bags requires much more time. The 3.75 kg of MLP (as resulted by 30 kg of fresh leaves of one day of harvest) present 18 bags of 200 g and a leftover of 150 g.

**Total labor time**

To quantify the labor time needed for the whole transformation of fresh leaves to dried leaves and finally MLP, no data were identified within the literature review that suits the design of the study case (use of solar dryer and electronical mill). Thus, the labor time to produce 3.75 kg of MLP was also estimated within the participatory workshop; results are presented in the following table. Based on this data, the labor time was projected to one year (111 days of harvesting in the first year, 196 days of harvesting in the second year).

**Table 19:** Total estimated labor time to transform fresh leaves into MLP

| Activity | Labor time to produce 3.75 kg MLP [man- hour/day] | Total Labor Time in the first year [man-hour/year] | Total Labor Time in the second year [man-hour/year] |
|---|---|---|---|
| **Washing** | 1 | 111 | 196 |
| **Stripping** | 2 | 222 | 392 |
| **Drying** | | | |
| loading the dryer | 0.5 | 55.5 | 98 |
| removing dry leaves from the dryer | 0.25 | 27.75 | 49 |
| **Milling** | 0.5 | 55.5 | 98 |
| **Packaging** | 0.5 | 55.5 | 98 |
| **Cleaning the workshop** | 1 | 111 | 196 |
| **TOTAL** | **5.75** | **638.25** | **1,127** |

Source: Own representation

**Transportation**

Finally, the transportation of the final product to the sales point was assumed to be performed ten times in the first year and also ten times in the second year. Thereby it was assumed, that in the first year, smaller amounts of products will be delivered to each sales point at one time as the product will be in its market introduction phase. For each time of transportation an entire man-day was estimated to be necessary within the participatory workshop. For the purpose of this analysis on time of transportation is represented by one service unit transportation.

#### 5.4.2.5 Final product

The **final product** should be labeled on both sides of the package to promote the sales of MLP. Thus, 4,100 labels have to be printed in the first year and 7,400 in the second year. Two different kind of labels should be produced; one part in English and the other part in Spanish language. Considering that tourists language is usually English and taking into account the US customs regulations, it is recommended to label the products sold to tourists in English language. The time to label the final product was estimated to be 0.5 man-hour for the 18 or 19 packages that are produced out of the 3.75 kg MLP resulting from one day of harvesting. In total it means that 55.5 man hours are necessary in the first year of production and 98 in the second year of production. Even this activity is considered to be part of marketing; it will be performed by the processing agent and will be done before the transportation of the final product to the sales points.

Further **advertising activities** includes amongst other the posting of posters and handout of flyers. Posters should be hanged up at the two clinical centers and the seven medical stations as well as at the chosen **sales points** (15 addressing local people and 15 addressing tourists). Thus, a total of 24 posters in Spanish and 15 in English are required in the first year of production. To simplify the calculations, the same amount will be used for the second year. Additionally, flyers are prepared to help promoting the product during time of introducing Moringa. Therefore 2,000 flyers are considered. They might be handout by medicals and the sales points.

An overall time budget of 150 man-hour for advertising activities was estimated in the participatory workshop to be necessary. This amount includes an overall administration of the sales.

#### 5.4.2.6 Waste

Waste outcome is identified within each step of the Moringa VC. However, according to time limitation of this investigation it is not possible to account this flows. The amounts of waste could not be quantified and is therefore not included in the flow accounting analysis. However, considering the low-input production of MLP, a general low waste output is considered. Furthermore, at least all the organic waste will be reused within the cultivation of Moringa and does therefore not present a waste outcome of the VC.

#### 5.4.2.7 Summary

To summarize the physical accounting of the study case along the MLP VC, Table 20 presents the physically flow accounting summarized per year. Thereby the recycling activities are excluded as it was not possible to evaluate the flows of this VC steps.

**Table 20:** Summary physical flow accounting

| VC Step | Indicator | Unit | Amount First year | Amount Second year |
|---|---|---|---|---|
| Input Supply | Total Seeds Input | seed | 1,833 | - |
| | Total Land Input | ha | 1 | 1 |
| | Total Manure Input | kg | 825 | - |
| Production | Total Labor Time | man-hour | 573 | 774 |
| | Total Fresh Leaves Output | kg | 3,300 | 5,940 |
| Processing | Total Fresh Leaves Input | kg | 3,300 | 5,940 |
| | Total Labor Time | man-hour | 638 | 1,127 |
| | Total Water Input | l | 4,440 | 7,840 |
| | Total NaCl Input | kg | 2 | 3 |
| | Total Electricity Input | kWh | 89 | 141 |
| | Total MLP Produced | kg | 410 | 740 |
| | Total Bags Input (for 200 g MLP) | bag | 2,050 | 3,700 |
| | Total Packaged MLP Output | package | 2,050 | 3,700 |
| | Transportation | service unit | 10 | 10 |
| Marketing | Total Packaged MLP Input | package | 2,050 | 3,700 |
| | Total Labor Time | man-hour | 150 | 150 |
| | Total Label Input | label | 4,100 | 7,400 |
| | Total Poster Input | poster | 39 | 39 |
| | Total Flyer Input | flyer | 1,000 | 1,000 |
| | Total Final Product Output | package | 2,050 | 3,700 |
| Consumption | Total Consumption | package | 2,050 | 3,700 |

Source: Own representation

### 5.4.3 Monetary flows

#### 5.4.3.1 Factors of production

Based on the preceding parts of the VCA, the factors of production were identified. The following table presents an overview of the factors of production for the study case including its monetary accounting for the entire accounting period.

**Table 21:** Factors of production

| VC Step | Factor of production | Unit | First Year | | | Second Year | | |
|---|---|---|---|---|---|---|---|---|
| | | | Amount | Costs of production | | Amount | Costs of production | |
| | | | | [NIO] | [USD] | | [NIO] | [USD] |
| Production | Seeds | seeds | 1,833 | 200 | 8.00 | 0 | 0 | 0.00 |
| | Manure | kg | 825 | 3,230 | 129.20 | 0 | 0 | 0.00 |
| | Machete | item | 5 | 500 | 20.00 | 5 | 500 | 20.00 |
| Processing | Water | l | 4,440 | 120 | 4.80 | 7,840 | 120 | 4.80 |
| | NaCl | kg | 2 | 20 | 0.80 | 3 | 30 | 1.20 |
| | Electricity | kWh | 89 | 444 | 17.76 | 141 | 705 | 28.20 |
| | Bags | item | 2,050 | 5,884 | 235.34 | 3,700 | 10,619 | 424.76 |
| | Transport | service unit | 10 | 4,000 | 160.00 | 10 | 6,000 | 2.40 |
| Marketing | Label | item | 4,100 | 12,850 | 514.00 | 7,400 | 23,150 | 926.00 |
| | Poster | item | 39 | 6,250 | 250.00 | 39 | 6,250 | 250.00 |
| | Flyer | item | 2,000 | 5,000 | 200.00 | 1,000 | 5,000 | 200.00 |
| TOTAL | | | | **38,498** | **1,539.90** | | **52,374** | **2,094.96** |

Source: Own representation

Thereby, the available market price (gross price) was determined whenever possible. For the seeds a symbolic price of 200 NIO that presents also the time to collect the seeds was used. One service unit of transportation was priced based on the estimation by the participatory workshop. The price of 400 NIO includes labor time, fuel and the wear of the motorbike. Furthermore, the calculation of electricity costs is based on 5 NIO per kWh. This value was used as the average electricity price in 2013 for isolated areas (to which Ometepe Island belongs to) according to INE (2014) is about 4.89962 NIO per kWh.

For the sales no further costs of production are included in this calculation as there are no direct costs for MLP. The overall costs of the sales point are represented by the sales provision which is included in the final sales price of the product.

According to the perennial nature of the crops the costs of production per unit of production are increasing in subsequent years e.g. costs associated with seedling are not recurring again.

#### 5.4.3.2 Investment goods

Also the investment goods were identified within the preceding parts of the VCA. The following table presents an overview of the investment goods for the study case including its monetary accounting.

**Table 22:** Investment goods

| VC Step | Investment good | Price per unit | | Useful life | Annual Depreciation | |
|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | [year] | [NIO] | [USD] |
| Input Supply | 1 ha land | 500,000 | 20,000.00 | n.a. | n.a. | n.a. |
| Production | 1 Fence | 2,500 | 100.00 | 2 | 1,250 | 50.00 |
| | 1 Horse | 5,000 | 200.00 | 5 | 1,000 | 40.00 |
| Processing | 1 Workshop | 500,000 | 20,000.00 | 20 | 25,000 | 1,000.00 |
| | 1 Water connection | 750 | 30.00 | 10 | 75 | 3.00 |
| | 1 Solar dryer | 10,000 | 400.00 | 5 | 2,000 | 80.00 |
| | 1 Mill | 7,500 | 300.00 | 5 | 1,500 | 60.00 |
| | Other Equipment | 6,250 | 250.00 | 5 | 1,250 | 50.00 |
| TOTAL | | **1,032,000** | **41,280.00** | | **32,075** | **1,283.00** |

Source: Own representation

According to the Law 822 the straight line depreciation method was applied to calculate the annual depreciation of the investment goods. Thereby the useful life was assumed as provided by the same law. Within the processing an additional category for other equipment is included to incorporate investment goods which are necessary for the processing, but were so far not specified (e.g. scale, plastic containers, working clothes, etc.).

Concluding, it has to be emphasized that this project (in the way it is planed) requires high investment costs, especially for the land and the workshop. In this study case the financing is possible due to the NGO involvement. Nevertheless, to increase the Moringa production in the study area the investment costs for the single actors have to be reduced or financial support should be given. Investment cost might be reduced when the processing agent for example increases its capacity and might thus cooperate with different production agents. Local farmers might than use their available land for the Moringa cultivation without the need of further financing.

#### 5.4.3.3 Labor time

The labor time as presented within the physically flow accounting is evaluated monetary by applying 20 NIO per hour for farming and processing activities, and 30 NIO per hour for the marketing activities (based on the discussion during the participatory workshop). The results are stated in the following table.

**Table 23:** Labor time

| VC Step | First Year | | | Second Year | | |
|---|---|---|---|---|---|---|
| | Labor time | Costs | | Labor time | Costs | |
| | [man-hour] | [NIO] | [USD] | [man-hour] | [NIO] | [USD] |
| **Production** | 573 | 11,460 | 458.40 | 774 | 15,480 | 619.20 |
| **Processing** | 638 | 12,760 | 510.40 | 1,127 | 22,540 | 901.60 |
| **Marketing** | 150 | 4,500 | 180.00 | 150 | 4,500 | 180.00 |
| **Total** | **1,361** | **28,720** | **1,148.80** | **2,051** | **42,520** | **1,700.80** |

Source: Own representation

#### 5.4.3.4 Sales price of the final product output

To perform the monetary flow accounting of the MLP VC, it is necessary to incorporate the market price for the outcome. However, a market price does not exist within the study area. Therefore, an assumed market price based on the following considerations will be applied. These considerations are separated for tourists and for local people.

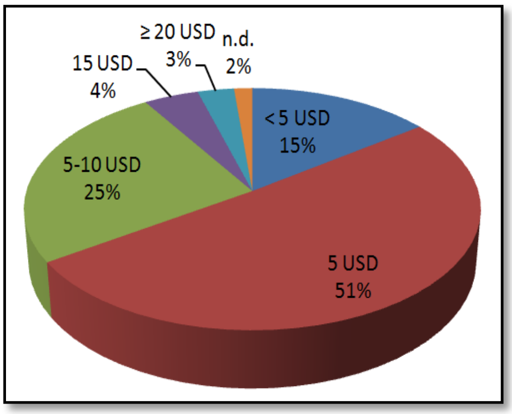
On internet it is possible to buy MLP in the USA for about 20 USD per 200 g and in Germany for about 20 EUR per 200 g. However, as there does not exist a local market for MLP in Nicaragua, there is no market price for MLP available that might be applied in this case study. Therefore, the 67 tourists that would (or probably or maybe would) buy MLP during their vacations on Ometepe Island, where asked how much they would spend for a 200 g package. The results are presented in Table 24 and Figure 19.

**Table 24:** Price that tourists would pay for 200 g MLP on Ometepe Island

| Price tourists would pay | Number of tourists |
|---|---|
| **< 5 USD** | 10 |
| **5 USD** | 34 |
| **5-10 USD** | 17 |
| **15 USD** | 3 |
| **≥ 20 USD** | 2 |
| **n.d.** | 1 |

Source: Own representation

**Figure 19:** Price that tourists would pay for 200 g MLP on Ometepe Island




Source: Own representation

Based on this analysis, a 200 g package of MLP would mostly be bought for 5 USD (125 NIO). However, it might also be sold for up to 10 USD (250 NIO) coming along with a lower number of products sold. For the purpose of introducing MLP 5 USD per 200 g package will be considered within ongoing calculations.

For local people it did not work to ask during the interviews for how much they would buy MLP; the answers were not appropriate for the purpose of this study. Thus, other information need to be considered to determine a market price for the introduction of MLP in the study area. First, to local people the product might definitely be sold cheaper, considering that sales could be performed directly by the producer or in a local store ("pulperia") as available in every community. Second, having a look on the market prices of the dietary supplements mostly sold in the local pharmacies might bring further input on determining a price for local people. Table 25 presents an overview of this analysis. Comparing the price per unit of nutrient does not make sense in this case as MLP cannot compete with those products on a specific nutrient basis, but when considering the complexity of nutrients provided.

This table shows that local people are paying between 1.50-7.00 NIO, presenting a weighted average of 3.00 NIO, for a daily dose of a dietary supplement. Considering now, that 200 g of MLP could be consumed within about 20 days (based on a considered daily intake of 10 g per day[21]) 1 bag of 200 g might be evaluated between 30 to 140 NIO, which is

[21] Even though, the recommended intake dose of MLP is about 10-30 g per day (see section 2.2), local people involved in the Balgüe Moringa Project all agreed that 10 g per day would be the maximum amount that local people would consume. Just in case people are suffering an illness, they might be willing to consume more. Thus, they recommend promoting a consumption of 10 g per day for dietary purposes.

equal to 1.2 to 5.6 USD. Assuming the weighted average of 3 NIO per daily dose a 200 g Package would cost 60 NIO (2.4 USD).

**Table 25:** Market price of local available dietary supplements

| Indicator / Product | Content | Price [NIO] | Daily dose | Price per day [NIO] |
|---|---|---|---|---|
| **IVK Vitamin C** | 1 pill | 1.50 | 1 pill | 1.50 |
| **Macro-vitamin** | 240 ml | 120 | 5 ml | 2.50 |
| **Nutrison** | 240 ml | 95 | 5 ml | 2.00 |
| **Intrafer TF 500** | 150 ml | 200 | 5 ml | 7.00 |
| **Forti-Ferro** | 240 ml | 98 | 5 ml | 2.00 |
| **Ferridoce 2** | 220 ml | 80 | 5 ml | 2.00 |
| **Cabalex** | 10 ml | 30 | 1 ml | 3.00 |
| **Fortiplex** | 10 ml | 30 | 2 ml | 6.00 |

Source: Own representation

However, it has to be considered that Ometepe Island presents one market for both local and foreign people. In the case that the market price of MLP for local people (labelled in Spanish) would be much lower than the final market price of the product for tourist (labelled in English), the further value added of the product for tourist would have its origin in the english label and the sales points specified on tourists and not in the production or processing. In this case, farmers would not benefit from the tourists willingness to pay a higher price for MLP than local people would do. The higher value added would than just benefit the sales points, which are often owned by foreigners. Thus, the final price of MLP for local people should be oriented first to the final price tourists would pay and reduced by the price of 0.25 USD (6 NIO) for label per package and the higher percentage of sales provision specified on tourist compared to the sales provision of local stores. Thereby it was not possible to statistically evaluate the sales provision within the study area during the fieldwork. Most of the interviewed sales points were not able to determine a sales provision for MLP as they do not know this product. However, within the interviews of sales points addressing tourist 25 % was mentioned and within the sales points addressing local people 10 % were mentioned. As these are the only available data, these data will be considered for the purpose of this study being aware that it might not be representative.

Following this argumentation it seems to be realistic to initially sale the MLP for tourists as per 5 USD (125 NIO) for a package of 200 g including 25 % of sales provision. Thus, the final product would be sold from the processor to the sales point as per 4 USD (100 NIO).

Considering the price of labelling a package of 0.25 USD (6 NIO), the package to local consumers might be sold to the local store for 3.75 USD (94 NIO). Adding a 10 % local sales provision, the final price for introducing of MLP to local people presents 4.10 USD (110 NIO). This value is still lower than the highest possible price when considering what local people currently do spend on dietary products. However, it is almost the double of the price resulting when assuming the weighted average that local people spend currently on dietary supplements. Anyways, these values present a recommendation by the author for the price of 200 g MLP for its introduction in the study area. If the price to local people would be lower, those actors selling MLP to tourist might simply buy the product aimed for local consumption and re-label the product in English if the producers is not willing to sale the product also cheaper to the sales point. Thereby, a higher sales provision would be earned by the sales point in any case and farmers would less benefit from the value tourist gave to MLP when willing to buy it for 5 USD per 200 g. Furthermore, if local people would not buy 200 g of MLP for 4.10 USD, the producer would first aim to sale the product to the tourist and just if the demand by the tourist is satisfied, they would produce for local people. This would limit the initial idea of introducing MLP in the study area to bring the health benefits to local people. However, the real situation on the market has finally to determine the market price.

#### 5.4.3.5 Value added

The VA is calculated as follows: VA = value of output – value of factors of production. As emphasised within the section 4 the VA in this study case is calculated for an overall VC level. Thereby the value of the output depends on the amount of product sold to tourist and the amount of products sold to local people as the value of these both products is different. Therefore the following calculation will account for three different scenarios:

- Scenario 1: 50 % of the produced products are sold to tourists and 50 % to locals
    - First year: 1,025 packages for tourists and 1,025 packages for locals,
    - Second year: 1,850 packages for tourists and 1,850 packages for locals);
- Scenario 2: 35 % of the produced products are sold to tourists and 65 % to locals
    - First year: 718 packages for tourists and 1,332 packages for locals,
    - Second year: 1,295 packages for tourists and 2,405 packages for locals;
- Scenario 3: 65 % of the produced products are sold to tourists and 35 % to locals
    - First year: 1,332 packages for tourists and 718 packages for locals,
    - Second year: 2,405 packages for tourists and 1,295 packages for locals.

The value of the factors of production is the same in each scenario as it does not depend on whether the client is a tourist or a local person.

**Table 26:** Value Added first year

| | | Scenario 1 | | Scenario 2 | | Scenario 2 | |
|---|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | [NIO] | [USD] | [NIO] | [USD] |
| Value of output | | | | | | | |
| MLP for tourists | + | 128,125 | 5,125.00 | 89,750 | 3,590.00 | 166,500 | 6,660.00 |
| MLP for local | | 105,063 | 4,202.50 | 136,530 | 5,461.20 | 73,595 | 2,943.80 |
| | = | 233,188 | 9,327.50 | 226,280 | 9,051.20 | 240,095 | 9,603.80 |
| Value of factors of production | – | 38,498 | 1,539.90 | 38,498 | 1,539.90 | 38,498 | 1,539.90 |
| **Value Added** | = | **194,690** | **7,787.60** | **187,782** | **7,511.30** | **201,597** | **8,063.90** |

Source: Own representation

**Table 27:** Value Added second year

| | | Scenario 1 | | Scenario 2 | | Scenario 2 | |
|---|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | [NIO] | [USD] | [NIO] | [USD] |
| Value of output | | | | | | | |
| MLP for tourists | + | 231,250 | 9,250.00 | 161,875 | 6,475.00 | 300,625 | 12,025.00 |
| MLP for local | | 189,625 | 7,585.00 | 246,513 | 9,860.50 | 132,738 | 5,309.50 |
| | = | 420,875 | 16,835.00 | 408,388 | 16,335.50 | 433,363 | 17,334.50 |
| Value of factors of production | – | 52,374 | 2,094.96 | 52,374 | 2,094.96 | 52,374 | 2,094.96 |
| **Value Added** | = | **368,501** | **14,740.04** | **356,014** | **14,240.54** | **380,989** | **15,239.54** |

Source: Own representation

### 5.4.3.6 Gross profit

The GP is calculated as follows: GP = VA – wages – interest charges – taxes.

Interest charges are not included in the GP calculation as the project is equity financed by an NGO. However, it has to be aware that for an extension of the project to other farmers, the GP and thus also the NP would be reduced considering interest charges.

The included taxes are based on the information gathered during the interviews at the city hall of Altagracia (see section 5.3). Thereby, it is taken into account that the agricultural sector is still informally organized within the study area. Thus, no business tax, IR and social insurance are considered to be due. The business taxes of the sales points are not included as they are not directly allocated to the sale of MLP. Concluding, the only tax that has to be considered is the annual tax on 1 ha land of 600 NIO.

**Table 28:** Gross profit first year

| | | Scenario 1 | | | Scenario 2 | | | Scenario 2 | |
|---|---|---|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | | [NIO] | [USD] | | [NIO] | [USD] |
| Value Added | | 194,690 | 7,787.60 | | 187,782 | 7,511.30 | | 201,597 | 8,063.90 |
| Wages | – | 28,720 | 1,148.80 | | 28,720 | 1,148.80 | | 28,720 | 1,148.80 |
| Taxes | – | 600 | 24.00 | | 600 | 24.00 | | 600 | 24.00 |
| Gross Profit | = | **165,370** | **6,614.80** | | **158,462** | **6,338.50** | | **172,277** | **6,891.10** |

Source: Own representation

**Table 29:** Gross profit second year

| | | Scenario 1 | | | Scenario 2 | | | Scenario 2 | |
|---|---|---|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | | [NIO] | [USD] | | [NIO] | [USD] |
| Value Added | | 368,501 | 14,740.04 | | 356,014 | 14,240.54 | | 380,989 | 15,239.54 |
| Wages | – | 42,520 | 1,700.80 | | 42,520 | 1,700.80 | | 42,520 | 1,700.80 |
| Taxes | – | 600 | 24.00 | | 600 | 24.00 | | 600 | 24.00 |
| Gross Profit | = | **325,381** | **13,015.24** | | **312,894** | **12,515.74** | | **337,869** | **13,514.74** |

Source: Own representation

#### 5.4.3.7 Net profit

The NP is calculated is follows: NP = Depreciation on investment goods.

**Table 30:** Net profit first year

| | | Scenario 1 | | | Scenario 2 | | | Scenario 2 | |
|---|---|---|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | | [NIO] | [USD] | | [NIO] | [USD] |
| Gross Profit | | 165,370 | 6,614.80 | | 158,462 | 6,338.50 | | 172,277 | 6,891.10 |
| Depreciation | – | 32,075 | 1,283.00 | | 32,075 | 1,283.00 | | 32,075 | 1,283.00 |
| Net Profit | = | **133,295** | **5,331.80** | | **126,387** | **5,055.50** | | **140,202** | **5,608.10** |

Source: Own representation

**Table 31:** Net profit second year

| | | Scenario 1 | | | Scenario 2 | | | Scenario 2 | |
|---|---|---|---|---|---|---|---|---|---|
| | | [NIO] | [USD] | | [NIO] | [USD] | | [NIO] | [USD] |
| Gross Profit | | 325,381 | 13,015.24 | | 312,894 | 12,515.74 | | 337,869 | 13,514.74 |
| Depreciation | – | 32,075 | 1,283.00 | | 32,075 | 1,283.00 | | 32,075 | 1,283.00 |
| Net Profit | = | **293,306** | **11,732.24** | | **280,819** | **11,232.74** | | **305,794** | **12,231.74** |

Source: Own representation

#### 5.4.3.8 Summary

To summarize the monetary flow accounting for the study case Table 32 (first year) and Table 33 (second year) presents an overview in form of a production-trading account on the consolidated VC level. Thereby it is assumed that all final products are sold within one accounting period. The presentation is limited on the currency USD for clarity reasons.

**Table 32:** Production-Trading Account first year

| Utilization | | | | Supply | | | |
|---|---|---|---|---|---|---|---|
| | Scenario 1 [USD] | Scenario 2 [USD] | Scenario 3 [USD] | | Scenario 1 [USD] | Scenario 2 [USD] | Scenario 3 [USD] |
| **Beginning stocks** | **0.00** | **0.00** | **0.00** | **End stocks** | **0.00** | **0.00** | **0.00** |
| **Factors of production** | **1,539.90** | **1,539.90** | **1,539.90** | **Sales** | | | |
| | | | | MLP for tourists | 5,125.00 | 3,590.00 | 6,660.00 |
| **Value added** | | | | MLP for locals | 4,202.50 | 5,461.20 | 2,943.80 |
| Wages | 1,148.80 | 1,148.80 | 1,148.80 | | 9,327.50 | 9,051.20 | 9,603.80 |
| Taxes | 24.00 | 24.00 | 24.00 | | | | |
| Depreciation | 1,283.00 | 1,283.00 | 1,283.00 | | | | |
| Net profit | 5,331.80 | 5,055.50 | 5,608.10 | | | | |
| | **7,787.60** | **7,511.30** | **8,063.90** | | | | |
| | | | | | | | |
| **Total Utilization** | **9,327.50** | **9,051.20** | **9,603.80** | **Total Supply** | **9,327.50** | **9,051.20** | **9,603.80** |

Source: Own representation based on FAO (2005b)

**Table 33:** Production-Trading Account second year

| Utilization | | | | Supply | | | |
|---|---|---|---|---|---|---|---|
| | Scenario 1 [USD] | Scenario 2 [USD] | Scenario 3 [USD] | | Scenario 1 [USD] | Scenario 2 [USD] | Scenario 3 [USD] |
| **Beginning stocks** | **0.00** | **0.00** | **0.00** | **End stocks** | **0.00** | **0.00** | **0.00** |
| **Factors of production** | **2,094.96** | **2,094.96** | **2,094.96** | **Sales** | | | |
| | | | | MLP for tourists | 9,250.00 | 6,475.00 | 12,025.00 |
| **Value added** | | | | MLP for locals | 7,585.00 | 9,860.50 | 5,309.50 |
| Wages | 1,700.80 | 1,700.80 | 1,700.80 | | 16,835.00 | 16,335.50 | 17,334.50 |
| Taxes | 24.00 | 24.00 | 24.00 | | | | |
| Depreciation | 1,283.00 | 1,283.00 | 1,283.00 | | | | |
| Net profit | 11,732.24 | 11,232.74 | 12,231.74 | | | | |
| | **14,740.04** | **14,240.54** | **15,239.54** | | | | |
| **Total Utilization** | **16,835.00** | **16,335.50** | **17,334.50** | **Total Supply** | **16,835.00** | **16,335.50** | **17,334.50** |

Source: Own representation based on FAO (2005b)

## 5.5 VCA: Sustainability considerations

The following exposition presents the verbal analysis on the sustainability of the introduction of Moringa as a food commodity as in the study case. The arguments are based on the preceding analysis. Thereby, positive arguments are introduced by the + symbol and negative once by the – symbol.

### Environmental aspects

+ The cultivation of Moringa offers the chance to improve existing agricultural practices towards agroecological practices in the study area. For example, the production of compost and the use of mulch could be promoted to close nutrient cycles. By this fertilizer input in general could be decreased. It further improves the soil quality.

+ The cultivation of Moringa as in the study case presents a low input cultivation. Synthetic fertilizer is not necessary and generally, manure as organic fertilizer is just required in the first year during seeding the plants. Also the use of pesticides is excluded and an irrigation system is not necessary.

- + Thus, MLP has the potential to become an organic certified product.
- + Furthermore, the promotion of polyculture cultivation in the study area brings environmental benefits such as weed suppression, reduction of insect damages by improving the balance of insect pests and associated natural enemies, better use of soil nutrients, erosion control, and water conservation.
- + The production of MLP as in the study case requires a very low electricity input. To produce one package of 200 g MLP 23 MWh of direct electricity input are necessary. Thereby, the energy supply on Ometepe Island will soon be based to 100 % on renewable energy. However, it does not include the electricity necessary to produce the investment goods and factors of production.
- + When tourist buy the product directly where it is grown and produced as in the study case, the environmental impact of consuming MLP in regions where it does not grow locally, is reduced by avoiding additional transportation.
- − However, the production of MLP produces waste which might not easily reuse or recycled considering that in the study area exist no adequate waste management system (see political aspects). Therefore, the local consummation of MLP would still imply waste output which would usually be burned. This presents an environmental and social (health) risk, which goes back on political issues.

**Socio-economic aspects**

- + Polyculture cultivation of Moringa allows the cultivation of other crops coming along with an income diversification. Thus farmers become more independent from the market of one crop. Also a higher income generation per ha is possible taken into account that Moringa could still be harvested within the dry season.
- + Moringa production implies job creation and a value added to local economy.
- + It further reduces the dependency on imported dietary supplements.
- + Moringa has the potential to respond on malnutrition in the study area.
- + The Moringa cultivation and consumption has the general potential to influence local eating patterns towards a more healthy way.

- + General knowledge and awareness rising about Moringa might also open other uses of Moringa bringing further socio-economic benefits e.g. the promotion of Moringa as forage for local feedstock.
- + The production of MLP is characterized by low input production and those by low production costs.
- − Nevertheless, it requires high investment costs that present a barrier to most of local people. NGO involvement might help to solve this problem.
- − Problems in the distribution of the VA along the VC are potential, leading to social inequity. Farmers might not contribute from the higher value tourist give to Moringa as they do not have direct sales access to this client group. However, this problem might be solve by creating direct sales channels from the farmers to the tourist; a target that should be followed up to support local agriculture.

**Political Aspects**

- − There exist no adequate health and quality standards valid on the Moringa production in the study area. Neither exist a system to control the compliance of regulations in the agricultural sector. Therefore, it is not ensured that the final MLP will have the properties as presented in section 2.2.
- − Neither exist an adequate waste management system in the study area, which requires further political intervention to reduce negative environmental and social impacts of the MLP production and the general economic development.
- − The high net profit as resulted in the study case is diluted according to the fact that the agricultural sector is still informal organized. With further development it is assumed that business taxes and IR as legally definite in Nicaragua will be due within this sector as well. Than the net profit would be less.

# 6 CONCLUSION AND RECOMMENDATION

Moringa presents a prospective commodity for organic food in the study area, which amongst others has the potential to respond on malnutrition (especially in the form of MLP) like locally presented in the study area. Even it might be thought that local people simple plant their own trees and consume the fresh leaves, it is more probably that they prefer to buy MLP as a dietary supplement at a short considering the local eating patterns. The consumption of fresh Moringa parts at a large would presume a change in culture specially according to agriculture and nutrition, coming along with a strong awareness rising. Furthermore, it is concluded that a sustainable development of the Moringa VC is possible. Negative aspects on the sustainability are related mainly to political issues, the relatively high investment costs, and the distribution of the VA within the VC. However, these problems might be solved and have to be addressed to support Moringa as a sustainable food commodity on Ometepe Island. Especially the NGO involvement, as NGOs are the main driver of the introduction of Moringa in the study area, should address these issues.

Taking into account the different Moringa production possibilities and the specific conditions on Ometepe Island, for the commercial MLP production it is recommended to apply and study a cultivating system without an additional water irrigation system, without the use of synthetic fertilizer and pesticides. Such a system would require soil preparation at the end of the dry season to support the seeding at the beginning of the rainy season. Considering a rainy season of six month it would be possible to cut the leaves for producing MLP four times in a the first year of cultivation and six times in the subsequent years. Based on an intercropping cultivation practice of Moringa with a spacing of 2 m by 3 m on 1 ha of land, 3,300 kg of fresh Moringa leaves could be harvested in the first year of production and 5,940 kg in the second year. By this a final MLP output of 410 kg in the first year could be realized and 740 kg in the second year.

Within the Moringa VC, the solar dryer presents a bottle neck, as it limits the production capacity. Under the current circumstances of the study area (especially taken into account the frequently lacks of electricity supply), it is not recommended to use mechanical drying methods. Thus, taking advance of the higher milling capacity or a general higher fresh biomass production presume the increase of the solar dryer capacity while attending to other factors like air temperature control and drying material protection for example.

Concluding the analyzed study case, it is recommended to use a price of 5 USD (125 NIO) for a 200 g package to tourists and 4.10 USD (110 NIO) for local people to introduce MLP in the study area. Practice will show which market price will finally be established. Thereby, the different valuations of MLP by locals and tourists, which are presented by the final amount both consumer groups are willing to pay, present a risk in the study area considering that the island presents one market addressing both consumer groups. To reduce the risk that the higher value of MLP for tourists results in higher gains just for the sales points, farmers should search for possibilities to direct sell their products (including MLP) to tourists

Furthermore, once the product is accepted by the local consumers, it is recommended to increase the size of one package for local people, to reduce the processing costs as well as the waste output. Increasing the package size for tourists does not make sense as tourist have to carry the product within their limited luggage.

Just by the polyculture Moringa cultivation on 1 ha land, a value between about 7,500 and 8,000 USD in the first year and between about 14,200 and 15,200 USD in the subsequent years could be added to local economy. Thereby a net profit of between about 5,050 and 5,600 USD in the first year and between about 11,200 and 12,200 USD in subsequent years could be realized. Nevertheless, it has to be emphasized that this net profit will be reduced by the interest charged in case that debt financing is necessary and by taxes once the agricultural sector gets formal organized in Nicaragua.

In general, the MLP production on Ometepe Island requires low production costs but relatively high investment costs mainly based on the value of land and the necessary processing workshop. However, there is also the potential to reduce investment once farmers use their own available land for cultivation purposes and if the processing workshop would be available for various cultivation agents. To organize processing for this purpose, a cooperation of farmers, as it is common within the study area for example for the production of coffee, might present a solution and should be analyzed. To further reduce investment cost for small-scale producers, a manual milling should also be considered, which further implies the elimination of energy input but an increase of labor time.

NGO involvement to introduce Moringa in the study case would encourage the development. The following tasks are recommended:

- Knowledge rising about Moringa,
- awareness rising on nutrition in general,

- further Marketing activities,
- including support to farmers to establish direct sales channels to tourists,
- supporting the finance of the investment,
- training on Moringa cultivation and processing,
- ensuring that adequate quality standards would be met during the MLP production,
- creating partnerships with local authorities to introduce health and quality standards; and
- promoting waste management solutions in the study area to reduce negative impacts of business activities in general.

Furthermore, the following research questions were identified by this investigation and should be followed up in general and also to establish a local Moringa market on Ometepe Island:

- Best agricultural practices of Moringa cultivation where no irrigation system is available and thus Moringa harvest is reduced to the dry season require further investigation. Adequate studies on biomass production with low plant density and limited cuttings during rainy season are not available, but have to be performed in the study area to better evaluated yield outcome.
- Comparing the costs and efficiency of different MLP processing techniques under equal conditions.
- Studying the performance of the solar drying process in the study area.
- Analyzing the nutrition deficits and the consumption of dietary supplements in the study area.
- Studying the effects of Moringa responding on malnutrition in the study area.
- Comparing the costs of nutrients provided by Moringa with those of other possible nutrient resources within the study area.
- Analyzing and understanding the eating culture in the study area would bring insights to the promotion of fresh Moringa products.

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# ANNEX 1: Nutrition requirements according to FAO and WHO

## Proteins (incl. amino acids)

**Table 1:** Safe level of protein intake for adult men and women > 18 years

| Weight [Kg] | Safe level of protein intake [g/day] |
|---|---|
| 40 | 33 |
| 45 | 37 |
| 50 | 42 |
| 55 | 46 |
| 60 | 50 |
| 65 | 54 |
| 70 | 58 |
| 75 | 62 |
| 80 | 66 |

Source: WHO, FAO and UNU (2007)

**Table 2:** Safe level of protein intake for infants, children and adolescent boys and girls

| Age [years] | Boys | | Girls | |
|---|---|---|---|---|
| | Weight [Kg] | Safe level of protein intake [g/day] | Weight [Kg] | Safe level of protein intake [g/day] |
| 0.5 | 7.8 | 10.2 | 7.2 | 9.4 |
| 1 | 10.2 | 11.6 | 9.5 | 10.8 |
| 1.5 | 11.5 | 11.8 | 10.8 | 11.1 |
| 2 | 12.3 | 11.9 | 11.8 | 11.4 |
| 3 | 14.6 | 13.1 | 14.1 | 12.7 |
| 4-6 | 19.7 | 17.1 | 18.6 | 16.2 |
| 7-10 | 28.1 | 25.9 | 28.5 | 26.2 |
| 11-14 | 45.0 | 40.5 | 46.1 | 41.0 |
| 15-18 | 66.5 | 57.9 | 56.4 | 47.4 |

Source: WHO, FAO and UNU (2007)

**Table 3:** Amino acid requirements of adults

| Amino acid | Requirements [mg/Kg per day] |
|---|---|
| Histidine | 10 |
| Isoleucine | 20 |
| Leucine | 39 |
| Lysine | 30 |
| Methionine | 10 |
| Cystine | 4 |
| Methionine + cysteine | 15 |
| Phenylalaline + tyrosine | 25 |
| Threonine | 15 |
| Tryptophan | 4 |
| Valine 26 | 26 |

Source: WHO, FAO and UNU (2007)

## Minerals

**Table 4:** Recommended mineral intake

| Group | Calcium [mg/day] | Selenium [µg/day] | Magnesium [mg/day] | Zinc[22] [mg/day] | Iron[23] [mg/day] | Iodine [µg/day] |
|---|---|---|---|---|---|---|
| **Infants** | | | | | | |
| 0-6 month (breastfed) | 300 | 6 | 26 | 1.1-6.6 | n.d.[24] | 90 |
| 7-12 month | 400 | 10 | 54 | 2.5-8.4 | 6.2-18.6 | 90 |
| **Children** | | | | | | |
| 1-3 years | 500 | 17 | 60 | 2.4-8.3 | 3.9-11.6 | 90 |
| 4-6 years | 600 | 22 | 76 | 2.9-9.6 | 4.2-12.6 | 90 |
| 7-9 years | 700 | 21 | 100 | 3.3-11.2 | 5.9-17.8 | 120 |
| **Adolescents** (10-18 years) | | | | | | |
| Females | 1,300 | 26 | 220 | 4.3-14.4 | 9.3-65.4 | 150 |
| Males | 1,300 | 32 | 230 | 5.1-17.1 | 9.7-37.6 | 150 |
| **Female Adults** | | | | | | |
| 19-50 years | 1,000 | 26 | 220 | 3.0-9.8 | 19.6-58.8 | 150 |
| 51-65 years | 1,300 | 26 | 220 | 3.0-9.8 | 7.5-22.6 | 150 |
| > 65 years | 1,300 | 25 | 190 | 4.2-14.0 | 7.5-22.6 | 150 |
| **Male Adults** | | | | | | |
| 19-65 years | 1,000 | 34 | 260 | 4.2-14.0 | 9.1-27.4 | 150 |
| > 65 years | 1,300 | 33 | 224 | 4.2-14.0 | 9.1-27.4 | 150 |

Source: Own representation based on FAO and WHO (2004)

[22] This value depends further on a person's specific diet, especially the composition of nutrients sources (animals versus plants). The bioavailability of zinc depends on these diet considerations (FAO and WHO, 2004).

[23] This value also depends further on a person's specific diet, which influences the iron absorption. Furthermore, for women it has to be considered that iron losses occur during menstrual blood losses (FAO and WHO, 2004).

[24] Neonatal iron stores are sufficient to meet the iron requirement for the first 6 months in full-term infants. Premature infants and low birth weight infants require additional iron (FAO and WHO, 2004).

**Vitamins**

**Table 5:** Recommended Vitamin intake

| Group | C [mg/day] | B1 [mg/day] | B2 [mg/day] | B3 [mg NE/day] | B5 [mg/day] | B6 [mg/day] |
|---|---|---|---|---|---|---|
| **Infants** | | | | | | |
| 0-6 month (breastfed) | 25 | 0.2 | 0.3 | 2 | 1.7 | 0.1 |
| 7-12 month | 30 | 0.3 | 0.4 | 4 | 1.8 | 0.3 |
| **Children** | | | | | | |
| 1-3 years | 30 | 0.5 | 0.5 | 6 | 2.0 | 0.5 |
| 4-6 years | 30 | 0.6 | 0.6 | 8 | 3.0 | 0.6 |
| 7-9 years | 35 | 0.9 | 0.9 | 12 | 4.0 | 1.0 |
| **Adolescents** | | | | | | |
| Females | 40 | 1.1 | 1.0 | 16 | 5.0 | 1.2 |
| Males | 40 | 1.2 | 1.3 | 16 | 5.0 | 1.3 |
| **Female Adults** | | | | | | |
| 19-50 years | 45 | 1.1 | 1.1 | 14 | 5.0 | 1.3 |
| 51-65 years | 45 | 1.1 | 1.1 | 14 | 5.0 | 1.3 |
| > 65 years | 45 | 1.1 | 1.1 | 14 | 5.0 | 1.5 |
| **Male Adults** | | | | | | |
| 19-65 years | 45 | 1.2 | 1.3 | 16 | 5.0 | 1.3-1.7 |
| > 65 years | 45 | 1.2 | 1.3 | 16 | 5.0 | 1.7 |

| Group | B9 [µg DFE/day] | B12 [µg/day] | A [µg RE/day] | D [µg/day] | E [mg α-TE/day] | K [µg/day] |
|---|---|---|---|---|---|---|
| **Infants** | | | | | | |
| 0-6 month (breastfed) | 80 | 0.4 | 375 | 5 | 2.7 | 5 |
| 7-12 month | 80 | 0.7 | 400 | 5 | 2.7 | 10 |
| **Children** | | | | | | |
| 1-3 years | 150 | 0.9 | 400 | 5 | 5.0 | 15 |
| 4-6 years | 200 | 1.2 | 450 | 5 | 5.0 | 20 |
| 7-9 years | 300 | 1.8 | 500 | 5 | 7.0 | 25 |
| **Adolescents** | | | | | | |
| Females | 400 | 2.4 | 600 | 5 | 7.5 | 35-55 |
| Males | 400 | 2.4 | 600 | 5 | 10.0 | 35-55 |
| **Female Adults** | | | | | | |
| 19-50 years | 400 | 2.4 | 500 | 5 | 7.5 | 55 |
| 51-65 years | 400 | 2.4 | 500 | 10 | 7.5 | 55 |
| > 65 years | 400 | 2.4 | 600 | 15 | 7.5 | 55 |
| **Male Adults** | | | | | | |
| 19-65 years | 400 | 2.4 | 600 | 5-10 | 10.0 | 65 |
| > 65 years | 400 | 2.4 | 600 | 5 | 10.0 | 65 |

Source: Own representation based on FAO and WHO (2004)

## ANNEX 2: Guiding questionnaire for interviews with local people

1.) Lugar *(place):* ________________ 2.) Fecha *(Date)*: ________________________

3.) Edad *(Age)*: ________________ 4.) Sexo *(Sex)* ________________________

5.) Profesión *(Profession)*: ________________

6.) Usted conoce el Marango? (*Do you know Moringa?)*

7.) ¿Qué sabe del Marango? *(What do you know about Moringa?)*

8.) ¿Cómo supo del Marango? *(How did you learn about Moringa?)*

9.) ¿Consume el Marango? *(Do you consume Moringa?)*

10.) ¿Cómo, en cual ocasiones y cuantas veces lo consume? *(How, when and how often do you consume it?)*

11.) ¿Tiene propio palo o acceso a otro palo? *(Do you have a Moringa tree or at least access to any tree?)*

12.) ¿Cómo llego este propio palo a su tierra? *(Where did you get this tree from?)*

13.) ¿Hacen remedios caseros en la casa? *(Do you generally prepare home remedies?)*

14.) ¿Compran algunas plantas para hacer remedios caseros? *(Do you buy the plants to prepare home remedies or where do you get them from?)*

15.) ¿Toman a veces un complementario nutritivo? ¿Cuál? ¿Por qué? ¿Cuántas veces? *(Do you sometimes take a dietary supplement? Which one? Why? How often?)*

**¡Gracias por participar!** *(Thanks for participating!)*

## ANNEX 3: Guiding questionnaire for interviews with tourists

### A – Questionnaire

1.) Interview Location: ______________________ 2.) Date: ______________________

3.) Nationality: ______________________ 4.) Age: ______________________

5.) Profession: ______________________ 6.) Sex ______________________

7.) Reason for your stay in Nicaragua:

8.) Duration of your stay:

9.) For how long are you traveling totally?

10.) Do you know about Moringa? ▢YES ▢ NO

*If your answer is **YES**, please go on with questions 11 to 21 (part B).*

*If your answer is **NO**, please go on reading the short information about Moringa (part C) and then answer questions 22 to* 30 (part D).

**B – Questionnaire if Answer on 10 is Yes**

11.) How did you learn about Moringa?

12.) Do you consume Moringa? ▢ YES ▢ NO

13.) Why do you consume Moringa or why do you not consume it?

*If your answer is* ***NO****, please go on with question* **17**.

14.) How often and in which form (capsules, powder, tea, etc.) do you consume it?

15.) Where do you buy your Moringa products?

16.) How much do you spent on Moringa products?

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**17.)** Would you buy it here during your vacations in Nicaragua? Why or Why not?

18.) How much would you spent for it?

19.) Do you generally buy local product to take back home with you?

20.) Which kind of local products do you buy here in Nicaragua?

21.) Where do you usually buy them?

22.) How much money do you spent on local products from Nicaragua to bring back home?

23.) Any recommendations how to promote the sale of local Moringa products?

**Thank you for your support!!!**

## C – Short information about Moringa

Moringa (also known as Marango, drumstick tree, horseradish tree, ben oil tree and others) is a highly valued, fast-growing, medium sized and drought-resistant tree widely cultivated and naturalized in tropics and subtropical regions of the world. Its cultivation comes along with economic, social and environmental benefits for local communities and is therefore promoted by various NGOs, acting around the tropical belt, and also on Ometepe Island.


Source: Planeta Homa, 2011

Source: DeLange, 2005

Recently the plant has gained much global importance due to its multiple use and benefits. All the parts of Moringa could be used for various purposes e.g. such as fertilizer, animal feed stock, dietary supplement, medicine, biodiesel feed stock, and for water purification; making it a very valued plant for human beings. Amongst others Moringa is considered to be an important food commodity which has enormous attention as the 'natural nutrition of the tropics'. The leaves, fruit, flowers and immature pods of this tree are used as a highly nutritive vegetable (with further medical properties) in many countries. The leaves for example have been reported to be a rich source of β-carotene (vitamin A), vitamin C, proteins, calcium, potassium iron and magnesium as well as to act as a good source of natural antioxidants.

In industrialized countries Moringa is nowadays sold as dietary supplement in form of dried leaf powder, capsules, tea and others. In the USA 400 g of Moringa leaf powder is sold for about 40 USD and in Germany 150 g for about 20 EUR. The powder could be added to drinks, soups, salads or any other food to enrich the nutrition value of the dish or drink.

**D – Questionnaire if Answer on 10 is No**

24.) Would you now be interested in buying Moringa products?

25.) Would you buy it here during your vacations in Nicaragua? Why or Why not?

26.) Where in Nicaragua would you buy it (e.g. hostel, local store, souvenir shop)?

27.) How much would you spent for it?

28.) Do you generally buy local product to take back home with you?

29.) Which kind of local products do you usually buy?

30.) Where do you usually buy them?

31.) How much money do you spent on local products to bring back home?

32.) Any recommendations how to promote the sale of local Moringa products?

**Thank you for your support!!!**