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**APPROACH OF THE SYSTEMIC  
DESIGN IN MATERIAL AND  
INTANGIBLE CULTURE OF  
*ESTRADA REAL*:  
Territorial Serro Case**

candidate: **Kátia Andréa CARVALHAES PÊGO**







PhD IN  
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UEMG - FAPEMIG



**Kátia Andréa CARVALHAES PÊGO**

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Advisor: professor architect Luigi BISTAGNINO

Keywords: Systemic Design; Material and Immaterial Culture; Crafts.

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*To the future.*



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This study aimed to apply the Systemic Design methodology in the context of the *Estrada Real* (Royal Road), specifically in Serro Territory, in order to generate a new economic and development model in this location, by creating relationships between their production systems. The first step of the methodology involved the understanding the territory in all its amplitude, *i.e.*, the history of the place, its physical and climatic aspects, its natural resources, its activities (social, cultural and productive), the way and the pace of life community, as well as its infrastructure. The second phase encompassed the systematization and analysis of existing artisanal production systems in Serro Territory. For such a field survey was conducted in which the artisans were interviewed and the production sites were visited. On this occasion, we investigated all output and input of their activities. In the third step of the methodology were designed the matter and energy flows of the nine production systems in question, from the analysis of the “negative points” that emerged in the previous step, as well as the characteristics and potential of the material and immaterial local resources. This process allowed the emergence of several new activities and new products. In the fourth and last step, the current system (existing) and the systemic system (proposed) were compared. Such confrontation demonstrated that, with the approach of Systemic Design the same territory would come to get, on average, an increase of 530% of products and 820% of activity, resulting therefore in a huge business volume. As envisioned results are highlighted: i) in the economic field: expansion of activities; increase in jobs; increase income generation in the community; ii) in the environmental sphere: sustainable management of natural resources; iii) in the cultural field: appreciation of culture; enhancement of local know-how; iv) in the social sector: improving quality of life; keeps its inhabitants in their territory.

**Keywords:** Systemic Design; Material and Immaterial Culture; Crafts.



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# 1 introduction

Lately we are living in a time marked by economic, social and environmental crises. These certainly are consequences of our current model of production and consumption, which have been developing since the Industrial Revolution.

However, in fact, all these crises are generated by only one: the crisis of values. The value of our contemporary society is connected to the consumption, possession of objects, “to have” rather than “to be”. Medium and large industries are linked to quantitative values, *i.e.*, an increasingly and standardized production, with the lowest possible cost, regardless of the place of extraction of raw materials, the place and the conditions of work of manpower, the place of sale as well as the exorbitant amount of waste produced during and after the processes. As reminded by Bistagnino (2011), only 60 to 80% of the features that enter in production process are transformed into product, the remainder (20 to 40%) is comprised of waste and atmospheric emissions. In this globalized context the advertisement goes, guarded rare and heroic exceptions, the same line of reasoning in all the villages. It acts as a catalyst of these values, creating and selling needs solutions to the problems created by the model itself, as well as irrelevant or even nonexistent problems.

In this scenario, we \_ designers \_ must consider whether we want to continue to design forms for some (we call all), helping to maintain the current situation, or if we want to project for society in order to solve real problems, looking for to satisfy consumers in a true way. This research is for those professionals who are in the second case, and aims to present a true and proper paradigm break in the act of designing.

Obviously, we cannot solve the problems with old solutions, based on the linear approach, demonstrably bankrupt. The proposal then is to promote a new economic model, in which it is possible to develop both the industry and society. This is a new approach, which considers the application of natural mechanisms in the productive sector, called Methodology of Systemic Design.

The application of this methodology aims to develop the sustainable artifacts, healthy people and balanced environment, from changing the focus on the product to the focus on the process. To this end, we start from a simple principle: the output (disposal) of a system must become input (resources) to the other (s) system (s), in a systematic and continuous way, tending therefore the zero emission and zero discharge. Our ambition is to imitate nature, pointing out that it does not produce wastes, because these are always capitalized on another system (the five kingdoms: plants, fungi, animals, and protist monera). In this context, all materials have the same value, all systems are important and strongly interrelated, as well as a network: is the set of all nodes that lives its strength and effectiveness.

In this approach we do not limit ourselves to design a product or a line of them, quite the opposite, the product is simply a consequence of the process and have a specific reason for existing, completely contextualized. During the application of Systemic Design, above all, we designed relations, mainly in the same territory. As a result, a new economic and productive model is generated, able to be sustained for long periods of time.

For this purpose, the methodology of Systemic Design is divided into four stages, namely: 1) Understanding the territory - contextualizes the object in the territory and the production system in question: holistic relief; 2) systematization and analysis of existing production systems in the territory - investigates all input and output of activities (production systems) of the site; 3) Project matter and energy flows of production systems of the territory \_ establishing a network of relations between them; 4) Confrontation - confronts the current approach (existing) with systemic (proposal). Usually this process leads to an exponential increase in the production capacity of the territory in a matter and, therefore, the provision of jobs for local people, bringing a perspective of efficient, sustainable and durable scenarios. This methodology can be applied in various productive sectors, such as manufacturing, food supplies, services and crafts.

The object of this present study is the craftsmanship. The territory in a matter is located in *Estrada Real* (Royal Road) - Minas Gerais - Brazil, called Serro territory. The goal is to apply the methodology of Systemic Design in this context, generating multiple connections between their production systems, through the recognition of cultural values (tangible and intangible) of local traditional crafts.

Based on the construction of holistic relief of Serro territory and in the conducting field research, it was possible to understand how the current production system works. We note that, due to unawareness of the characteristics of local natural resources, the craftsmen exploit very few of their potential, generating a narrow production as well as their financial return. This situation creates a serious problem: the “death” of craftsmanship in the region because, according to the artisans, young people have no interest in giving continuity to this activity, as it does not offer enough financial return, causing the migration of them to major urban centers, generating another series of problems well known by all of us.

From the analysis of this context and in-depth studies on the intrinsic characteristics of natural resources and local know-how, we designed matter and energy flows between the existing production systems, and suggested several new activities and products. Confronting the current approach and the systemic proposal, we can say that the result was very positive and particularly surprising. The study examined nine activities, which give rise 32 products. With the approach of Systemic Design the same territory come to get, on average, an increase of 530% in products and 820% in activities, re-

sulting therefore in a huge business volume, in sustainable management of natural resources, the valuation of tangible and intangible culture sites, in improving the quality of life and the maintenance of the population in its territory.

The organization of this work was structured in seven chapters. In chapter 2 (Literature Review) we approached the material and immaterial culture, explained what we had considered as a territory and crafts, and elucidated the difference between the linear approach (current) and systemic. The goal was outlined in Chapter 3 (Objective). In Chapter 4 (Methodology) are presented holistic relief of Serro, the selection of the territory, the field research, and the nine current production systems. In chapter 5 (Results and Discussion) are found the projects of flows of matter and energy of all systems, beyond the confrontation between the current approach and the systemic proposal. Chapter 6 (Conclusions) recapitulates the outlines of the developed work, discusses the results achieved according to the established objective and presents the concluding remarks of the research.



## 2 literature review

## 2.1 Culture Material and Immaterial

One can imagine that the concepts of “culture”, “material culture” and “immaterial culture” are obvious and, therefore, it is unnecessary to give them an explicit definition. Although its global meaning is clear, the extent of these concepts is often inaccurate and simultaneously is far from offering precise and unique limits.

Therefore, it is necessary to clarify, initially, what is culture in its widest sense, since this is one of the main concepts inside the study of the humanities, at point of anthropology to constitute itself as science almost exclusively around the same. Indeed, since the nineteenth century, anthropologists try to determine the limits of their science by defining culture. The result is that the concepts of culture are multiple and sometimes contradictory (SILVA; SILVA, 2005).

Such a variety of interpretations and theories about what would be culture is directly linked to the historical process of anthropology identification itself as a social science, concomitantly with the definition of the concept of man, which is the smallest unit within the composition of all other cultural segments.

In the late eighteenth and early nineteenth century there was wide use of the German word *Kultur* when referring to the set of spiritual values of a people or nation. Parallel “civilization” was a French term which transmitted the idea of the structural development of a nation. Edward Tylor (1832-1917), British anthropologist, synthesized the two expressions in the English term “culture” and coined the concept of culture: “[...] is that complex whole which includes knowledge, belief, art, morality, law, customs and all other habits and skills acquired by man as a member of society” (TYLOR *apud* LARAIA, 2008, p. 25). He also emphasized learning in his definition of culture, believing that man receives knowledge and experience accumulated over the generations that preceded him, and if this information was appropriate and creatively manipulated, will enable innovations and inventions. So, these are not the result of isolated action of a “genius”, but the effort of the whole community. Culture is a cumulative process then.

According to Claude Levi-Strauss (1908-2009), French anthropologist, every culture can be considered as a set of symbolic systems. In the foreground of these systems pose to language, matrimonial rules, economic relations, art, science, religion. All of these systems look for express certain aspects of physical reality and social reality, and even more, the relationships that these two types of reality establish among themselves, and that the very symbolic systems establish with each other (LÉVI-STRAUSS, 1950 *apud* CUCHE, 1999).

In the same line of thought, Clifford Geertz (1926-2006), an American anthropologist, defended the concept of culture as essentially semiotic. The author conceived culture as a “web of meanings” that man weaves around himself and ties him (GEERTZ, 1989).

According to Kuper (1999), there are at least three points of consensus among anthropologists about the cultural problems. Firstly, the cultures are not results of capacities neither attributes that were biologically inherited, but they are conventions socially transmitted. Second, they are dynamic and changeable, that is nothing that looks like an always equal “chest of traditions”. The third is that culture refers to ideas and values, whether as knowledge systems, whether as meanings associated with activities or material objects.

But not every definition of culture comes from anthropology. The Brazilian scholar Alfredo Bosi, for example, defines culture from Linguistics and Etymology of the word: “culture” as well as “cult” and “colonization”, would come from the Latin verb *colo*, that means “I occupy the land”. Culture, therefore, would be the future of such a verb, meaning “what will be work”, “what you want to cultivate”, not only in terms of agriculture, but also the transmission of values and knowledge to the next generations. The author then asserts that culture is the set of practices, techniques, symbols and values that must be transmitted to future generations to ensure social coexistence (BOSI, 1992).

This set of certain characteristics (practices, techniques, symbols and values) is called identity. Therefore, when searching to interpret knowledge and techniques to making of a handmade product, for example, it is necessary to situate it in a repertoire of cultural expressions that reference the identity constitution of the social group in question. It takes it as a practice rooted in human relationships that were forged in a specific historical process, identifiable and interpretable, and that is still in the process of cultural construction, even if marked by a traditional reproduction in its slow process of changes and adaptations (MENESES, 2009). According to Corá (2013), identity is recreated at all times, both in the individual’s perspective, as the local or global perspective, it is a reflection of its own sense of cultural belonging.

In this context, the aspects that comprise the traditions, expressions of life and their relationship with the environment, produce the unique identity of communities, groups and individuals in all parts of the world, tell their story and reinforce citizenship.

Nevertheless, Silva and Silva (2005) argues that to existing culture is necessary that before there is a collective consciousness that, from everyday life, can draw up plans for the future of the community. This definition gives culture a very close meaning of the act of educating. From this perspective, culture is what a nation teaches to its offspring to ensure its survival. This set of knowledge, legacy of ancestors and passed on to descendants, produce tangible (material) and intangible (immaterial) assets.

However, in the search for understanding the traditional know-how, there is no way to separate the material and the immaterial, even if

they are distinguished from each other. The place and the value of the tools and knowledge, the raw materials and techniques, product and their meanings, form a complex unity (MENESES, 2009).

According to Bucaille and Pesez (1989), the specific term “material culture” is just a very restrictive formulation of the many aspects that make up this notion and does not cover its entirety: the material culture consists in part, but not only, by material forms of culture, because things and objects of human account cannot be dissociated from the lived realities. According to the authors, material culture can be defined, first of all, as the mainstream culture, *i.e.*, one that concerns the immense numerical majority of the community. It is possible, of course, to make subdivisions within that majority and distinguish, for example, social class, rural and urban groups, *etc.*, but this is not essential: the material culture, the collective culture, opposed primarily to individuality. So we could never talk about the material culture of this or that specific and isolated individual: culture is always shared with other individuals, usually numerous.

Bucaille and Pesez (1989) make clear that the study of material culture: i) privileges the masses to the detriment of individualities and the elites; ii) is dedicated to repeated facts, not to a event; iii) does not deal with superstructures, but infrastructure. Such study should know that the object has more than one meaning. A vase, for example, not only expresses a technique or function; by its form, its eventual decoration also corresponds to options that are also from supra-structural order; it can, after all, have a social meaning simultaneously witnessing an economic system. Even if just the technique and function are of immediate understanding and relatively evident, it is necessary do not forget the other meanings that the object contains.

One of the most important theorists of the history of material culture, Jerzy Kulczycki (1898-1974), indicated as its specific subjects: 1) the means of production extracted from nature (materials and natural energy) from the standpoint of their choice and use, and the natural conditions of life and the changes inflicted by man on the natural environment; 2) the forces of production, *i.e.*, working instruments or human means of production, as the man himself, his experience and the technical organization of man at work; 3) the material products obtained from such means and these forces, *i.e.*, the production instruments as manufactured objects and products for consumption. This line of reasoning leads us to observe that the material culture arises either “upstream” or the “downstream” of the production process (BUCAILLE; PESEZ, 1989).

According to Lima (2011), as well as language, culture material is a structured system of signs, so that it can be regarded as a text. In this textual analogy, the material texts should be read, unraveled their syntax, being implied the fact that people read them differently, such that material culture is open to multiple interpretation.



Through material speeches, a people talk quietly about itself, about its world view, about what cannot or should not be said verbally, and therein lives its strength. What is informed by the senses, including the material universe, it becomes an experience of consciousness. Perceptions and sensations shape the way how people feel the world, through practical experience, daily, individual. It is through the body (place of experience) and their sensory perceptions that we see and we are in the world. Our relationship with the materiality passes, necessarily, by these perceptions and sensations, so that not only the shape but also other sensory attributes such as color, texture, sound, taste and smell, need to be examined.

Accordance with Tilley (2006), the material forms not simply reflect social distinctions, ideas or symbolic systems. Rather, they are an effective means whereby these values, ideas, and social distinctions are constantly reproduced and legitimized, or transformed, so that a whole web of social relations settles from the material culture. Corá (2013) also believes that all cultural production can be explained by social relations, noting that his redesign is continuous.

To Lima (2011) there is no doubt that the material culture is a social construction, but based on the physical properties of materials, from the complex web of possibilities that these properties offer the human creativity, which appropriates them for the allocation of all sorts of meanings that change over the life history of objects, since they are not static. According to the author, the material culture is produced to play an active role, it is used to assert identities, to promote social change, mark social differences, negotiating positions, mark social boundaries and so on. There is no way to reverse this condition, which makes the material culture, in fact, the actual dimension of social relations.

The historic field called “History of Material Culture” also offers us an interesting approach. According to the historian José D’Assunção Barros<sup>1</sup>, this can be defined as the historical field that primarily studies the material objects in their interaction with the more concrete aspects of human life, unfolding in historical areas ranging from utensils study to feeding study, clothing, housing and material conditions of human labor. The fundamental notion that crosses this field is the “material” (or “material object”, which may either be durable type, such as in the case of monuments and utensils, such as perishable type, as in the case of food). However, this field should not examine the material object taken by itself, but its uses, its social appropriation, the techniques involved in handling, its economic importance and its social and cultural needs. After all, the notion of “culture” does not fail to go through this field.

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<sup>1</sup> Available in: <[http://www.uss.br/pages/revistas/revista\\_marica/patrimoniuss2010/pdf/artigo1](http://www.uss.br/pages/revistas/revista_marica/patrimoniuss2010/pdf/artigo1)>. Accessed in: Mar. 22. 2015.

From this perspective, an object of material culture is in fact the materialization of a series of social, political, cultural, economic and technological processes.

On the other hand, although the term “immaterial culture” suppose a contraposition to the aforementioned material culture, is an artifice that we use in order to better understand its articulation with the immateriality of social memory (MORIGI; ROCHA; SEMEN-SATTO, 2012).

The intangible culture refers to that knowledge which was not taught through books, formal records or systematic teaching, but on the knowledge imparted in practice, orally or through gestures, from generation to generation. This relates to the knowledge, skills, beliefs, practices, the way of life of people<sup>2</sup>.

According to the Institute of Historical and Artistic National Heritage (IPHAN<sup>3</sup>), the cultural assets of intangible nature relate to: i) those practices and domains of social life that are manifested in knowledge, crafts and ways of doing; ii) celebrations; iii) forms of scenic, visual, musical or recreational expression; iv) and places (such as markets, fairs and shrines that are home to collective cultural practices). The intangible cultural heritage is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, creating a sense of identity and continuity, helping to promote respect for cultural diversity and human creativity.

To Corá (2013), tradition and knowledge transference are key factors to the continuity of intangible culture, and the construction of a group identity, people or nation. According to the author, so that it is preserved, it is necessary to stimulate the holders of knowledge to transmit it to new generations, who appropriate this “knowing” to ensure the continuity of cultural practice. According to Gorz (2005), knowledge is, above all, a practical ability, a skill that does not necessarily imply knowledge that could be formalized and codified.

The transmission of knowledge in the family context is of utmost importance for the continuity of cultural practice, because the popular culture takes place in the daily lives of people who are now in possession of the cultural property. It can happen at schools, at homes, at shops or in activities for children, such as encouraging the “junior” demonstrations. In this sense, developing studies that seek to meet the “masters” or people responsible, either officially or unofficially, to pass the knowledge, habits, traditions to new generations can help to understand how this knowledge resisted the new generations as well, how they were being modified by them (CORÁ, 2013).

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2 Available in: <<http://www.brasil.gov.br/cultura/2009/10/material-e-imaterial>>. Accessed in: Mar. 29. 2015.

3 Available in: <<http://www.portal.iphan.gov.br>>. Accessed in: Mar. 29. 2015.

According to Costa and Castro (2008), loaded with memories, elders can express in their speeches, in their work, in their tales, in their stories and in their wisdom, the changes that have occurred, highlighting their implications in these everyday communities, which may be useful in understanding what is “common” in the past and in the gift set. On the other hand, it is also important to know what they think learners, those who are learning the ways of doing, learn and live in the community. An approximation to this group can lead us to know the ways of appropriation of knowledge, as well as the meaning of learning for the “young” future guardians of this knowledge. As well remembers Castro (2005), “The conversation enables the shared exchange, meeting with existing memories and mainly produces an effect of preservation and conservation of memories” (CASTRO, 2005, p. 207).

Therefore, in this study, culture is seen as a set of symbolic systems which comprises the traditions and their relations with the community and the environment, transmitted generation to generation, resulting in tangible (material) and intangible (immaterial) assets. Material culture is regarded as the concrete result of cultural expressions, represented by artifacts produced in a territory. Already immaterial culture is weighted as that knowledge which is transmitted in a practical way, not systematic, strictly related to the know-how of a people

## 2.2 Territory

Initially, Geography and Geopolitics were the first science to work the land issue and the concept of territory. However, more recently, other humanities and social sciences started to use this approach, especially in Economics, Sociology and Anthropology, all in order to understand their objects of analysis and research in a particular social area (AGUIAR *et al.*, 2009).

In each socio-spatial formation of the territory assumes different meanings. In the Western world, the concept of territory was first associated with the physical basis of states, including soil, airspace and territorial waters. On the other hand, in indigenous societies, for example, the key is the sense of identity with the Mother Earth, based on knowledge, cultural heritage and social and religious relations that these people have with that territorial area (ALBAGLI, 2004). The land can then be understood in various ways, sometimes not mutually exclusive. There are then approaches that complement each other and are multidimensional (SAQUET, 2007).

As pointed Dematteis (1996), in the territory are added concomitantly materiality and immaterialities, in time and space. The territory means (im) materiality; is not only substrate (stage) or spatial forms, not just social relations. Even the social relations have a (im) materiality; they are objective and subjective at the same time; they are plural and coexisting, change and remain in everyday life. There is, then, a concrete-abstract unity **in the** and **of the** territory that needs to be abstracted. The author understands the territory connected to the what he call as *material shaped space-environment* by political and the market forces, and not as two separate instances at different levels. According to the same, there is no territory without a web of social relations. In his conception of geography, space and territory they are not separate. Territory means identity, understood here as a product of reciprocal interactions within relationships that occur between the society and nature.

According to Saquet (2007), the territory is a living space, objectively and subjectively; it means ground, space forms, social relations, outside of man nature; they are works and content; it is a product and condition of historical actions and multi-scalar, with several disparities, differences, rhythms and identity (s). The territory is procedural and relational, (im) material.

The concept of territory, according to Bagnasco (1984), is beyond area with spatial forms, connection, articulation, product and condition of socio-spatial dynamics. Raffestin (1981) follows the same line of reasoning in stating that the territory is “a field of forces, a web or network of social relations” which project into space. Albagli (2004) corroborates these two authors, and adds that it is exactly this field of forces that produces singularities.

Carmo and Comitre (2010) argue that the territory's vision is not static, it is both the everyday act expressed by the hegemonic and conflicting relationships of the past. In this sense, the territory's vision includes the perspective of the complex reality in constant transformation, mirror of environmental, economic, social and cultural dynamics of the local context.

In this context, Krucken (2009) reminds us that the territory term, resulting from the French origin word *terroir*, means a territory characterized by interaction with the man over the years, becoming then, in a system of interactions of the natural, physical and biological environment with the human factors.

The effectiveness of a territory, according to Saquet (2003), occurs from the reciprocity of the relationship between economic, political and cultural forces in and with the geographical space. According to the author, the territory is socially constructed, results and condition

of the territorial process<sup>4</sup>; it is the product of the process of appropriation and social field daily. Already Albagli (2004) emphasizes the importance of the actors in this process. According to her, the establishment of a territory derives from the intervention and work of one or more players on a given space.

Paula (2004) clarifies that when a territory is established by endogenous action, your drawing is defined by identity elements chosen by local actors, *i.e.* the own territory in an autonomous relationship and, most often, democratic. This applies to the territorial divisions built “bottom-up” in a participative way. In these circumstances, it is a territorial self-establishment process; it is the local population (the active subject) that draws the territory from the recognition of their identities. The formation of these identities occurs then from the social interaction based on local historical and cultural relations.

From the symbolic point of view, the territory is as support as product of the formation of individual and collective identities, arousing feelings of belonging and specificity. Social representations, images, symbols and myths are projected and are materialized in space, turning into geographic symbols, providing common references and models to social actors and crystallizing a territorial identity (ALBAGLI, 2004).

In this context, Santos (2001) draws a strong correlation between identity and territory. For the author, “The territory is not only the result of the superposition of a set of systems of things created by man. The territory is the ground and over the population, that is, an identity, the fact and the feeling of belonging to what belong to us. The territory is the basis of work, residence, material and spiritual exchanges and the life, on which it influences” (SANTOS, 2001, p. 96).

Besides the actors, relations and the question of identity, Sénécal (1992) emphasizes the importance of culture in this context. For the author, the cultural dimension acts as “an invisible thread that binds individuals to space”. Carmo and Comitre (2010) also go in this direction to argue that the territory is inhabited space with social relations and cultural heritages. In this perspective, the concept of territory is able to broaden the understanding and the possibilities of intervention aiming to chart a new reality of social conformations and environmentally more appropriate to the local potential locations. In this case, the notion of territory is built in parallel and as a counterpoint to globalization, because it recognizes, it gives visibility, emphasizes and values the local and regional specificities in the face of the unifying idea of “think global”. The territory is then the social space in which

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4 The territoriality are forms of coexistence and regulation created from own territory, and remain on site (SANTOS, 2001). It is a triangular relationship between social actors mediated by space, built from interaction processes in the territory over historical time. “At the collective level, territoriality also becomes a means to regulate social interactions and strengthen the identity of the group or community” (ALBAGLI, 2004, p. 28).

the actors have greater commitment to the real and true connections with nature and with the space in which they live.

However, it is important to point out that globalization also produces positive effects. The sociologist Otavio Ianni (1926-2004), for example, noted that the irreversible process of globalization is producing a seemingly paradoxical phenomenon: appreciation of the local culture (GIANNI, 2004). Albagli (2004) corroborates this view, because for her the winds of globalization and transformation of technical and production base brought, on the other hand, the revaluation of the territory, and gave to the territoriality the factors of dynamism, differentiation and competitiveness.

However, the inability to realize the benefits of the plurality of development models, beyond thought economic growth, hindered the emergence of a thinking and acting locally on territorial bases. Thus, to make possible sustainable development at the local level, are necessary to preserve the cultural identities of local populations and environmental diversity (COMITRE; CARMO, 2010).

To Velloso (2008), the key points for the development of the area are the construction and strengthening of social networks, social capital and territory resources, and the establishment of strategies. Paula (2004) states that “nets” refer to non-vertical and non-centralized organizations, in which there is not a command center, but on the contrary, each participant core is independent and able to take its own initiatives. Its strength depends on the multiplicity of connection points, *i.e.*, as more dense is the weave, as more complex is the fabric, the flow of knowledge and information will be greater, which results in more democratic participation and more social control.

The cultural dynamic is approached by Arantes (2004) as a transversal issue to social and economic development policies. The aggregate value of cultural goods and services when facing dense territories and practices of cultural meanings and references, indicates new paths to promote social and human development.

In this context, the design is a great ally, as it is regarded as an inseparable area of culture and society (KRUCKEN, 2009; GARCIA; MACIEL, 2010). The design, according to Reyes and Franzato (2008), should be present in a strategic way, taking care of the recognition of internal values, the transformation of the territory in product, and allowing your communication in an external way by increasing the attractiveness potential that the territory will have.

To Krucken (2009), recognize and become recognizable local values and qualities are the main contributions of the design in favor of dynamization the resources of a territory and enhancement of know-how. Towards that goal, the author suggests actions for the promotion of products and territories, and for facilitating a transparent and lasting relationship between consumer and producer (FIG. 1):

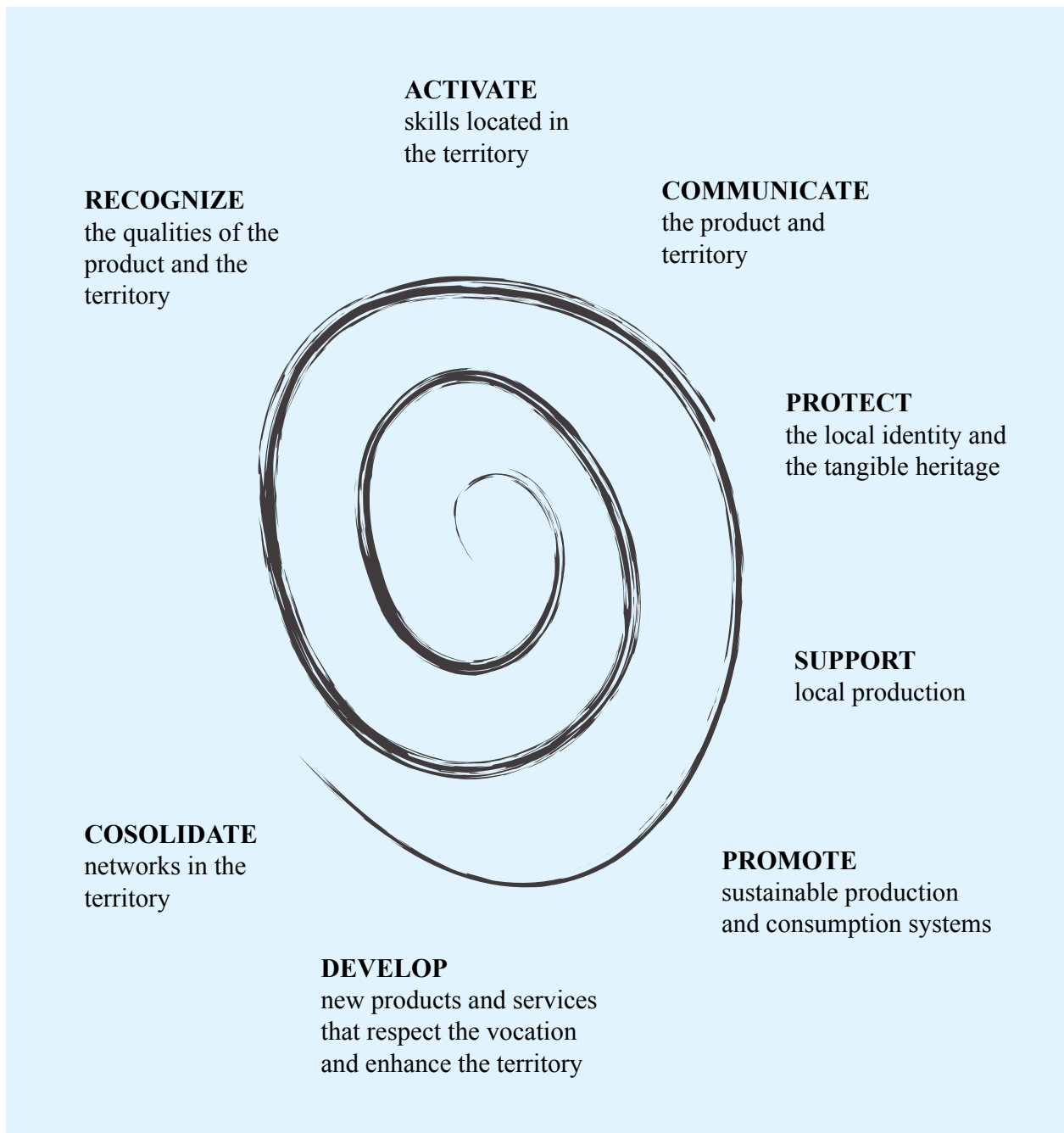


FIGURE 1 – essential actions to promote products and territories  
Source: Krucken, 2009, p. 108.

As seen, the design may support actions at various levels. However, the same author draws our attention to the importance in counting on professionals able to realize the elements of the territory that are present in products (material culture) and ways of doing (intangible culture), and plan ways to foster relationships that they constitute around the production and consumption.



Vale (2004) complements this reasoning since, according to the author, territorial attributes and cultural practices constitute differentiating elements of products and services that increasingly have differentiated market insertion. The new consumption patterns, opening market spaces, are demanding both in tangible quality as the symbolic quality, combined with the cultural values of the place where goods and services are produced.

Therefore, in this study, the term “territory” of a systemic concept, being understood as a set delimited by a space, in which individuals (actors) identify themselves and are identified by their specificities regarding the historical elements, cultural (material and immaterial), social, environmental, and relations in the context in question.

## 2.3 Handicraft

The emergence of artisanal activity in the Occident is associated with the development of cities and the emergence of urban activities necessary for life in the community, such as bakers, blacksmiths, carpenters, woodworkers, weavers, saddlers and architects. Only from the eighteenth century that appeared the first corporate offices with strict rules and regulations, defining the limits and duties of craftsmanship. However, with the industrial development of the handicraft entered a slow process of decay and social and economic marginalization, surviving as a consumer alternative to the peripheral populations, or lower purchasing power, economically unable to access to goods and services produced by industries (BARROSO NETO, 2001a).

The division of labor in handicrafts follows the logic of experience and knowledge, employing terminology dating back to the Craft Corporations of eighteenth century. At that time, an officer was the craftsman who had mastered the techniques of his activity and had a preparation of at least four years as an apprentice. But the master was who could undertake and contract work, and be responsible for their perfect execution. Currently, we designated as apprentice the auxiliary of craft production in workshops, responsible for drawing up parts of the work and who are in training process. In the same manner, officers are those artisans who produce, and in doing so often recreate the works proposed by masters, technical knowledge holders about materials, tools and processes of their specialty. Master craftsmen are those individuals who are noteworthy in their craft winning admiration and respect not only of their apprentices and officials, but also, and especially, the market itself. Their greatest contribution is to pass on to new generations the fundamental knowledge of their activities (BARROSO NETO, 2001a).



One of the characteristics of craft production, while work process, resides in the integration of manual activity with the intellectual, the association between the produced work and its author, the opposite of what occurs in industrial production where, then yes, due to the principle of social division of labor and specialization, these instances may present separated (LIMA, 2007).

According to the document published by Unit Nations for Education, Science and Culture Organization (UNESCO), the handicraft is part of the cultural heritage of groups and communities: i) by its representative capacity of the popular imagination, traditions and customs; ii) its function of preserving for posterity knowledge and techniques; iii) and the creation of objects, artifacts and instruments, recognized and concerning the culture of a people (CORRÊA; LAGE, 2010). According Cuéllar (1997), handicrafts, based on the legacy of past traditions that are renewed in every generation, is a true “living heritage”. In this context, the emphasized handicraft is considered as a cultural material good as an object, and an immaterial cultural good as well as craft.

The typical handicraft, according to Di Giorgi and Germak (2008), operates in a geographically defined territory, with available materials in the territory, has techniques, processes and languages of tradition. Thus, develop handicraft products means to use elements to report the product to its place of origin, either through the use of certain typical materials and inputs and production techniques of a region, either by the use of symbolic elements that make mention of origins of their producers, or their ancestors. To do so, it must use the colors of your landscape, its favorite images, its fauna and flora, portraying human types and their most unique customs, use the raw materials available in the region, and the techniques that have been passed down from generation to generation. To these differences is gave the name of cultural identity. These are unique elements that give meaning to the handicraft and indicate to the craftsman his place in the world (SEBRAE \_ BRAZILIAN SERVICE IN SUPPORT OF MICRO AND SMALL ENTERPRISES, 2004).

From an anthropological point of view, identity is formed mainly from two main elements: 1) the characteristics present in the occupied territorial space; 2) the set of symbols and linguistic signs, codes and standards (moral and ethical), objects, artifacts, customs, rites and myths (religion, folklore, music, food, clothing, etc.) accepted and practiced collectively, able to distinguish a particular social group of others (SEBRAE \_ BRAZILIAN SERVICE IN SUPPORT OF MICRO AND SMALL ENTERPRISES, 2004).

In Brazil, the handicraft is mostly based on family production or small neighboring groups, which allows and encourages the continuation of technical, original, expressive processes and designs of local culture and representative of their traditions. Its importance and cultural value stems from the fact of being custodian of a past to

accompany stories handed down from generation to generation, an integral and inseparable part of the uses and customs of a particular social group (BARROSO NETO, 2001a).

However the individualist artisan behavior (accustomed to working alone, most often held in his own home, sharing his experience and his knowledge only with his family members or any apprentice of the neighborhood) complicates the implementation of cooperative activities, which could result in significant savings, increased profitability and job quality (BARROSO NETO, 2001b).

On the other hand, the cooperative production would allow artisans to share and cultivate their technical-productive, social, cultural and environmental references, promoting: i) strengthening the collective, including face the challenge of managing their activities and marketing of its products; ii) local economic development through income generation; iii) and therefore the contention of emigration for the big urban centers. Thus, the cooperative work seems to be the most appropriate because it facilitates mainly the development of relations between the artisans and their production systems.

The handicraft is characterized by being an activity both economic and social, which contains the production of knowledge, perpetuating a tradition that goes beyond the knowledge of techniques and is configured in a way of life (CORRÊA; LAGE, 2010). It is therefore an alternative income which transposes financial nature because the qualitative value that ensures those who survive of this function. And that survival brings as a result reports of human relations in the form of objects that seek to bring to the daily grind a type of sensory comfort. The handmade object satisfies a need no less imperative than hunger or thirst: the need to be enchanted with the things we see and touch, whatever their everyday uses (PAZ, 1991).

UNESCO<sup>5</sup> has a global and integrated vision of the role cultural, social and economic crafts in the community, people and countries. According to the report of the World Commission on Culture and Development of this institution, it is estimated that the handicraft represents about a quarter of micro-enterprises in the developing world. According to the Brazilian Handicraft Program – PAB (2002), the Ministry of Development, Industry and Foreign Trade – MDIC, Brazilian craft segment represents 8.5 million people in their supply chains, moving around R\$ 28 billion per year (CUÉLLAR, 1997).

Nevertheless, the handicraft in Brazil has always been considered an embedded activity in the context of social assistance programs, treated in a patronizing perspective, without considering its economic and social dimension. Certainly there were exceptions, and these only confirm the rule (BARROSO NETO, 2001a). This situ-

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5 Available in: <<http://www.portal.unesco.org>>. Accessed in: Fev. 22. 2015.

ation was generated after the phase of industrialization, when the handicraft is regarded as not an office, but as an activity linked to folklore, popular culture, or as works of prisoners and *hippes*.

However, we can currently observe the approach between design and craft areas in Brazil, through the multiplication of socio-economic projects promoted by universities, non-governmental organizations (NGO's), public and private institutions. This new design of the field creates a demand for studies that deal with the subject in greater depth (CORRÊA; LAGE, 2010).

Subdued the secondary category of production from the technological development provided by the Industrial Revolution, only recently the handicraft back to occupy space in the market not only as a potential economic activity, but above all as a practice that rescues social and cultural values (CORRÊA; LAGE, 2010). In this sense, the handicraft is the counterpart to the massification and standardization of globalized products, it promotes the cultural revival and regional identity (SEBRAE \_ BRAZILIAN SERVICE IN SUPPORT OF MICRO AND SMALL ENTERPRISES, 2004).

Those who buy handicraft are also buying a bit of history, even if its own history of travel and discovery. A product, however good it may be, must be accompanied by something that contextualize, that locate in time and space. Information about the person who made a particular piece, the number of hours or days it took to perform this task may have an unsuspected value to whoever acquires. This information is very important for people to understand a little more of what they are buying and thus realize their intrinsic value (BARROSO NETO, 2001b).

Therefore, it is necessary to consolidate links between handicraft and tourism, turning, for example, the production place of the craftsman in a tourist destination from the context in which it appears, and its history (SEBRAE \_ BRAZILIAN SERVICE IN SUPPORT OF MICRO AND SMALL ENTERPRISES, 2004). In this sense, we can cite as an example the case of Solidary Tourism "Clay's Journey to Art"<sup>6</sup>, which provides the tourist not only a visit to the production site, but a real experience. The tourist experience the activity (production of ceramic parts) to 360<sup>0</sup> C degrees, for six days in the field of community *Buriti* \_ Minas Gerais, in the *Vale do Jequitinhonha*, one of the poorest parts of Brazil. This process begins with the reception of tourists by the host masters (ceramist masters), hosting them in their own homes in full board (breakfast, lunch and dinner) where they can enjoy the typical dishes and the famous *quitandas* (snacks from Minas Gerais state). In the five days that follow, tourists go through the whole process of production of ceramic pieces, *i.e.*, since the obtaining of the clay, the workshop modeling and painting,

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6 Available in: <<http://www.raizesds.com.br>>. Accessed in: Mar.18. 2015.

ending with a ceremony of burning the piece. According to the creator of this project, the products (handicraft) have much more value when the tourist goes to the place, know the people and their stories.

Traditionally, craft sale occurs at fairs and local markets, a custom in cities in the interior of the Brazilian states. This is a form of marketing and socialization of the local community, and has been valued as a cultural asset, becoming, in this way, “mandatory” roadmap tourists.

Handicraft is then considered, in this research, such as that object or artifact made with unique elements that relate to a particular territory, which essentially uses local raw materials. It is an activity that involves the traditional know-how of a people, transmitted from generation to generation. In this context, the handicraft is considered as material (tangible) culture as “object”, and as immaterial (intangible) culture as “activity”. Anyway, it’s a practice that goes in the opposite direction of globalized products, because it recognizes and appreciates the techniques, raw materials, the identity and the local community.

## 2.4 Linear Versus Systemic Approach in the Field of Design

Nowadays we can observe an ample discussion about crises that affected in several areas, as well as conjectures to solve them. However, debates about its origins are still scarce. We believe that without an in depth understanding on this field, any proposition becomes superficial, partial, and effective only in the short term. On the other hand, from the understanding of the origins of these crises, we can envision our future more clearly.

According to Fritjof Capra (1982), all current crises are facets of one, the “crisis of perception”. This results from the fact that even today, we are trying to apply concepts of an archaic vision of the world, in the shadow of the mechanistic Cartesian-Newtonian science, to a reality that can no longer be understood through these. Thus, our individual health and social are being seriously affected by the limitations imposed by the mechanism with its linear approach, as well as its system of values.

Bistagnino (2011) corroborates with Capra, believing that the crisis of values overlaps the collapses social, cultural and political. Nevertheless, highlights that, although dramatic, is an extraordinary opportunity to reorganize and begin again with new motivations, including a radical way where needed.

The crisis of values above refers to a society that puts the “**have**” as principal amount, which leads consumers to buy products that satisfy their **desires induced** and not exactly a necessity, called **consumerism**. Linear thinking, rational, typical of industrial production, has generated this principle.

However, our life is measured by ownership and by the choice of certain objects, which puts the product in the centre, guiding all other considerations. The culture of discarding “old” products and acquire “new” in an ever-increasing rate, triggers a series of problems environmental, social, economic and cultural. Already understand that we must change our habits, but the question is how.

Bistagnino (2011) believes that the basis for this change is the inversion of our current values, of “having” to “being”, and that if we act in this manner we will realize immediately that the most important value is the life. Tamborrini (2012) emphasizes the vital role that designers has in this context, because presently these professionals are being called to act as designer relationships, then abdicating, its traditional role as designer of form / function.

Notwithstanding, to delineate a new path is needed to understand how our vision is limited and change the angle of view, based on a systemic approach, i.e. putting deepest values at the centre of this reflection, connected to “being” to our context life, in a real humanism and cultural, connecting harmoniously to the surroundings, against globalization, which, according to Rattner (1995), act not only in the economic-financial field but undertake including prosperity or decay of cities and regions.

According to Capra (1982), our science and technology are based on the seventeenth-century belief in which that the understanding of nature involves domination by man, which, combined with the mechanistic model of the universe, with the excessive emphasis given to linear thinking, produced a technology unhealthy and inhumane. Its goals are control, mass production and standardization.

During the XVI and XVII centuries there has been a paradigm shift, in which the vision of the world, predominantly organic, came to be regarded as a machine metaphor used until the present day. This change was caused by the initiation of the scientific revolution, triggered by Copernicus: the Earth ceased to be the centre of the universe. Galileo has validated the hypothesis of Copernicus and associated scientific experimentation with the use of mathematical language in order to formulate the laws of nature.

Nevertheless, Francis Bacon was the first to formulate a clear theory of inductive procedure (inductive empirical method), namely, conduct experiments, extract general conclusions, to test on new experiments.

The method of analytic thinking (rational deductive method), developed by René Descartes, was published in his book “Discourse on the Method of Rightly Conducting the reason and seeking truth in the sciences”. This method is to decompose a complex phenomenon in small parties to understand the behaviour of the whole from the properties of its parts. For him, the universe was a machine and nature works according to mechanical laws. This thought led scientific research and development of all theories of natural phenomena until the late XIX century.

Descartes argued that one can only believe in that it is perfectly known and on which no doubt relates, reasoning that culminated in his famous statement: “I think, therefore I am”. This certainty, Cartesian, is essentially a mathematical.

The overvaluation of mind over matter, took Descartes to believe that mind and matter are separate and essentially different, which generated different effects “collateral” that affects us to this day: i) directed us to the overvaluation of mental work in relation the manual; ii) prevented doctors were to consider the psychological dimension of illness; iii) confusion in the relationship between mind and brain was caused; iv) interpret atomic phenomena was hard to quantum theorists. Despite the undeniable usefulness of his method, it led fragmentation our thinking and reductionism in science.

Isaac Newton synthesized works of Nicolau Copernicus, Johannes Kepler, Francis Bacon, Galileo Galilei and René Descartes, and developed a complete mathematical formulation of the mechanistic view of nature. He gathered empirical inductive method of Bacon with the rational method of deductive Descartes, this methodology that became the basis for natural science. For him, all physical phenomena were referring to motion of material particles caused by gravity, and can be described mathematically by their equations of movement. This became the basis of classical mechanics.

According to Newton, all phenomena have a definite cause that cause an effect also defined, so the future of any part of the system could be anticipated with certainty if there was detailed information on their state in a given time: approach strictly linear of cause and effect.

The mechanistic model, until then, could be used to explain everything, which supported the idea that the universe was a mechanical system that operated under the laws of Newton. Thus, physics became the basis of all sciences, and the mechanics of Newton able to clarify all your behaviour.

The mechanistic concept was applied to many areas, even in the social sciences, novelty at the time. This trend was so intense during the eighteenth century that this entire period was called the “Enlightenment”, in which the philosopher John Locke excelled.



New discoveries and models that have demonstrated the limitations of the mechanistic model marked the early XX century. In this context, we highlight: i) studies of Michael Faraday and James Clerk Maxwell on the effects of electric and magnetic forces; ii) the notion of evolution, which appeared in geology from the studies that concluded that the Earth is in a continuous process of development; iii) the theory of evolution, first by Jean-Baptiste Lamarck, followed by Charles Darwin. The latter was certainly crucial to transition from the mechanistic conception to the holistic.

A holistic conception is the exact opposite of mechanistic studies because the whole is studied without breaking it, in other words, analyse it from a systemic approach. The biologist Ludwig von Bertalanffy was the first to introduce, in 1940, the idea of a General Theory of Systems<sup>7</sup>. According to the author, the system is “[...] set of interacting elements [...]” (Bertalanffy, 2012, p. 63). This certainly is the core point of systemic view.

Subsidies biologists and ecologists were also fundamental to this transition. The first emphasized the conception of living organisms as integrated wholes, and later enriched by Gestalt<sup>8</sup>. Already ecologists began studies flows of matter and energy through ecosystems, thanks to the specialists of cybernetic<sup>9</sup>, which made the “feedback loops” and other dynamic patterns a basic subject of investigation of scientific.

However, the greatest contribution to the definitive break was mechanistic theory of relativity and quantum theory by Albert Einstein. These theories marked the beginning of modern physics and established the XX century thought.

Modern physics has restructured the concepts of space, time, matter, object, cause and effect, resulting in the emergence of a worldview quite different from the previous one. The universe came to be described as a whole, a system in evolving, ever changing, indivisible, whose parts are interrelated, in short, a network of interconnected relationships. Thus, understanding the universe from its isolated parts would not be possible no longer possible, making the understanding of their interrelationships essential: basis of systemic approach.

According to quantum theory, beyond the observer identify the properties of an atomic phenomenon he can also cause these properties. Capra (1982) cites, for example, that the choice of how we

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7 The General Systems Theory is “[...] a scientific investigation of “sets” and “wholes” [...]” (BERTALANFFY, 2012, p. 14).

8 German theory that studies the way humans perceive things to be. Claim that our perception is not by “isolated points”, but by a vision of “all”.

9 Cybernetics was started by a group of scientists through an informal network for investigation of common scientific interests.

observe an electron determine, to a certain degree, their properties. In other words, the Cartesian split between mind and matter does not hold. Modern physics has a systemic view of the world.

Capra (1982) compares the machines with the organisms in order to bring to light the main differences between mechanistic and holistic thinking: i) the machines are built, the organisms grow; ii) the activities of the machines are determined by its structure, this relation is inverted in organisms, i.e., the organic structure is determined by processes; iii) the construction of machines is given by the assembly of parts set in advance, the organisms show a high degree of flexibility (that allows them to adapt to new circumstances) and internal plasticity, these two particulars make the principle of self-organization<sup>10</sup>; iv) the machines operate on linear chains of cause and effect, organisms are driven by cyclic models of information flow (non-linear); v) machines are closed systems, organisms are open systems (to stay alive, they must exchange matter and energy with the environment constantly); vi) the machines are not able to reproduce, but the organisms can.

Briefly, we can describe the mechanistic thinking as rational, composed of linear chains of cause and effect, in which science is synonymous with mathematics, is based on the analytical method, believes that mind and matter are separate and distinct, and the world is seen as a perfect machine.

We emphasize, as more devastating effect produced by linear thinking, the belief that if something is appropriate for an individual, will also be for others. However, when a human being is involved in the issue can not grant that he will act as a machine, because as well remembers Edgar Morin (2000) we are complex, because we inscribed a long biological order and because we are producers of culture.

In holistic thinking, the whole is considered as more than the sum of its parts, mind and matter are interdependent and correlated, ponders the world as an indivisible whole and intrinsically dynamic, considers the context and the relationships, is a thought process.

Capra (1982) believes that the present problems are systemic, because they are closely linked and are interdependent. However, we still face problems in a fragmented way, disregarding their interconnections and interdependencies. The linear models are not appropriate in situations involving interdependencies between systems, whether social and/or economic. We need a holistic approach that mechanistic view cannot offer us.

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10 “The two principal dynamic phenomena of self-organization are self-renewal - the ability of living systems continuously to renew and recycle their components while maintaining the integrity of their overall structure - and self-transcendence - the ability to reach out creatively beyond physical and mental boundaries in the processes of learning, development, and evolution” (CAPRA, 1982, p. 269).



The scope of a project in the traditional industrial field, where the prevailing logic of linear processes and development, is the “product” of the classical point of view, i.e., one that will be sold in selling point. Thus, the traditional industry generates an exaggerated amount of waste, since it considers the “product” as single output<sup>11</sup> of this system, all others are considered waste valueless (FIG. 2).

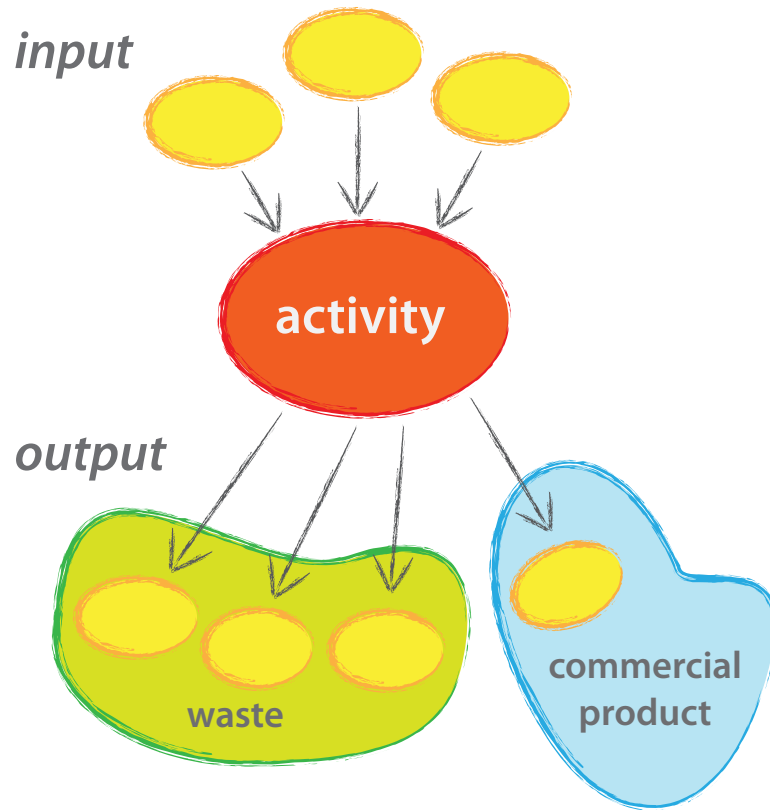


FIG. 2 – Traditional industry approach

The consequences of this approach may elucidate, in large part, environmental, economic, social and cultural crises. The first involves, among an endless list, the excess production of waste, reduction of energy and non-renewable resources, the expansion of the hole in the ozone layer, loss of biodiversity, and pollution at various levels, extensions and permanence. The effects also involve the damage to human health, poverty and “savage” competition, because we must always re-

<sup>11</sup> According to Cozzo, *apud* Bistagnino (2011), output is conventionally the final product, the result, and the emission data. In the management process, by unlike, identifies the flow of outlet data. The Systemic Design methodology considers “output” the outlet data (tangible and intangible) that are transformed into input (raw material) for new production processes. So, the wastes are not disposal elements, but dynamic elements within the various productive processes that can be transformed into raw material, generating economic value.

member that the human being is also part of the environment. The economic crisis is caused basically by the criterion used by industries in the selection of workmanship and resources: the lowest possible cost, made feasible by globalized production and consumption. As the products can be manufactured and marketed anywhere in the world, regardless of the distance, there is a substantial increase in the use of transport and consequently the consumption of fossil fuels. We can cite, for example, the manufacture of a pair of jeans (Lee Cooper LC 10) which “runs” until the day of your marketing, about 65,000 km (FIG. 3).

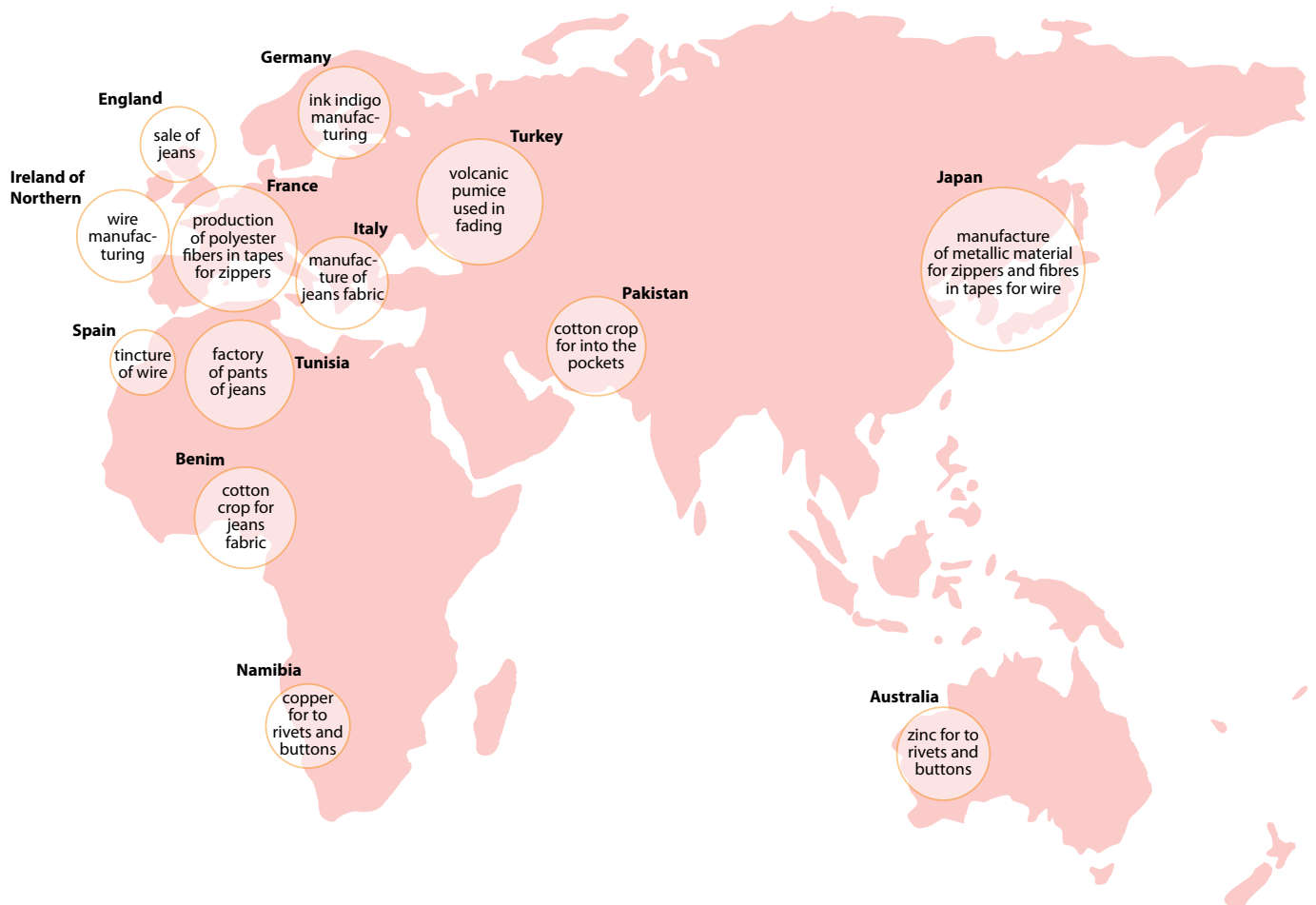


FIG. 3 – Manufacturing a jeans around the world  
Source: Adapted from Kazazian, 2005, p. 61.

At this circumstance, all gains on transaction are moved to other locations and not remain in the territory in which the company operates. This deviation causes social crisis, which involves the issue of employment, income, poverty, violence, dignity, and poor quality of life.

Already cultural crisis stems from the fact that the production and acquisition of globalized products (impersonal and decontextualized) impoverishes the culture of the people, leads to the suppression of know-how, distances us from our origins and finally converts us in “uniform people”.

In this context, the focus of designers is restricted to the materiality of the product, the solution of a specific problem, because they tend to respond to the demands of the industries unquestioningly. This position prevents them from perceiving the relationships that can be established between the various parties involved.

However, we must emphasize that the entire industrial process is generated by our own demands, and that these are “designed” by industries based on our linear behaviour, characterizing in a dangerous vicious cycle.

As opposed to the linear approach, the purpose of the systemic approach in industry is man<sup>12</sup>, the product is only one result of the process.

The application of systemic design in this scope tends to Zero Emission<sup>13</sup>, because it considers all the output of the system as a product (or raw material) on the same level, i.e., all that is generated by a process will be input to another in such territory, including the product of the classical view (FIG. 4), which may also generate economic value.

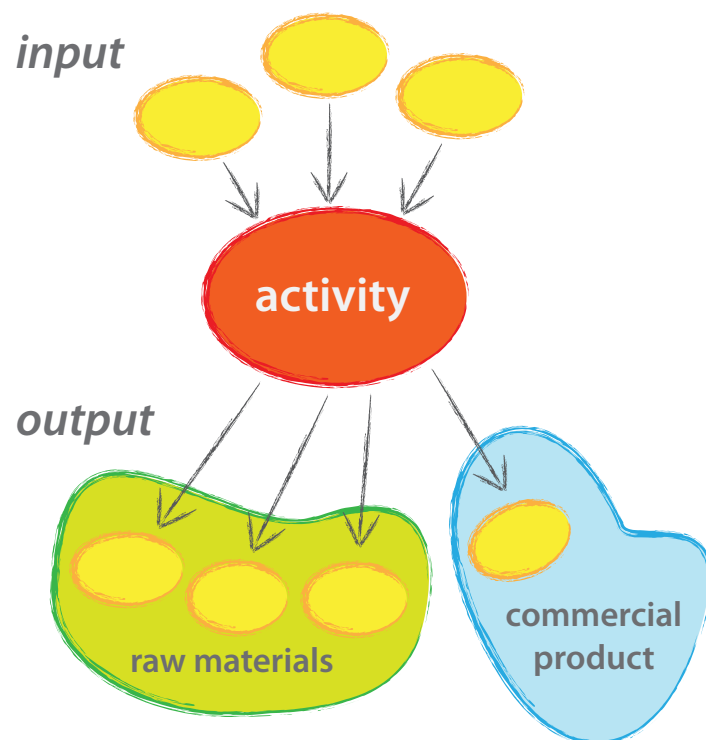


FIG. 4 – Systemic design approach

12 According to Signori, apud Bistagnino (2011), the man is a “cultural artefact” because is inserted as an individual in a social context in which he lives, works and generates relationships.

13 According to Di Salvo, apud Bistagnino (2011), Zero Emission is habitually understood as the elimination of all emissions, whether in liquid, solid or gas. This objective is achieved in Systemic Design by reuse of output as raw material for new productions (input-output).

In this context, a broad understanding of the territory is key to building the network of interconnections. Bagnasco (1984) examines the concept of territory beyond the area of spaces forms, and perceives it as connection, joint, product and condition of social-spaces dynamics. According to Saquet (2007), the effectiveness of the territory starts from the reciprocity of the relationships between economic, political and cultural forces, **in** and **with** the geographic spaces.

In Systemic Design is considered not only the amount of *output* systems, but above all their quality<sup>14</sup>, because these will feed another system. Thus, “savage competition” among companies in linear approach gives way to collaboration between actors involved, since the interest ceases to be individual and becomes collective, the welfare a means the welfare of all, and vice versa.

In this perspective, the designers are going designing flows of matter and energy, creating a new economic model, considering local resources, contributing to the revival of the cultures and identities of the territories, and dramatically reducing transport distances.

Therefore, attention projective no longer limited to products and goes on to consider the possible relationship between the processes involved and that can be generated in a system of social values, cultural and ethical<sup>15</sup>, valuing the know-how. In this model, the several activities of life and production coexist in a participatory manner and have their essential role in the system, neither prevails over the other, but each is thanks to all the others.

Importantly, this approach is not restricted to the environmental issue, but it is a new economic model based on industry cycles open projects, i.e., those that form and consider themselves according to their input and output.

According Bistagnino (2011), the application of systemic approach enables avail the resources and hence generate a macro autopoietic system<sup>16</sup> (or self-generative) consists of all local systems micro territorial, and create a network of new relationships that carry to positive change of environment and territory. In this approach, ideally,

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14 In filed of linear system, the quality is defined by International Organization for Standardization - ISO. In the systemic approach, the actors involved define the quality.

15 According to De Giorgi, apud Bistagnino (2011), ethics is not just a philosophical position in the systemic view, but a need to maintain life and health on Earth.

16 According to Campagnaro, apud Bistagnino (2011), autopoiesis is the self-organize property that all living systems has and redefine itself continuously according to the relations (system organization) that exist between the elements that compose it (the structure of the system) based on reciprocity that drives the relationship with their environment. An autopoietic system is open to context, its value is greater than the sum of individual contributions. The goals (equilibrium or evolution which tends) will apply to all components. These latter are mutually interdependent, strategic and necessary in the management of flows of matter and energy (incoming and exit) and in the processes of production and processing endogenous.

do not have waste production, as occurs in nature. How reminds Bistagnino<sup>17</sup>, “[...] the nature is a teacher and example”.

Act under the systemic approach in the field of design, involves project of systems placing man at the centre of the project, to create relationships between the actors and productive reality in social and cultural context in question. Relations generated incite the emergence of a strong collaborative network, as these is not based on money but in their own relationships, in which the interest is collective.

In this context, the production for differentiated markets not allows the creation of globalized economic systems and indistinct, but specific and contextualized. From this type of activity, we can amortize waste, reverse the consumerist tendency, organize production according to the characteristics of the ecosystem and the local population, generating therefore new jobs and improving the quality of life and environment more lasting.

In this perspective, the product is the last of the values to be considered, because the production of an object loses completely meaning if not meets what is really necessary for the existence of the actors involved, if was not taken into account in advance the values that are important to human life. This gives strength to values related to “being” and not to “have”, reversing the priority of relations and valuing, both within the company, as the production.

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<sup>17</sup> Available from: <[http://www.edilcamp.it/notizie/108/luigi\\_bistagnino\\_la\\_natura\\_maestra\\_ed\\_esempio.html](http://www.edilcamp.it/notizie/108/luigi_bistagnino_la_natura_maestra_ed_esempio.html)>. Accessed at: 13th July 2013.





The objective of this research is to apply the methodology of Systemic Design<sup>18</sup> within the *Estrada Real* (Royal Road), specifically in the Territory of *Serro*, in order to generate a new economic model and development in this location, long-term, through the creation of connections between your productive systems, by recognizing their cultural values (tangible and intangible).

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18 The methodology of Systemic Design was developed by professor Luigi Bistagnino, do *Politecnico di Torino* (POLITO).





# 4 methodology

This research is based on the Systemic Design, methodology developed by Professor Luigi Bistagnino (2011), which aims to contribute to the solution of contemporary crises rebalancing and maintaining the relationship between production, the environment and society through the development of products, services and processes which tend to zero emissions<sup>19</sup>. In summary, this methodology can be grouped into three main stages, namely:

**1. Understanding the territory**

Construction of the current scenario, called Holistic Relief. This includes understanding the context, that is, the territory in all its amplitude.

**2. Systematization and analysis of existing productive systems in the territory**

Investigation of all input and output of local activities (production systems).

**3. Design of flows of matter and energy**

Project of flows of matter and energy between the productive systems of the territory in question, through a network of relationships between them.

**4. Confront**

Confront between the current system and the systemic system.

## 4.1 Step 1 Understanding the Territory | Relief Holistic

The first step of the methodology of Systemic Design (understanding the territory) comprises the construction of the current scenario, called Holistic Relief. Understanding the territory must involve the history of the place, its physical and climatic aspects, its natural resources, its activities (social, cultural and productive), the manner and pace of community life as well as its infrastructure. This group of specificities makes the territory be unique.

### 4.1.1 The municipal district of Serro

The municipal district of Serro is located about 330 km away from Belo Horizonte, capital of Minas Gerais state (FIG. 5), comprises an area of 1214.95 km<sup>2</sup> and a population of 21,004 inhabitants. In urban areas 11 784 inhabitants live, but in the rural area 9,220 live. The population density is 17.1 ha. / Km<sup>2</sup>.

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<sup>19</sup> The zero emission is understood as elimination of all emissions, whether in liquid, solid or gaseous state.

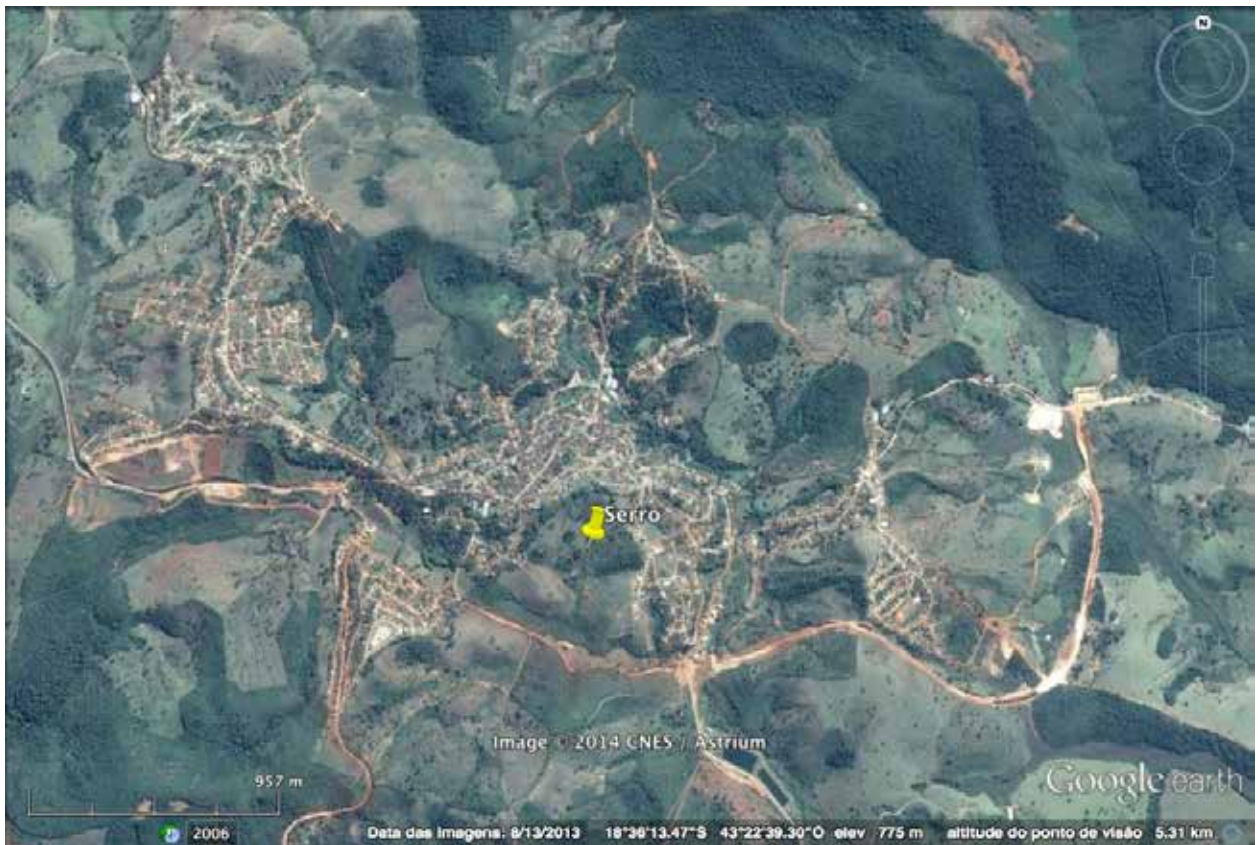


FIGURE 5 – Serro  
Source: Google Maps; Castriota (2009)

According to the Technical Assistance and Rural Extension Enterprise of the State of Minas Gerais (EMATER-MG), the city has about 11% of plane area, 22% of corrugated area and 67% mountainous area. Its altitude varies between 600 and 1200 meters.

The climate of Serro is characterized as tropical of altitude with well distributed rainfall between the months of September and March, with an average rainfall rate of around 1,300 mm per year (EMATER-MG).

The total normal annual average rainfall is 1.404mm, and the month of January is the rainier (about 307 mm) and June, is the drier (about 8 mm) (CASTRIOTA, 2009).

The annual average temperature is 21<sup>0</sup>C, with a minimum average of 14<sup>0</sup> C and maximum average 27,5<sup>0</sup> C (ANDRADE; MAGALHÃES, 2008). The normal annual average total insolation is 920 hours, with relatively constant annual values, around 80 hours per month, which corresponds to 2.7 daily hours of sunshine (CASTRIOTA, 2009).

In the western portion the vegetation is a herbaceous cover join field (the highest places), with small and medium-sized vegetation with branches and twisted trunks and thick and leathery leaves, typical of *Cerrado*<sup>20</sup>. In the eastern portion the vegetation is larger, with thick forests, associated with areas covered by typical *Cerrado* (ANDRADE; MAGALHÃES, 2008).

The most common types of vegetation are: “clear field”, “dirty field”, *Cerrado*, gallery forest, vereda and typical *Cerrado*. The *Cerrado* has a huge diversity of plants, animals and people, such as indigenous, *quilombolas*<sup>21</sup>, *geraizeiros*<sup>22</sup>, *sertanejos*, *vazanteiros*<sup>23</sup> and riversides, that for many generations have been using the resources provided by nature (SAMPAIO, 2011).

Three soil types are found. Across the central and eastern part, the soil is well-developed and lacking in nutrients. In the western part,

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20 The *Cerrado* is the second largest biome in Brazil, occupying 24% of the country and approximately 50% of Minas Gerais. In 2009, the *Cerrado* has been recognized as a National Natural Patrimony as well as the Amazon, Atlantic Forest and Pantanal.

21 According to the National Institute of Colonization and Agrarian Reform (INCRA), the *quilombola* communities are ethnic groups, predominantly consisting of the rural or urban black population who define themselves from relationships with the land, kinship, territory, ancestry, traditions and cultural practices own. Available in: <<http://www.incra.gov.br/index.php/estrutura-fundiaria/quilombolas>>. Accessed on: Mar.01. 2014.

22 Farmers in the plains, slopes and valleys of the *Cerrado* that often divide their yards to plant and raise animals using various productive local cultures and traditions. The naming of these people comes from the term “Gerais” (from Minas Gerais state), understood as synonymous with *Cerrado*, because before there was no reference of this term, only to Gerais, then giving origin to the name “geraizeiros”. Available in: <<http://www.cerratinga.org.br>>. Accessed in: Mar.02. 2014.

23 *Vazanteiros*, or *barranqueiros*, are people who have a life connected to the river.



the soil shows properties similar to that described above, but with good physical properties and most lack water. To the south of this area, along the stretch of rocky outcrops, the soils, where they exist, are poorly developed, dry and often lack in nutrients (ANDRADE; MAGALHÃES, 2008).

The topography of City of Serro is attended by a range of mountains and rivers. The municipal district is a divider of two watershed basins: *Rio Doce* and *Jequitinhonha*.

Large batches and sparsely occupation mark the urban set of Serro, not just on the periphery. The predominance of very steep terrain, with slopes ranging from 30% to 100%, strongly contributed to shaping the local architecture, marked by a specific type of houses that will accommodate more floors on one side of the building, reaching up to four decks (CASTRIOTA, 2009).

Besides forests, waterfalls and archaeological sites, the territory of Serro is composed of the *Espinhaço* Mountain Range (in the southern portion), considered the only mountain range in Brazil. It is configured as a long and narrow chain of mountains, about 1000 kilometers in length, and a range of 50 and 100 kilometers wide. Its altitude varies considerably, alternates between 1,000 and 1,500 meters, with peaks up to 2017 meters, allowing a huge rainfall and climatic diversity. It holds a biodiversity greater than the magnificent Amazon region, and a natural reservoir of much of the water that supplies the Brazil, because it is the “cradle” of several river sources (SANTOS, 2008) (FIG. 6).

The variety of soil types, moisture and temperature provides a wealth of fauna and flora. At some points, Atlantic Forest, *Cerrado*

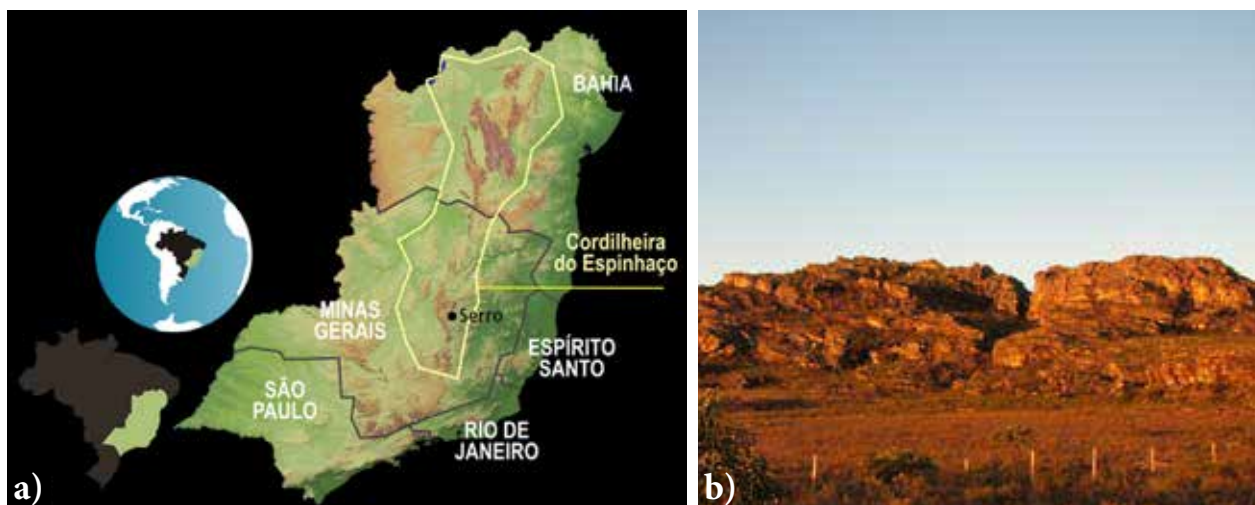


FIGURE 6 – *Espinhaço* Mountain Range. Source:  
a) Adapted from <<http://www.serradoespinhaco.com.br/mapa>>  
b) Castriota (2009)

and *Caatinga* interact, giving to these mountains a unique feature, harboring many endemic species, *i.e.*, specimens of fauna and flora that only exist in those conditions and in that place in the world.

Although to put together the three largest Brazilian ecosystems, the vegetation that predominates in *Espinhaço* Mountain Range is what experts call the rocky fields, considered one of the *Cerrado* subgroup. These are associated with altitudes above 900 meters above sea level, in shallow, rocky, rocky or sandy soils.

The Serro drainage network (FIG. 7) includes the watersheds of the rivers *Doce*, *Jequitinhonha* and *San Francisco*, with its larger coverage area (almost all) within the basin of the *Rio Doce* (Sweet River). The area is drained by four main courses: the *Rio do Peixe* (River's Fish) and *Crisprino*, *Siqueira* and *da Saia* streams. The *Rio do Peixe*



FIGURE 7 - Drainage Network Serro  
Source: <<http://www.mg.gov.br>>

(River's Fish), located to the west of Serro, cuts the area in the direction from north to south. The *Crisprino*, *Siqueira* and *da Saia* streams, located in east-central area, drain southeastward toward the *Guanhães* river (ANDRADE; MAGALHÃES, 2008). In the region we found yet, *Ribeirão Lucas* (Lucas Brook) and the *Quatro Vinténs* (Four Pennies) streams.

In the city of Serro there is a single hydrogeological field, framed in fissured aquifer system, of the schist type. Aquifers found in the region are unproductive and only in rare situations occur wells with high flow rates. Of the nine registered<sup>24</sup> deep wells, four have depths between 36.0 and 80.0 meters, and flow rates between 1.4 and 9,3m<sup>3</sup> / h; two wells with depths of 80 and 102 meters, and flow rates of 5.04 and 10,51m<sup>3</sup> / h. Of the seven wells in which samples were collected, the water was classified as sweet (SEARCH OF MINERAL RESOURCES COMPANY, 2004).

The water and sewage system is made in the city of Serro, as in the rest of the state, by the Sanitation Company of Minas Gerais (COPASA). The water catchment is made in *Rio do Peixe* river, and the Lucas Stream is the receiving body (WATER SUPPLY SERVICES REGULATORY AND SANITATION OF MINAS GERAIS AGENCY – ARSAE/MG, 2011). The public water supply meets 64.40% of households, while 29.27% are provided by well or private sources and 6.33% have a different way of water supply (Brazilian Institute of Geography and Statistics – IBGE, 2000). The sewage system serves 27.09% of households. The IBGE census data demonstrates that 80.23% of households have septic tank, and 19.76% have no sanitary installation. A minority of the waste generated is collected (31.44%) by the cleaning service, while 68.56% are burned, discarded on an empty lot or public place or in the drainages (RESOURCE SEARCH MINERALS COMPANY, 2004).

Like many villages in the region, as well as others throughout Brazil, still have no access to water supply system, the federal government implemented the Water for All program (FIG. 8). This is part of the Brazil Without Poverty Plan, and was conceived from the need to provide universal access to and use of water to needy populations residing in rural communities not served by this essential public service, attended by deficient supply systems or even that receive diffuse supply. The program aims to ensure broad access to water for dispersed rural populations and extreme poverty, either for their own consumption or for food production and animal husbandry, allowing the generation of marketable surpluses for the expansion of family income of farmers.

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24 The wells have few constructive data. Most data were informed.





FIGURE 8 – “Water for all” Program

Source:

a) <<http://www.pac.gov.br>>

b) Author’s file

Currently, the program supports the implementation of the following technologies in particular: a) cistern of consumption – reservoirs with a capacity of 16,000 liters for catchment of rainwater for human consumption; b) cisterns of production – rainwater catchment systems intended for storing water for farmers; c) collective water supply systems – systems for capturing, adduction, treatment (when necessary), reservation and distribution of water coming from “water bodies”, wells or springs; d) “Barreiros” (which is extracted earthenware) or small dams – small containment for rainwater catchment designed to meet the shortage of water for agricultural and food production; e) Irrigation Kit (utilities set) – composed of water tank, pump, hose, among others gathered to form a small irrigation system, with a capacity to irrigate with a drip system, an area of 500m<sup>2</sup> to 2,000 m<sup>2</sup>; f) underground dams – digging up rocks,



ditches, whose walls are lined with plastic sheeting, and then filled with the removed soil in order to retain rainwater on the rock; g) wells – groundwater catchment works made with the use of drill in a vertical hole.

Electrical power is provided by the Energy Company of Minas Gerais (CEMIG). This concessionaire is responsible for 96% of supply. The company has 70 hydroelectric power plants, besides thermo-electric power plants and windfarms with an installed capacity of about 7000 megawatts in the states of *Minas Gerais*, *Espírito Santo* and *Santa Catarina*. Its generation and distribution system is interconnected. However, the energy that reaches the region of Serro derived from power plant of *Salto Grande*, *São Paulo* state, at an approximate distance of 840 km from the city (FIG. 9). The *Salto Grande* station still operates on three fronts in order to reduce the environmental impacts caused by dam construction in *Paranapanema* river: 1) conducts ecological studies of the lake, which include a full study of water as an ecological environment, in order to proceed the evaluation of the reservoir and establish appropriate actions to preserve the aquatic fauna; 2) produces fingerlings for restocking the river, fish such as: *pacu-guaçu*, *piava três pintas*, *corimbatá*, among others; 3) develops research to improve production technology, *i.e.* analysis of the feasibility of production of some fingerlings species, such as *mapará*; *jurupoca*; *jurupecê*.



FIGURE 9 – Power plant of *Salto Grande*  
Source: <<http://www.memoriaduke.com.br>>

### 4.1.2 History

The region of Serro is located in Middle *Espinhaço*, in the state of Minas Gerais. Headquarters of the first four districts of the Captainship of Minas, was established by the Portuguese crown as *Vila do Príncipe do Serro Frio* (Cold Serro Prince's Village) in 1720. Its name was due to its first inhabitants, the *Botocudos* indigenous, who called the area of *Ibi-ti -ruí* or *Ivituruí*, meaning "mountain of cold winds".

The formation of this region occurred from several ranches that were built near these streams, giving rise to the small villages. The region was taking shape gradually over a principal axis that connected two settlements of miners: *Arraial de Cima* (Top Small Village) toward the *Quatro Vinténs* Stream (Four Pennies Stream) and *Arraial de Baixo* (Down Small Village), which follows the *Ribeirão do Lucas* (Lucas stream), corresponding to high and low parts of the city, which later originated the village of Serro Frio (Cold Serro). In 1838, the *Vila do Príncipe do Serro Frio* (Cold Serro Prince's Village) was elevated to city status under the name of Serro.

Since the middle of seventeenth century, the gold is found nearby the Serro, mainly concentrated in alluviums and terraces of *Rio do Peixe* (Fish River) and its affluents. Diamonds were found in several waterways, as in affluents of the *Doce* and *Jequitinhonha* rivers (ANDRADE; MAGALHÃES, 2008).

With the decline of the gold cycle in the second half of the eighteenth century, the city of Serro intensified their agricultural activities. In the northern region there are many cattle breeding farms, and production of artisan cheese, which has always been traditional in the region.

What distinguishes the city of *Serro* from all other historical centers of *Minas Gerais* is its rural character. It is one of the few mining region cities to have its economy also marked by agriculture since the beginning of their occupation (CASTRIOTA, 2009).

The growth of Serro followed a longitudinal trend in East-West direction, articulating around three main axes: *Rua Direita* (Straight Street), *Rua de Cima* (Top Street) and *Rua do Corte*, (Cutting Street), which have a confluence point in the city's entry into the *Estrada Real* (Royal Road). Its basic urban layout is still close to that of the eighteenth century, keeping characteristics of eighteenth-century style of the mining villages, which is why its architectural and urban ensemble was listed by the National Institute of Historical and Artistic Heritage (IPHAN) in 1938. Some streets still keep the traditional pavement of "*pé-de-moleque*" (type of pavement made with small round stones known as head of black or kid's foot, because of the similarity it has with the peanut candy that has the same name), labored by slaves.

Currently, the economic base of the region is dairy farming. The Serro, along with neighboring municipalities, produces around 80,000 liters of milk. Of these, approximately 15,000 liters are intended for milk processing industry held by the Cooperative of Rural Producers of Serro, around 60,000 liters are transformed into artisan cheeses from in natura milk. Artisanal cheeses are the main source of sustenance of nearly 1,000 farmers in the region, with the majority (76%) are family economy producers (EMATER-MG).

#### 4.1.3 Traditional Cultural Events

The first music band in the region was founded in 1917 by the participants of the former Workers League, called *Euterpe Santíssimo Sacramento* Band Music (Euterpe Blessed Sacrament). The workers were mostly blacks and mulattos who worked as shoemakers, carpenters, masons, painters, civil servants and other services. Currently, the city of Serro has two choral groups, operating since 1984.

But the theater group, founded almost 30 years ago, is responsible for several performances, including the famous living pictures of Holy Week.

The history of “mining cuisine” (typical cuisine of Minas Gerais) has a very close relationship to the time of the pioneers and cattle drivers from São Paulo state, because they went on the road leading beans, beef jerky, pork backfat and flour, resulting in the famous and traditional recipes of the mining cuisine such as bean *tutu* (food made with beaten and seasoned beans), *farofa* (food made from cassava flour, seasoned and with little pieces of meat) and *angu* (salty porridge made of corn flour). According to Castro, Duke and Silva (2013), “Mining cuisine” refers to the kitchen that was born in the cities where there was mining. According to the authors, the mining cuisine is a cultural construction, where the memory and the population’s everyday costumes are important landmarks to the cultural landscape of the way of life of people from Minas Gerais state.

Plenty of farms in the region of Serro, installed at the time of the gold cycle, is one of the responsible for developing classic dishes from “mining cuisine”, which combined Portuguese, African and Indigenous tastes like, for example, the “*pururuca* of pork and *canjiquinha* (food made with minced and seasoned corn) with ribs pork”.

The mining cuisine, although rich in ingredients, scents and flavors, is based on four main food: corn, greens, vegetables and meats, especially pork and dairy products, especially cheese, which were first to be produced in Brazil.

The pork was the center of the domestic economy at the time due to several factors: i) trade of beef was hampered by precarious roads and the high price; ii) their food was based on leftover food; iii) its

use was almost total: lard was used to make greaves and preservation of meat; with blood was made chorizo; with the casings were made sausages; feet, tails and ears were served with beans to the slaves; iv) its meat was preserved for much longer in the fat compared to beef. Note that pork preservation technique in own fat was taught by the indigenous people.

The tools used in the kitchen are produced in wood, wrought iron, taquara (bamboo), leather, clay and soapstone. The latter, according to the cooks, keeps the temperature much longer than ordinary, ideal for preparing beans, *angu* (polenta), broths, soups and the classic *frango a molho pardo* (chicken in brown sauce) and *feijão tropeiro* (mule driver beans).

For traditional cooks of handmade candies from Minas Gerais state, when using a wooden spoon, the sweet has more durability and the fruit flavor becomes more intense. Good cooks also believe that the termite clay ovens bake evenly candies and meat, keeping the nutritional values of food and providing better taste.

The leftovers of food like rice, beans, meat, cabbage, onion and eggs, mixed with cassava or corn flour, were used to make the *mexido* (tweaked). In rural communities of Minas Gerais state this dish is still enjoyed as the first meal of the day.

For most of the people from Minas Gerais, today, the kitchen is the most important room in the house and the main meeting point of the most intimate visitors. According to Maria Lucia Clementino Nunes, better known as *Dona Lucinha*<sup>25</sup>, “The business card of a place is its cuisine” (NUNES, 2010, p. 163). This, in connection with the yard we can find: small animal husbandry (chickens, pigs and other small animals) heritage of Portuguese traditions; kitchen garden with cultivation of cabbage, lettuce, okra, scarlet eggplant, green onions, parsley and some other herbs and vegetables used in the preparation of typical dishes; and orchard with various fruits, which are raw materials for the manufacture of jams and classic candy compote as the famous candy of milk from Minas Gerais, usually served with cheese. The people from Minas Gerais state are known for their hospitality, which maintain the habit to offer *quitandas*<sup>26</sup> to guests.

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25 “Dona Lucinha”, born in the city of Serro in 1932, is a famous cook in Brazil and partner-owner of several mining cuisine restaurants.

26 The authors define *quitandas* as “[...] all the variety served at breakfast, afternoon snack, in the meetings of friends like: cakes, cookies, corn bread cornmeal with fennel, sweets, the *curau*, the *pamonha*, the *canjica* with milk, cookies of ringlets, *mentiras*, sponge cake of water, the various threads and the most famous *quitanda* from Minas Gerais: cheese bread, made with grated cheese matured, eggs, lard (or oil) and fermented cassava starch, which should be served right out of the oven. They are always served with coffee”.

The typical cuisine of the Serro region involves: Cheese of Serro, coffee sweetened with brown sugar, *quitandas*, *feijão ferrado*<sup>27</sup>, *ora-pro-nóbis*<sup>28</sup>, bracken sprout and almost ripe papaya, white beans with *dobradinha* (stew made with part of the ox gut), chicken in brown sauce, chicken with okra and corn mush, “*roupa-velha*<sup>29</sup>”, *e escaldado*<sup>30</sup>, pork sausage, savory sausage, beef liver with scarlet eggplant or onions, small guts of pork or chicken<sup>31</sup>, preserves made from bamboo sprout and other vegetables.

The typical candies, produced from the colonial era, are *rapadura* (sugarcane molasses bar), milk jelly roll, the *pé-de-moleque* (peanut candy), the *ambrosia* (sweet made with hewn milk, eggs and sugar), rice pudding with lemon peel and cinnamon, fruit candies<sup>32</sup>, the *furrundu*<sup>33</sup>, the banana candy, the guava paste, the quince paste, white and black coconut candies, fruit candy bars, fruit jams and jellies<sup>34</sup>, the *canjica* with milk or flavored with peanuts, coconut milk or coconut and clove.

The home-made drinks are the liqueurs (of fig leaf, *jabuticaba*, orange, milk, *jurubeba*, *jenipapo* and plum), wine (grape, *jabuticaba* and rose petals), *cachaça* (sugar cane brandy) and *queimadinha*<sup>35</sup> (CASTRO; DUKE; SILVA, 2013).

However, the most illustrious product of the region is the cheese of Serro, which was the first product registered as Intangible Heritage of Minas Gerais, in 2002. It was also recorded in Intangible Heritage of Brazil, in 2008. This product certainly is part of the imaginary state, which surpasses the conceptual limit of food and economic output, can be regarded as an interpretation of Minas Gerais culture. Its importance is such that there is a specific date to celebrate the cheese of Serro, performed about 50 years by the community (EMATER / MG).

The traditional process of production of the Serro's Minas cheese is passed from generation to generation for almost 300 years and remains virtually unchanged.

As well as in the entire state of Minas Gerais, the Serro also features folk traditions and promotes various religious celebrations that are

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27 *Feijão ferrado* is a typical food mule driver.

28 *Ora-pro-nóbis* is a kind of plant found in the rock high regions of Brazil.

29 “*Roupa-velha*”: beans with salt meat.

30 *Escaldado*, knew as “*maneco com jaleco*” is made with corn flour and eggs.

31 Small guts: kidneys, liver and heart.

32 The fruits are banana, guava, peach, pineapple, coconut, pumpkin, grated cider, sweet stick and papaya.

33 *Furrundu*: wrapped green papaya.

34 Jam of fig, papaya, peach, earth orange, quince and cider.

35 *Queimadinha*: milk “drowned” in sugar syrup or honey.



TABLE 1

MONTHS	CELEBRATIONS AND THEIR CHARACTERISTICS
January	<b>Feast of Saint Sebastian:</b> novena, Mass, procession and blessing of the Blessed Sacrament.
February	<b>Brás Day</b> - Blessing of throats <b>Carnival</b> - presentation caricatured blocks
April	<b>Holy Week</b> - Palm Sunday: Procession of the meeting, celebration Wash Feet, Via Sacra, staging of the Passion and Death of Christ, procession of the Resurrection, Judas burning. Streets and windows of Serro are decorated by the population for the processions passing by. <b>Regional Meeting of Music Bands</b>
May	<b>The Coronation of Our Lady:</b> Children dress up as angels and sing small verses for the coronation. <b>Our Lady of Fatima:</b> children crown Our Lady, dressed in shepherdesses. <b>Celebration of Saint Cross:</b> prays of the Craft to Saint Cross beneath the cross. This festival occurs since the eighteenth century in Minas Gerais. <b>Celebration of Saint Rita:</b> novena, Mass and Benediction of the Blessed. <b>Celebration of the Holy Spirit</b> (on Pentecost Day): procession of the Empire of the Divine, <i>Guardas de Marujos</i> (Sailors guards) and <i>Boi da Manta</i> (Ox with cover), and folkloric events such as the dance of the " <i>Bumba-meu-boi</i> ", the rise of the greasy pole and the dispute of the breaks pot. There are also little stands with typical food, and distribution of breads and holy cards with the Divine by devotees who pay their promises after Mass. <b>Horse Party</b> - ride, animal exhibits, auctions, rodeos and musical performances. <b>Labour Day</b> (1 <sup>o</sup> ) - popular celebrations in honor of workers
June	<b>June festivities:</b> quadrille presentation, popular demonstrations with fireworks, little stands with typical food, and lifting of the flagpole of St. Anthony, St. John and St. Peter. <b>Corpus Christi:</b> solemn Eucharistic procession. <b>Sacred Heart of Jesus Feast:</b> novena Mass, procession and Benediction of the Blessed Sacrament.
July	<b>Feast of Our Lady of the Rosary:</b> Output whistles box toward the house of partygoers to have breakfast; flag procession accompanied by the <i>Catopés</i> Guards, Sailors, <i>Caboclos</i> and blogging of <i>Boi de Manta</i> (Ox with cover); procession of the Kingdom (judges, king, queen, <i>Catopés</i> Guards, Sailors and <i>Caboclos</i> ); outdoor Mass; lifting flagpole; and little stands. <b>Feast of Our Lady of Carmo:</b> a Third Order Carmelite promotes the triduum, procession and renewal ceremony of the commitments of the members of the Order. Still organize the dawn with bells and fireworks, solemn Mass, imposition of scapularies and the blessing of the Blessed Sacrament. <b>Jubilee of Our Lady of Sorrows:</b> novenas, procession Mass, payment promises and little stands. " <i>Culturando</i> " project - cultural fair, cultural performances and art meeting
August	<b>Feast of Saint Christopher:</b> Mass, blessing of the cars, fire pit, and little stands with typical food.
September	<b>Jubilee of Senhor Bom Jesus de Matosinhos</b> (Good Lord Jesus from Matosinhos): the brotherhood of <i>Senhor Bom Jesus de Matosinhos</i> organize novenas, Mass and the blessing of the Blessed Sacrament. <b>Party Cheese</b> - parade and dance of the Cheese Queen, typical cuisine in many bars and restaurants, delivery of trophies and shows. <b>The Homeland Week</b> - civic schedule in several locations.
October	<b>Feast of Our Lady Aparecida:</b> the devotees, next to the parish, organize Mass, procession and Benediction of the Blessed Sacrament. <b>Feast of Our Lady of the Rosary:</b> novena. <b>Project Santa Cecilia</b> - concert, hearing, serenades, artistic and musical performances. Baylon of Serro Frio
November	<b>Feast of St. Cecilia,</b> patroness of music: concert in her honor.
December	<b>Party Immaculate Conception,</b> patroness of the city: the brotherhood of Our Lady of Conception organizes liturgical rituals with the characteristics of the eighteenth century - Novena, Rosary prayer to Our Lady, Mass, procession and Benediction of the Blessed Sacrament. <b>Courting Folia de Reis and Pastorinhas</b> (Christmas and New Year) - visit to several houses that make the nativity scene and invite <i>Folia</i> or <i>Pastorinhas</i> (Pastorelle Sisters) to sing and pray with the family, always with a coffee after the presentation.

Source: Prepared by the author

part of its cultural wealth derived from its past (Table 1). Such events always involve dramatized dances, called “*folguedos*”. Among them stand out the *Boi de Manta* (ox with cover), as *Pastorinhas* (the Pastorelle Sisters), the *Folia de Reis* (revelry of kings) and the *Guardas de Catopés*, *Caboclos* and *Marujos* (Sailors).

In religious celebrations the ringing of bells is still remarkable sound. Every occasion has a touch. The bells are audible expressions of faith and religious life in historic cities.

#### 4.1.4 Municipal Human Development Index (HDI)

The Municipal Human Development Index (HDI) of the municipality of Serro is 0.658 (2000). The HDI is a result of the combination of three dimensions: Longevity, measured by life expectancy at birth; Education, measured by a combination of adult literacy rate, weighing 2/3, and combined enrollment rate in all three educational levels, weighing 1/3; and Income, measured by GDP ( *per capita*, expressed in PPP dollars or purchasing power parity (CASTRIOTA, 2009).

#### 4.1.5 Agricultural activity

The main agricultural products of the municipality are typical of regions where practicing family farming and subsistence. The larger areas of arable land are destined for corn, especially the sugarcane as the highest average yield per acreage cultivation. There are still the banana, cassava and orange cultivations.

Industry production data indicate a traditional production, craft, supported mainly on family labor. Of the entire workforce employed in agriculture in the municipality of Serro, approximately 84% consists of work with family bond with the owner.

Urban agriculture comes from understanding the urban-rural character of Serro because of cultivation and the presence of the backyards of their homes. According Castriota (2009, p.259), “[...] the city of Serro, located in the ‘Diamond District’ is one of the few mining region cities to be marked by agriculture, since the occupation began” (CASTRO; DUKE; SILVA, 2013).

Although some of these products is market-oriented, much of the income of the population still originates in forms not monetized exchange, given the characteristics of the region and its main agricultural products (CASTRIOTA, 2009).

#### 4.1.6 Industry Production

The high participations (67.17% in 2002) of the agricultural and service<sup>36</sup> sectors in Minas Gerais and in the central region of the state, show poor performance in industrial production in the city of Serro, both in relative and absolute terms.

#### 4.1.7 Mineral activity

The mineral activity involves the exploration of talc, quartz, sand, clay and hematite (Iron), the latter is the main one (ANDRADE; MAGALHÃES, 2008).

#### 4.1.8 Material Culture of Serro Territory - Handicrafts

There was a time that the city of Serro was known by the five “p” handicrafts: *pote* (pot), *panela* (pan), *pito* (pipe), *peneira* (sieve) and *pente* (comb). The Serro handicrafts has relative range of simple products, which primarily cater to domestic demand.

#### 4.1.9 Synthesis of the Holistic Relief

The iconographic scheme below summarizes the Holistic Relief of the Serro region (FIG. 10).

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36 “Services “in the methodology of distribution to contribution sectors in the economy are commerce activities, accommodation, food, rent, transportation, communications, public administration.



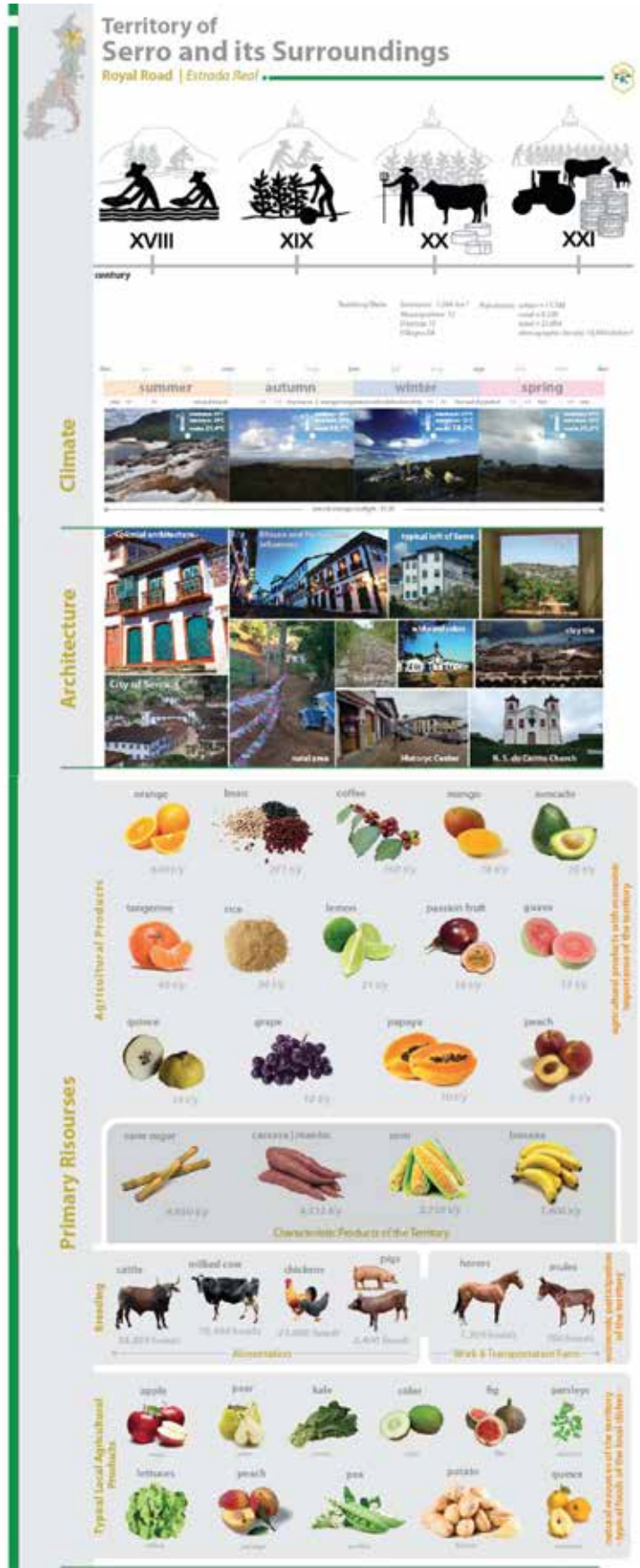


FIGURE 10-A - Relief of holistic Serro region



Local Suppliers

**Farms**

Large and Medium Producers

**Small Farms**

Rural Microproducers

Traditional Local Dishes

**'Tutu à brasileira'**

Spiced beans and sautéed vegetables of local beans, onion and garlic, served with rice and 'farofa' (fried bread crumbs).

**'Costelinha com canjica'**

Grill ribs with sautéed ground corn and tomatoes.

**'Biscoito com leite'**

Seasonal porridge with sautéed egg.

**'Tegão brasileiro'**

Grain porridge with sautéed flour, pork ribs, sausage, eggs, garlic, onion and herbs.

**'Tegão branco com doboralicha'**

White beans with sautéed flour.

**'Tro-pis-ráboli com salsinha e ango'**

String beans with sautéed ground pork.

**'Vingão com tutuão'**

Sautéed with flour.

**'Vetivale'**

Sautéed beans and sautéed pork ribs.

**'Ancho de porco com farofa'**

Spiced pork ribs with 'farofa' (seasonal sautéed flour), fried sausage, sautéed string beans and 'salada' (diced fresh vegetables).

**'Vingão ao molho preto'**

String beans with sautéed ground beef and onion.

**'Bando de leitão com feijão'**

Porc knuckle with sautéed beans and sautéed eggplant.

**'Salsinha com brócolis de semântola'**

Sautéed beans with 'fave' spread.

Legacy of Portuguese traditions, Brazilian Indian and African traditions

Local Dishes & Products

**'Vaca de leite'**

Seasonal milk.

**'Mamão verde enrolado'**

Grilled green papaya.

**'Goleada com queijo'**

Sautéed greens with cheese.

**'Marmelada'**

Seasonal jam.

**'Vinho doce com casta de leite e canela'**

Hot pudding with cheese and cinnamon.

**'Biscoito com doce de leite'**

Sautéed sautéed with sautéed milk.

**'Arrozado'**

Sautéed.

**'Cacada pronta e branca'**

Sautéed pork ribs and white.

**'Porco enrolado'**

Sautéed pork ribs.

**'Vipalura'**

Sautéed pork ribs.

A variety of natural flours combined on stone or second stone

Dairy Products

**Butter in a bottle**  
'Manteiga de garrafa'

Traditional butter in glass bottles.

**Semi-processed cheeses and derivatives: matured cheese, card cheese, butters and raw cheese**  
'Queijos de leite pasteurizado e curado, manteiga, manteiga sem sal, manteiga de leite cru.'

'Queijos de leite cru' - Seasonal Production of Minas Gerais and Cultural Heritage of Brazil (2004, 2012). Last hand change with rubber stamp and label with year of production and name of the producer. Production/Processing examples: 12 or 14 days aged cheese weighing 200g/1kg.

Dairy products are from local sources (Serra da Mantena)

Beverages

**Teas & infusions**  
'Chás e infusões'

Seasonal herbs and fruits.

**Fruit liqueurs**  
'Licor de frutas'

Seasonal liqueurs: fruit, jam, orange, milk, jam, jam, jam (fruit).

**Jaboticaba wine with rose petals**  
'Vinho de jaboticaba com pétalas de rosa'

Seasonal wine made from jaboticaba fruit and rose petals.

**'Cachaça'**

Seasonal wine made from jaboticaba fruit and rose petals.

Typical Kitchen Tools

**'Wood bin'**

Binário

**'Supper pot'**

Panela de madeira

**'Wooden spoon'**

Colher de pau

**'Wood pestle'**

Colher de madeira

**'Iron pestle and mortar'**

Colher de ferro e moedor

**'Serra clay oven'**

Forno de barro da Serra

FIGURE 10-B - Relief of holistic Serro region



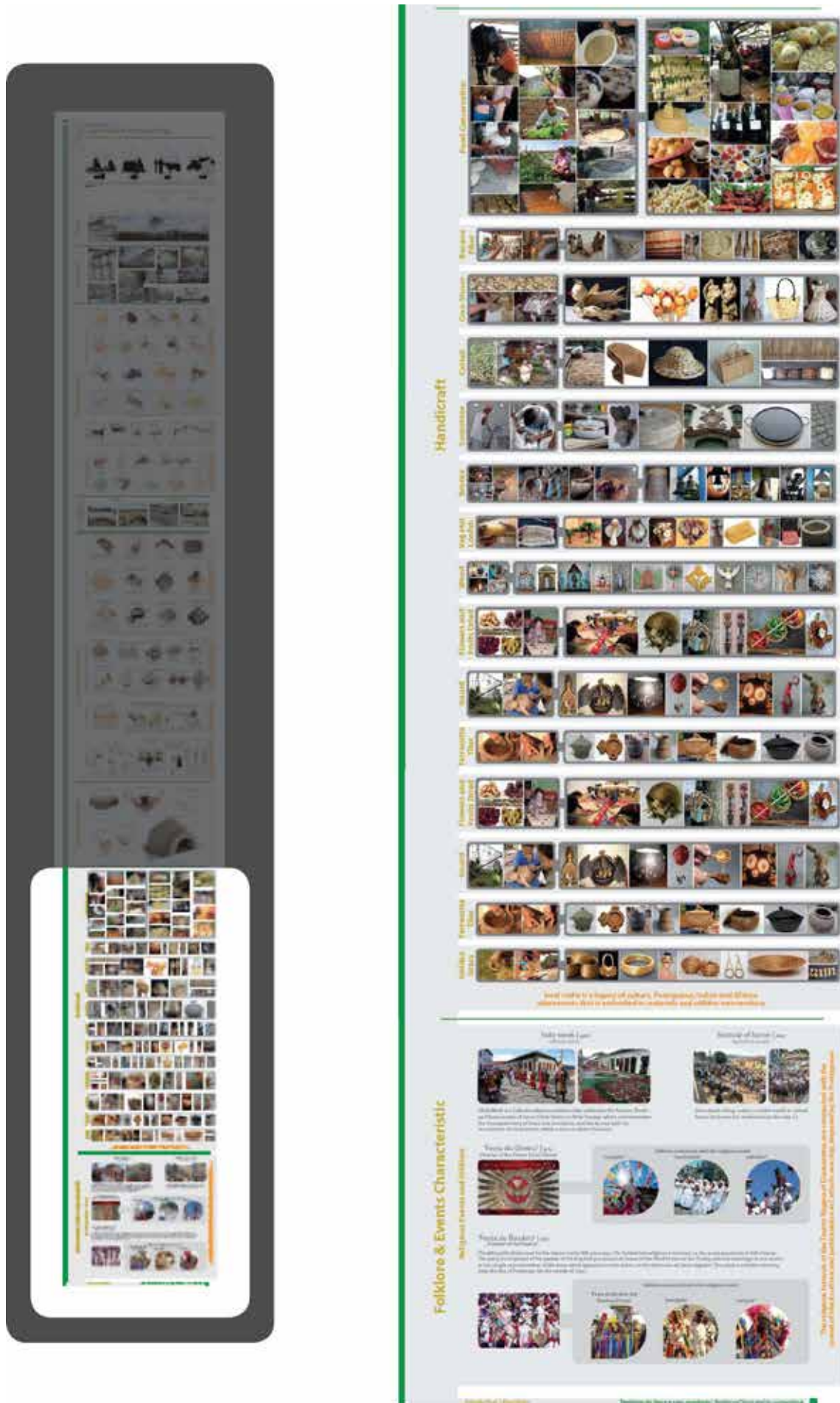


FIGURE 10-C- Relief of holistic Serro region

## 4.2 Territory selection

The selection of the territory was given from *Estrada Real* (Royal Road), in the Diamond Way. The territory of Serro (FIG. 11) comprises the communities of the towns of *Boa Vista de Lages* (Serro thorp), *Capivari* (Serro thorp), *Galheiros* (Diamantina thorp), *Pedra Redonda* (Serro thorp), *São Gonçalo do Rio das Pedras* (Serro district), and the city of *Serro*.

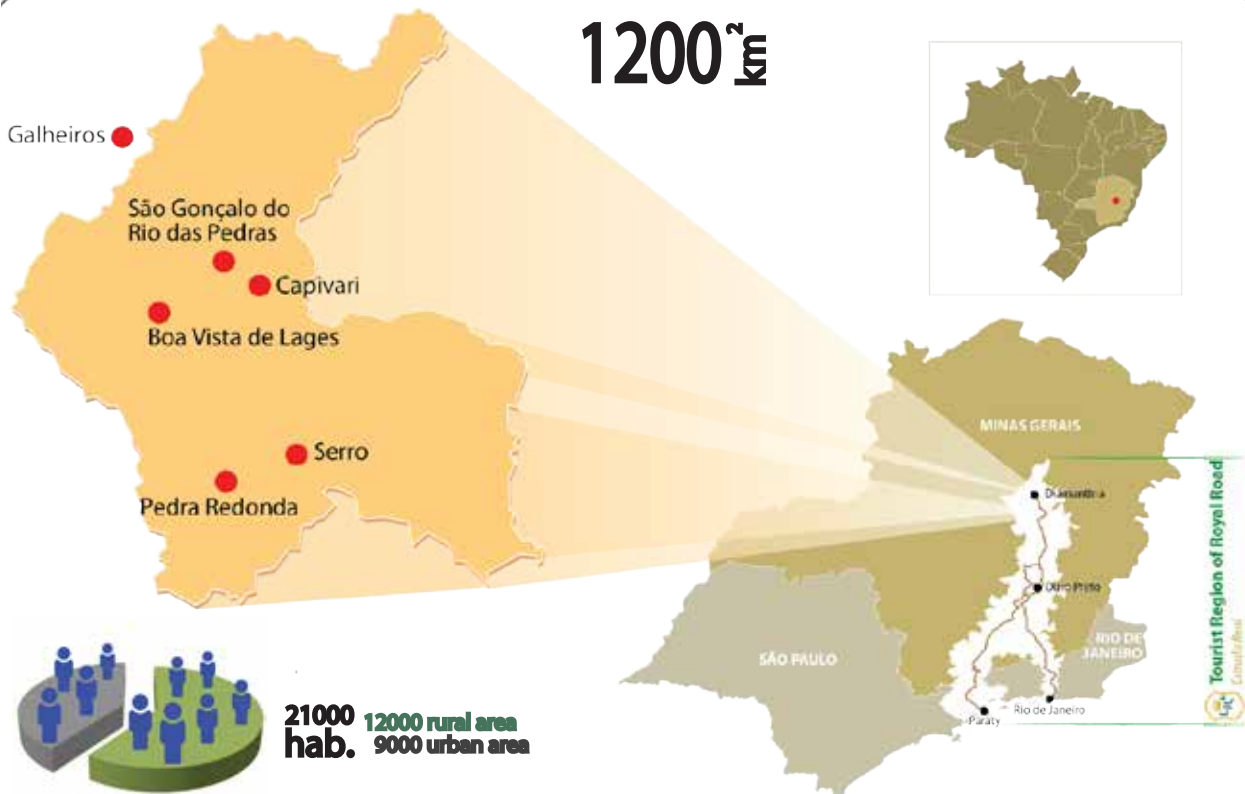


FIGURE 11 – Serro Territory

The demarcation of this territory was due to some characteristics favorable that this territory has, the study and application of Systemic Design (FIG. 12), namely:

- Strong presence of artisans: know-how;
- Use of local resources in production systems;
- Several small family businesses;
- Small communities;
- Strong link between the population and its territory;
- Production at small scales.



FIGURE 12 – Serro Territory Characteristics

### 4.3 Field research

The field survey, conducted between August and October 2014, involved visits to production sites, semi-structured interviews with artisans (digitally recorded and later transcribed), and photographic record. This research has allowed a more accurate view of production processes, know-how, and its peculiarities. Special emphasis to the retelling of the stories of their families, which started activities in this territory, and how, so far, such activities survived.

The ways of urban entertainment are imposed as symbols of changes in the forms of sociability, consisting in what is considered “modern” and “developed”, in contraposition to the values and standards of the local culture regarded as “traditional” and “conservative”.



In this context, the standards and values of urban culture become more attractive to the eyes of the younger generation: the dynamics of the consumer society deals with the culture, their expressions and regional and local manifestations as if they were objects and disposable things.

This dynamic includes an intensified mediatization of culture, where the ephemeral and the saturation of information determine a movement that goes away from the memory into the oblivion.

In this context, it is important to note that during the field research, we experience the “death” of one of the traditional activities of Serro: leather products for saddlery (FIG. 13).



FIGURE 13 – Leather products for Saddlery

The artisan (Mr. “Torresmo”), from the city of Serro, learned to fabricate these products with his father, who in turn, learned from his grandfather. The leather was derived to cattle from the region, and the wood for the small local farms structures. The work (cutting and sewing) was performed by the artisan and by a single employee who has just retired.

Mr. “Torresmo” declared that can not afford to perform the activity alone and could not find another professional, because “[...] young people do not want to learn that the ancients did and continue with this and other traditions, today they only want to know computers”. In this fact, it adds up to competition with similar products (low cost, low quality, admits the artisan) acquired from São Paulo and resold in the city. So Mr. “Torresmo” decided to abandon the activity and be one of the area resellers because, he said, such products have yet demand.

On the other hand, we can still observe some traditional activities that still resist to time, as described below. The techniques are original and father passed to son for generations. They are products involving natural resources found in the region: *Sempre-vivas* (evergreens), *Capim Dourado* (golden grass), *capim Barba-de-bode* (beard-of-goat grass), *taquara* (bamboo), corn straw and fruits of the *Cerrado* – *Mutamba*, *Macaúba*, *Pacari* and *Amesca* (FIG. 14).

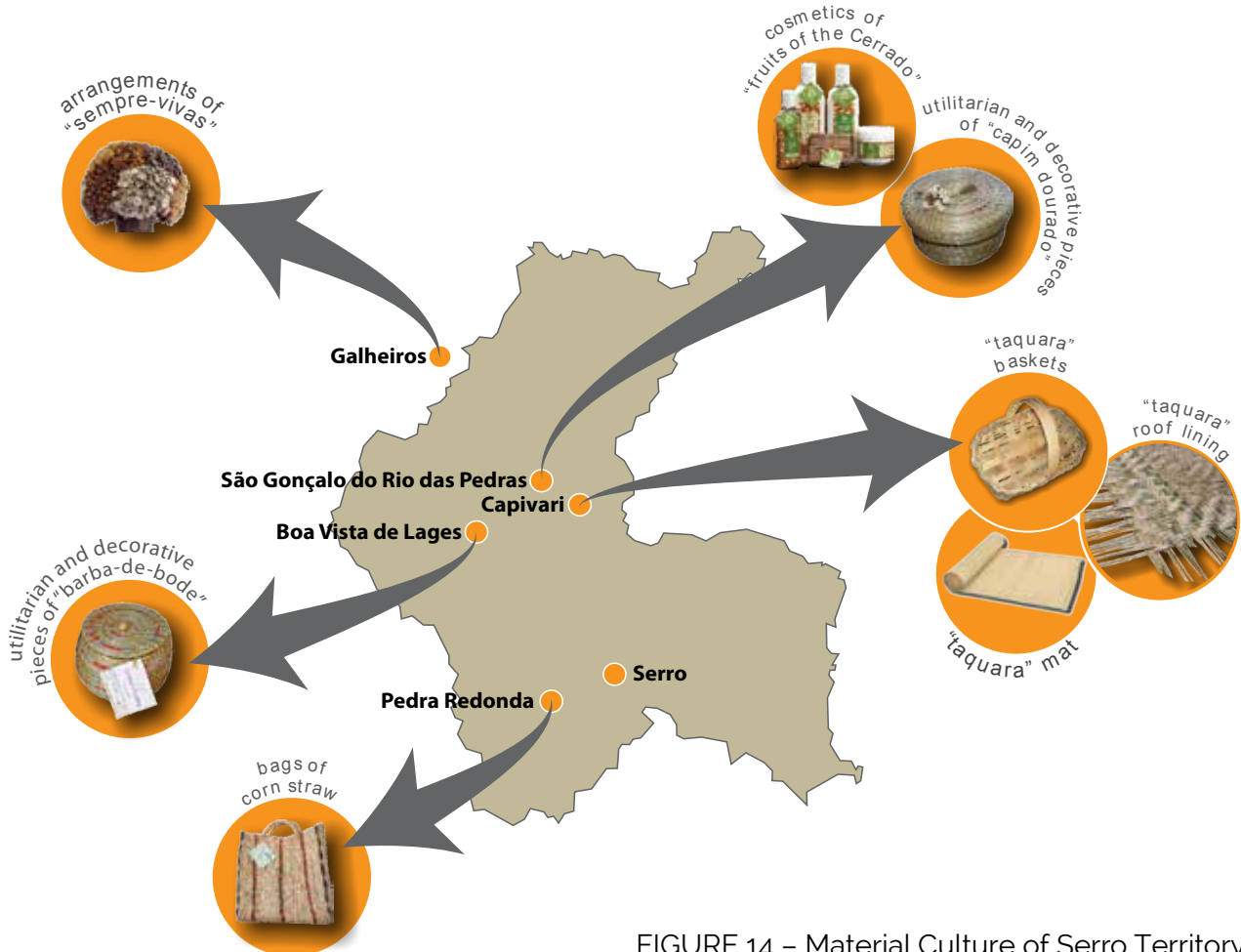


FIGURE 14 – Material Culture of Serro Territory

The items produced are found in the homes of artisans (local production) in the districts and villages in the municipality of Serro, beyond the city itself and Diamantina. Sales are also made at craft fairs, restaurants, shops and warehouses of the locality.

#### 4.3.1 Fruit of *Cerrado* Cosmetics

In *São Gonçalo do Rio das Pedras*, a district that is distant of 31 km from the district of Serro, 30 community women have created an associative enterprise handicraft production of cosmetics based on native plants region, drawing on traditional knowledge transmitted by mothers and grandmothers for many years.

This group, called *Flor do Cerrado* (*Cerrado's Flower*) (FIG. 15), was formed in 2004 in response to a demand from the community of women who have been through situations of mistreatment or social difficulties. The project that began as a collective therapy, currently, in addition to promoting the ransom of self-esteem of women and traditional culture, it works as a working generator and income, contributing to local social development.



FIGURE 15 – *Flor do Cerrado* (*Cerrado's flower*) Group of Women

The cosmetic line is produced in co-operative. The group is divided into three functions: crop, production of extracts, and manufacturing, however, all of them are able to perform all these activities. The products (shampoos and conditioners for hair, soaps and massage oils) use four fruits of the *Cerrado* found in the region, namely: *Amesca* or *Breu Branco*, *Macaúba*, *Mutamba* and *Pacari* (FIG. 16).



FIGURE 16 – *Flor do Cerrado* (*Cerrado's flower*) products

The fruits of *Mutamba* and *Macaúba*, the stem of the *Pacari* and resin *Amesca* are harvested at different times.

These materials are prepared for production by adding some components in relation to each product.

For shampoos are added:

- I) Sodium lauryl ether sulfate - Function: tensoactive with emulsifying properties, foaming, wetting and solubilizing. It is a chemical. According to the National Health Surveillance



- Agency (ANVISA), this product may cause allergic reactions if the concentration is above 50%<sup>37</sup>;
- II) Dehyton AB - Function: amphiprotic agent; tensoactive. It is a chemical German patent;
  - III) Amide 90 - Function: thickener, foam stabilizer, greasing. Is a chemical;
  - IV) Distilled water - Function: diluent;
  - V) Lactic acid - Function: humectant. Is a chemical;
  - VI) Methyl paraben (Nipagin) - Function: preservative active against Gram + bacteria. It is a chemical. According to pharmacologist Maurício Pupo, preservatives can bring harm to health. Parabens penetrate the skin and are deposited in the glands, going straight into the bloodstream and changing estrogen levels. "This is alarming because there is a huge use of cosmetics containing parabens by pregnant women and lactating women, children and patients undergoing various treatments, such as cancer, hormone replacements and chronic therapies. Today, the market has more modern or natural preservatives which, until now, have demonstrated safety, allowing the development of safer formulations<sup>38</sup>;
  - VII) Sodium chloride - Function: thickener;
  - VIII) Essence - Function: provides the aroma.
- Importantly, all of these products are purchased in *Belo Horizonte*, distant 220 km from *São Gonçalo do Rio das Pedras*.

For conditioners are added:

- I) Cetostearyl alcohol - Function: greasing, thickener and emulsifier. Is a chemical;
- II) Cetyl alcohol - Function: emollient, moisturizing and stabilizing agent. Is a chemical;
- III) Butylhydroxytoluene (BHT) - Function: antioxidant and preservative. It is a chemical. Not readily biodegradable and has the potential to bioaccumulate<sup>39</sup>;
- IV) Mineral oil - Function: emollient, solvent and hair conditioning agent. It can affect the water quality of the water table. Not readily biodegradable<sup>40</sup>;
- V) Propylene glycol - Function: solvent, antiseptic, emulsifying, wetting, viscosity donor. Is a chemical;
- VI) Glicerina - Função: umectante;
- VII) Metil parabeno (Nipagin) - Function: preservative active against Gram + bacteria. It is a chemical<sup>41</sup>;

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37 Available in: <[http://www.anvisa.gov.br/cosmeticos/informa/parecer\\_lauril.htm](http://www.anvisa.gov.br/cosmeticos/informa/parecer_lauril.htm)>. Accessed in: Feb. 03. 2015.

38 Available in: <<http://www.maisequilibrio.com.br/beleza/de-olho-na-composicao-de-cosmeticos-6-1-5-340.html>>. Accessed in: Feb. 03. 2015.

39 Available in: <[http://www.emfal.com.br/alcool/\\_ArquivoProdutos/58092.pdf](http://www.emfal.com.br/alcool/_ArquivoProdutos/58092.pdf)>. Accessed in: Feb. 02. 2015.

40 Available in: <[http://www.emfal.com.br/alcool/\\_ArquivoProdutos/59248.pdf](http://www.emfal.com.br/alcool/_ArquivoProdutos/59248.pdf)>. Accessed in: Feb.02. 2015.

41 Available in <<http://www.maisequilibrio.com.br/beleza/de-olho-na-composicao-de>

- VIII) Propylparaben (Nipazol) - Function: a preservative antimicrobial activity, bacteriostatic and fungistatic. Is a chemical;
- IX) Ethylenediamine tetraacetic acid (EDTA) - Function: metal sequestrant, preservative, antioxidant. It is a chemical, is not biodegradable and has adverse effects on aquatic organisms<sup>42</sup>;
- X) Quaternary ammonium - Function: cationic surfactant. It is a chemical. Not easily biodegradable, can contaminate water, air, soil and cause damage to the flora and fauna<sup>43</sup>;
- XI) Essence - Function: provides the aroma;
- XII) Distilled water - Function: diluent;
- XIII) These products are also obtained in Belo Horizonte.

For soaps are added:

- I) Glycerin base - Function: solvent base for the manufacture of soaps;
- II) Essence - Function: provides the aroma.  
These articles are purchased, also in Belo Horizonte.

For massage oils are added:

- I) Essence - Function: provides the aroma.  
Just like the previous ones, acquired in Belo Horizonte.

The packaging material in conditioning shampoos, hair conditioners and massage oils is high density polyethylene (HDPE), derived from petroleum. This thermoplastic are recyclable, opaque, waterproof, rigid, with excellent chemical and mechanical resistance, qualities that are certainly adjusted to the products conditioning needs. These packages are purchased in *Belo Horizonte*.

The self-adhesive labels, aggregated to packaging, are also plastic material. Already the tag are made of paper. These are produced in *Diamantina*, 22 km away to *São Gonçalo do Rio das Pedras*.

The material used in the packaging of soaps are banana leaves, acquired in the region. The group itself prepares the wrappers.

As the artisans only harvest the amount of raw material that will be used, and only acquire the amount of chemicals and corresponding packaging production at the moment, there is no waste generation apparently. On the other hand, plastic and glass chemicals are directed to collect regular garbage of the city.

Products are arranged in a small selling point in the city, in the same place of production.

The marketing of products is strictly local, namely: the store managed by the group itself, in guesthouses, restaurants and markets of

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cosmeticos-6-1-5-340.html>. Accessed in: Feb. 03. 2015.

42 Available in: <<http://www.fca.unicamp.br/portal/images/Documentos/FISPQs/FISPQ-%20EDTA%20Acido.pdf>>. Accessed in: Feb.2. 2015.

43 Available in: <[http://www.emfal.com.br/alcool/\\_ArquivoProdutos/59391.pdf](http://www.emfal.com.br/alcool/_ArquivoProdutos/59391.pdf)>. Accessed in: Feb.04.2015



FIGURE 17 – Trading

São Gonçalo do Rio das Pedras (FIG. 17), in the cities of *Milho Verde*, *Gouveia*, *Serro* and *Diamantina*, in addition selling door-to-door.

However, for while the trade is done informally. The main difficulties encountered by the group to carry forward the project are the trademark registration and product formulas, and hire a chemical that authorizes the lawful marketing of the products, as there are some procedures that should be performed by the National Surveillance Agency Health (ANVISA)<sup>44</sup>.

In this sense, the University of the State of Minas Gerais (UEMG) is already working to address these barriers through the Center for Technological Innovation and Technology Transfer (NIT).

#### 4.3.1.1 Characteristics of the Amesca or *Breu Branco*

The *Protium heptaphyllum*, the *Burseraceae* family, is popularly known as Amesca or *Breu Branco* (FIG. 18). It is a medium-sized tree, between 20 and 30 meters high. Its trunk is thick, between 50 and 60 cm in diameter at the base and has a dark red shell. This tree grows in the areas of land in sandy and clay soil, abundant in the organic areas<sup>45</sup>.

According to Ferrão (2001), the species is originated from the Antilles and all of South America, it is found in upland forest, in the *Cerrado* (MAIA; ZOGHBI; ANDRADE, 2001) and in the Pantanal (GUARIM NETO, 1987). Bandeira *et al.* (2007) report that this specie is found in Brazil in damp or dry sandy soils, which are prevalent in the Amazon region.

44 “To ensure the consumer to purchase safe and quality products, ANVISA is responsible for the marketing authorization of toiletries, cosmetics and perfumes, by granting registration or notification. Anvisa also oversees and establishes standards for manufacturers, checking the production process, the techniques and methods used to final consumption”. Available in: <<http://www.portal.anvisa.gov.br/wps/content/Anvisa+Portal/Anvisa/Inicio/Cosmeticos>>. Accessed in: Feb.12. 2015.

45 Available in: <<http://www.amazonoil.com.br>>. Accessed in: Feb.26. 2015.



FIGURE 18 – Amesca – Tree

Source: <<http://www.refloresta-bahia.org>>

The leaves of *Protium heptaphyllum* are composed, with odd number of follicles (such as feathers). The flowers are gathered in fascicles (curl-shaped bouquet) axillary, with numerous red flowers. The fruits are the kind that has many distinguished seeds, dehiscent (opening) with red peel protecting one or two seeds wrapped in white pulp mild, sweet flavor and refreshing, can be consumed *in natura*<sup>46</sup>.

According to Lorenzi (1992), flowering occurs during the months of August and September, and the ripening of fruits between November to December. According Guarim Neto (1991), the plant produces annually a large amount of viable seeds, widely distributed by birds of several species, that take the aryl surrounding the seeds.

This specie expels large amounts of resin, white-reddish color, known as *almécega-do-brasil* (mastic of the Brazil), gum lime, due to its aroma, or *Breu Branco* (pitch-white). The resin production in *Protium heptaphyllum* is stimulated by the larva of an insect of the family *Curculionidae*, which remains on the tree until adulthood<sup>47</sup>. According to Bandeira *et al.* (2007) resin is a generic name of a class of substances. It is a flammable viscous liquid, translucent yellow / brown color to white.

Initially, the *Breu* has brilliant white color, resembling a mineral. Over time, it solidifies to form a stiff dough, whitish and gray or gray-green, very brittle and highly flammable. To find it in the trunk, sees the clear reflection of the recently expelled resin, similar to a rough stone embedded in the wood, which exudes fresh scent when touched. To remove resin from the trunk of the tree, takes place the knife under the base of the crust to remove it. The *Breu* is collected from the trunk and

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46 Available in: <<http://www.colecionandofrutas.org>>. Accessed in: Feb.26. 2015.

47 Available in: <<http://www.seresvivosdorn.blogspot.it>>. Accessed in: Feb.26. 2015.

manual way to the floor, all year long, but especially in the summer. After collection, should be placed to dry the shade and then stored in bags or jute fiber. The first cut in the *Breu Branco* tree can be done between 8 and 10 years. When it is not extracted, the Breu will “mature” and solidifying to fall to the ground and then appear again on the tree trunk. To have a sustainable exploration, they are not recommended more than two to three cuts per year<sup>48</sup>.

According to Susunaga (1996), the resin of *Protium heptaphyllum* has a high content of amyrin (40.98%), being classified as “*elemi*”. When dry, it has a high yield of essential oil (2.5%) having as main components the monoterpenes,  $\alpha$ -terpinolene (24.25%), limonene (20.12%) and dillapiol (8.05%).

The major components identified in this species sheets were monoterpenes and sesquiterpenes such as myrcene (18.6%) and  $\beta$ -caryophyllene (18.5%); in the resin oils, monoterpenes were verified as  $\alpha$ -pyrene (10.5%), limonene (16.9%),  $\alpha$ -phellandrene (16.7%), and terpinolene (28.5%); and oil of the fruit,  $\alpha$ -pyrene (71.2%) (BANDEIRA *et al.*, 2001).

According to Corrêa (1984), the wood of *Protium heptaphyllum* is white-reddish, with darker, compact, uniform core, wave and silky. It is moderately heavy (density 0.77 g / cm<sup>3</sup>), compact, hard, interlocked, but docile to the shaver, quite elastic, highly durable when in dry places.

Like so many others, the White Breu is a sacred plant for the indigenous people, who use their resin in healing rituals and spiritual ceremonies to “ward off evil spirits” and the physical problems<sup>49</sup>.

In folk medicine, this species is considered an important therapeutic agent being used as anti-inflammatory, analgesic, expectorant and healing (BANDEIRA *et al.*, 2002). Revilla (2002) highlights the popular therapeutic indications: weak headache, venereal diseases, schistosomiasis, to cause sleep, antidiarrheal, against gangrenous ulcer, general inflammation, bowel neuralgia, eye diseases, hernia and headache.

The extracted resin stem is used as an antitumor for bronchitis, cough, whooping cough, antiseptic place, as a stimulant (MAIA, ZOGHBI; ANDRADE, 2001) and to treat venereal diseases (REVILLA, 2002). The resin mixed with peel and leaves is disinfectant and healing (SUSUNAGA, 1996). Recent pharmacological studies with oil resin confirmed its therapeutic efficacy, demonstrating anti-inflammatory, antineoplastic and contraceptive activity (BANDEIRA *et al.*, 2002).

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48 Available in: <<http://www.amazonoil.com.br>>. Accessed in: Feb.26. 2015.

49 Available in: <<http://www.bioorganicosbrasil.blogspot.it>>. Accessed in: Feb.26. 2015.



The bark is hemostatic, wound healing, anti-inflammatory and useful in the treatment of gangrenous ulcers (LORENZI, MATOS, 2002). From the stem bark is prepared a syrup for the treatment of coughs, bronchitis and fads (GUARIM NETO, 1987).

The fruits produce a yellow resin, oil, used in folk medicine in curing syphilis, pimples, sores, swellings and headache (ARBELAEZ, 1975). The Chaco indigenous people, from Colombia and Panama, consume the pulp of the fruit.

The essential oil of fruits and leaves inhibits the formation of flagella in the infective form of the parasite *Schistosoma mansoni*<sup>50</sup> (SUSUNAGA, 1996) and shown to have antifeedant effect on larvae of *Spodoptera frugiperda* (caterpillar of the cartridge corn) (SILVA; BAPTIST; FAVERO, 2002).

The leaves are hemostatic (LORENZI; MATOS, 2002) and healing (SUSUNAGA, 1996).

Its resin is quite used in the manufacture of cosmetics (BANDEIRA *et al.*, 2001), toiletries and perfumery (REVILLA, 2001), such as in fragrances for perfumes, soaps, creams, shampoos and conditioners, aromatic oils and environmental flavorings. When burned, the resin exudes a very aromatic smell, so it is used as incense, as well as in the manufacture of aromatic powders and sachets (REVILLA, 2001). The resin is also used in the manufacture of varnishes and paints (BANDEIRA *et al.*, 2001), in the manufacture of candles (REVILLA, 2001), and sealing vessels mixing it with oil or sebum under the heat of fire. It also highlights its use by the population as an insect repellent (BANDEIRA *et al.*, 2001) and for smoking process and houses lighting (SUSUNAGA, 1996).

According to Lorenzi (1992), the wood of *Breu Branco* is suitable for construction, internal works, floors, lathe services, carpentry and joinery.

In aromatherapy it is used for physical and energetic cleansing. It has a stimulating effect and helps concentration<sup>51</sup>.

The specie can be used for plant reforestation in degraded areas of permanent preservation, mainly along rivers and streams (LORENZI, 1992). Its use is also recommended in squares, gardens, parks and even in trees sidewalks due also to their ornamental qualities.

In tests conducted at the Pharmaceutical Sciences School of the University of São Paulo in Ribeirão Preto, the oil produced by the *Breu*

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50 *Schistosoma mansoni* is a parasite that is responsible for schistosomiasis, a serious parasitic disease that causes millions of deaths annually.

51 Available in: <<http://www.aloucadosperfumes.com>>. Accessed in: Feb.22. 2015.

*Branco* showed antioxidant potential and its use can protect skin cells from solar radiation. The druggist Ana Luiza Forte, who led the study, found in the stem extract, substances that can neutralize free radicals, unstable molecules generated during excessive exposure to sunlight that can damage the components of cells, particularly lipids. Her proposal is to use the *Breu* extract incorporated into a gel to the skin, which would act as a protective layer against the sun's rays. She explains that the product would act neutralizing free radical molecules and reactive oxygen species that can interact with structures present in the skin causing damage in that tissue. "Excessive sun exposure induces production of these molecules so exacerbated that the natural protection of the skin are not able to remove them". The damage caused by these molecules may, in turn, lead to the appearance of aging and skin cancer. The gel polymer base proved to be the best option for formulating the extract, for its efficiency in the release and penetration of active substances. Tests on mice confirmed the protective gel action in the fight against free radicals. The next stage of the research, which still depends on resources, will be human tests. Forte believes in the product's potential, which could be used in combination with sunscreens, making them more effective. "Occasionally, the sun's rays can cause degradation of sunscreens leading to loss of its effectiveness. The use of antioxidants can help prevent this problem"<sup>52</sup>.

Currently wood, bark and leaves of *Breu* are marketed. The biggest consumer is the retail in local markets and, on a lesser scale, in wholesale to producing companies of repellents and phytotherapeutic goods. (REVILLA, 2001).

It is also worth noting that the *Breu* is used in the line of products called *Ekos*, by company Natura<sup>53</sup>. This company accessed the genetic component of this plant on the Reserve of Development of Iratapuru river, in Amapá, using the traditional knowledge of the community of San Francisco Iratapuru as a basis for their research. The Community, represented by the Mixed Cooperative of Extractive Producers of the Iratapuru River (Comaru), provides the *Breu Branco* for the company (PEREIRA; LIMA, 2008).

According to the Group of Women *Flor do Cerrado* (Cerrado's flower), the plant produces an aromatic resin, soothing, indicated to soften and smooth the skin. Its powder is used in soaps produced by the Group, promoting a gentle exfoliation of the exposed layers of the skin.

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52 Available in: <<http://www.cienciahoje.uol.com.br/noticias/2013/02/da-floresta-para-a-pele>>. Accessed in: Feb.28. 2015.

53 Natura is Brazil's largest company in the personal care industry, perfumery and cosmetics. In its vision of sustainability, declares that its existence should help to make better the environment and society, not just reducing and neutralizing the negative impacts of its activities, but generating positive impacts on economic, social, environmental and cultural spheres. Available in: <<http://www.natura.com.br>>. Accessed in: Feb.10.2015.

#### 4.3.1.2 Characteristics of *Macaúba*

The *Macaúba* (*Acrocomia aculeata*), belongs to the family *Arecaceae*, is a large economic potential of plant, it can be completely utilized (FIG. 19). It is a perennial palm tree, 10 to 15 m long and 20 to 30 cm in diameter. The node area is covered by dark spikes, sharp with about 10 cm long. Green leaves, arranged in different levels, giving a feathery aspect of the top of the tree (LORENZI *et al.*, 1996). The tree is fast growing, reaching grow one meter per year until they reach the normal size (MACHADO *et al.*, 2010).

This palm has strong interaction with wildlife, its fruits are part of the diet of macaws, capybaras, tapirs, emus and other animals, which are the dispersal of seeds (POTT; POTT, 1994) and also domestic animals like cattle, which contribute to their dispersion (TELES, 2009). It is fire resistant, springs even after burned, have good drought tolerance and are not attacked by ants (ANTONIASSI *et al.*, 2012).

Between the leaves there is the spathe of up to 2 m in length, with the yellow inflorescences and fruit clusters of yellowish brown tone. The flowers, of pale yellow color, are unisexual and both sexes appear in the same inflorescence. The female flowers are borne at the base of the inflorescence and the male on top (SILVA, 1994).



FIGURE 19 – *Macaúba* – Tree

Source: <<https://www.ssl.panoramio.com>>

Pollination occurs mainly by beetles and the wind. The main pollinators are *Andranthobius sp.* (*Curculionidae*), *Mystrops Mexican cf* (*Nitidulidae*) and *Cyclocephala forsteri* (*Scarabaeidae*). The inflorescences of *Macaúba* serve as feeding sites, protection, mating and reproduction for these species of coleopterans. The inflorescence is also visited by bees *Trigonia* group that collect pollen from male flowers and pollinate the female flowers (SCARIOT; LIERAS 1991).



The *Macaúba* is a native palm of the Americas. It is widely distributed in almost the entire territory of Brazil, where it occurs natively in practically all Brazilian states and in greater abundance in the states of Minas Gerais, Mato Grosso, Mato Grosso do Sul and the western state of São Paulo (LORENZI, 2006).

Its composition depends on the degree of ripeness of the fruit. When green, it is very rich in moisture, low in fatty acids, and its fibers are strongly bonded to other tissues, and is handling virtually unenforceable. Ripe, the pulp is sweet, flavored and rich in lipids (SILVA, 2009).

The fruit of *Macaúba* is the most representative product economically of the palm. It is composed of four distinct parts: on average has 20% peel (epicarp), 40% pulp (mesocarp), endocarp 33% and 7% almond (endosperm) (FIG. 20). Oil contents are slightly larger in the pulp (60%) in relation to the kernel (55%) (BHERING, 2011).

The fruits are spherical or slightly flattened, with a diameter ranging from 2.5 to 5.0 cm. The epicarp breaks up easily when ripe. The mesocarp is fibrous, mucilaginous, sweet tasting, rich in glyceride, yellow or whitish color, edible. The endocarp is strongly adhered to the pulp, with blackened bone wall, and the oily endosperm, edible, is coated with a thin seed coat layer. Each fruit generally contains a seed enclosed in hard and dark core and approximately 3mm thick (SILVA, 1994).

When ripe, the fruit gives off a characteristic aroma and the peel easily loose pulp, when green, the peel is very adhered to the pulp. The peel is thin, easily broken (MACHADO *et al.*, 2010).

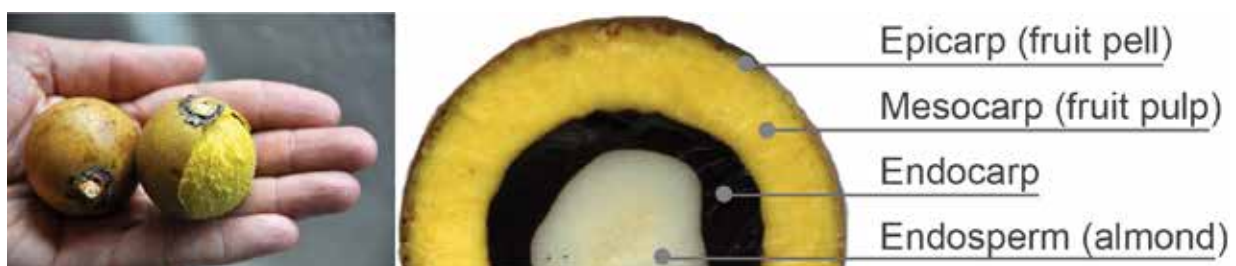


FIGURE 20 – *Macaúba* – Fruit

As the pulp is sweet, it is much appreciated by the children. Its bark is used to power furnaces, household stoves and charcoal production on an industrial scale. As animal feed, oily pulp has more frequent use in fattening pigs (MACHADO *et al.*, 2010). However, the cattle also eat in pasture areas, stimulating the production of milk (NUCCI, 2007).

Both the pulp and almonds of *Macaúba* produce oil of excellent quality for both human consumption and for the chemical industry in the manufacture of cosmetics, waxes and biofuel (MACHADO *et al.*, 2010).

The pulp *Macaúba* fruit has orange color due to high concentrations of carotenoids, wherein the  $\beta$ -carotene corresponds to 82% of the total composition. Other carotenoids are also found in smaller quantities such as  $\gamma$ -carotene,  $\beta$ -cryptoxanthin and cis lycopene (RODRIGUEZ-AMAYA; KIMURA; AMAYA-FARFAN, 2008).

The role of carotenoids in human health is related with pro-vitamin A activity and antioxidant. Act as response regulators of the immune system and reduce the risk of degenerative diseases such as cancer, cardiovascular disease, cataracts and macular degeneration. The crude oil *Macaúba* pulp is capable of reducing the rate of lipid oxidation reactions. This functionality is important in maintaining the oxidative stability of the oil during storage. The  $\beta$ -carotene is an excellent source of provitamin A when consumed raw in the form of olive oil (RODRIGUEZ-AMAYA; KIMURA; AMAYA-FARFAN, 2008).

According to the Brazilian Table of Food Composition (TACO, 2011), the fresh pulp of *Macaúba* shows 41.4% moisture, 2.1% protein, 40.7% lipids, 1.8% ash, 13.4% of dietary fiber and 13.9% of total carbohydrates, providing 404 kcal/100g. Thus, both the pulp as almond, being rich in lipids, become alternative raw material for biodiesel production and for food, detergent, soap and cosmetic industries.

The oil of *Macaúba* pulp, by having a predominance of unsaturated oleic type fatty acid, closely resembles the olive oil in relation to the percentage of saturation and the fatty acid composition in greater quantities, which establishes it between the High quality oils for edible purposes (ANDRADE; MARQUES; ZAPPI, 2006). The *Macaúba* can produce up to 10 times more oil per area than soybeans (ROSCOE; RICETTI; MARANHO, 2007).

Among the fatty acids contained in *Macaúba* of fruit oils stand out oleic, lauric, palmitic, linoleic, myristic, caprylic, capric, palmitoleic, linolenic and stearic. Oleic acid is an essential fatty acid (omega 9) found in the pulp, peel and almonds. Participates in the human body metabolism, playing a key role in the synthesis of hormones. It is known to promote increased biliary secretions that stimulate peristalsis. Strengthens the body's tissues, tones the nerves and calms the mucous membranes. It is believed that it assists in dissolving cholesterol deposits in arteries. It is widely used as an additive in base soaps and soap to give lubricity and softness. Internationally, it is used as a biological crop protection, ingredient in formulation of cosmetics, for food purposes in general and as an additive supplier to flavor food and drink (ANDRADE *et al.*, 2006).

Lauric acid is found in almond. It is tapped in the manufacture of surfactants for shampoos such as sodium lauryl ether sulfate, sodium lauryl ether sulphosuccinate, ammonium lauryl sulphate and triethanolamine lauryl sulfate. Can be reacted with glycerin to form monolaurin, which is a powerful anti-bacterial agent, anti-viral and anti-protozoan. Recently used in medicine and pharmaceutical industry in herpes simplex treatment and in reducing HIV viral load as it destroys the protective cover of the AIDS virus. Internationally, it is employed as a biological crop protection; additive for food purposes in general, as an emulsifier, surfactant and cleaning agent in cosmetic formulation (ANDRADE *et al.*, 2006).

Palmitic acid is found in the peel, in the pulp and in the almond. It is one of the fatty acids most frequently used in the manufacture of shaving creams, and in creams and emulsions cosmetic formulations. Internationally, it is tapped as a biological crop protection, as an additive flavor supplier of food and drinks, as emollient and emulsifying agent in cosmetics formulation and for food purposes in general (ANDRADE *et al.*, 2006).

Linoleic acid is found in the flesh, peel and almonds. It is one of the essential fatty acids (omega 6) which can reduce the bad LDL cholesterol and total cholesterol. However, high consumption may lower the good cholesterol HDL. Usually, it has been used in the manufacture of margarine, butter for cake, salad and cooking oils. Internationally, it is used as a biological crop protection, as an additive supplier of flavor to foods and beverages, as emollient in cosmetics formulation and for food purposes in general (ANDRADE *et al.*, 2006).

The myristic acid is found in almonds. It is one of more fatty acids used in making soaps, because the average size of its chain that provides good detergency with soaps, cleaning power and scum. The myristic acid is used in cosmetic creams and emulsions formulations. Internationally, it is employed as a biological crop protection, as an additive flavor supplier of food and drinks, as an emulsifier in cosmetics formulation and for food purposes in general (ANDRADE *et al.*, 2006).

Caprylic acid is found in almond. It is very used in cosmetic emulsion creams, conditioners, in formulations of shampoos and stick deodorants. Can react with glycerin to form a product with emollient and lubricating properties and is used infant bath oils and oils for the skin of babies. They are widely used in synthesis and manufacturing of perfumes and fragrances. Internationally, it is used as a biological crop protection, as an additive supplier of flavor to foods and beverages, as an emulsifier in cosmetics formulation and for food purposes in general (ANDRADE *et al.*, 2006).

The palmitoleic acid is found in the peel and pulp. Internationally, it is used as a biological crop protection, as an additive supplier of flavor to food and beverages and for food purposes in general (ANDRADE *et al.*, 2006).

The stearic acid is found in the peel, pulp and almond. As a consequence of the presence of the carbon-carbon bond, a hydrocarbon chain has flexibility, which makes it an important ingredient for the manufacture of margarine (reduces the melting point of the same). Internationally, is used as a biological crop protection as an additive supplier of flavor to foods and beverages, as an emulsifier and stabilizer in cosmetic formulation and for food purposes in general (ANDRADE *et al.*, 2006).

The linolenic acid is found in the pulp and peel. It is one of the essential fatty acids (omega 3). Your intake lowers the level of triglycerides and total cholesterol in the body. Its high consumption can slow blood clotting. Internationally, it is tapped for food purposes in general, as an additive supplier of flavor to foods and beverages and as an emollient in cosmetics formulation (ANDRADE *et al.*, 2006).

The oil of the *Macaúba* fruit pulp is considered a good soap agent and is commonly used in the manufacture of soap. In agriculture, it is used to combat *mosca-dos-chifres*<sup>54</sup> (horn fly) and *bicho-mineiro*<sup>55</sup> (leaf miner), and as a fixative of insecticides and pesticides. In the ceramic industry it is used as a release agent and in tanning is employed as greasing agent (TECHNOLOGICAL CENTER OF MINAS GERAIS FOUNDATION, 1983).

The thermal analysis indicated high oxidative stability for crude and refined oil *Macaúba* pulp, being similar to olive oil and higher than soybean and sunflower oil. This property allows its use in frying processes, and ensure greater stability during storage process. The oil *Macaúba* pulp meets the demand of oil with nutritional and industrial desirable characteristics (NUNES, 2013).

The oil of the fruit of the *Macaúba* almond also stands out for its pharmaceutical characteristics, and is used to combat bronchitis and other respiratory diseases (ANDRADE *et al.*, 2006). In this context, still stand out its use as a laxative, tonic and analgesic (headache and neuralgia). In the cosmetics area, it is tapped as hair moisturizer (NUNES, 2013).

The chromatographic analyzes showed that the oils *Macaúba* can be distinctly used, with energy potential for oil of the pulp and for the pharmacological oil of the almond (AMARAL, 2007).

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54 The “*mosca-dos-chifres*” – horn fly (*Haematobia irritans*) is considered a pest in many countries and as a major problem for the cattle. Its hematophagous activity is not its most harmful aspect, since its main effect is irritation to the infested animal, leading it to the critical state of stress. As a consequence, the animal loses interest in food and no rest, leaving it extremely agitated.

55 The “*bicho-mineiro*” – leaf miner (*Leucoptera coffeella*) is perhaps the most important pest of coffee. Injuries caused by the caterpillars of leaf miner in the leaves reduce photosynthetic capacity due to the reduction of leaf area. The main consequence for agriculture is that plants lose considerable areas of their leaves, making them weaker and committing the next harvest.

The pie almond, obtained from the pressing the almond for extraction of the oil, is rich in protein, so it is highly valued as an ingredient to make animal feed. It is a rich concentrate in omega 3 and omega 6, suitable for feeding birds, increasing production and the size of eggs (SILVA *et al.*, 2008).

There are several reports of traditional use of *Macaúba* as a source of oil for food purposes, production of soaps and burning for lighting and heating purposes. This palm has significant potential for production due to the high oil content and ability to adapt to dense populations. The potential productivity per area resembling the *dendê* palm, reaching more than 4 tonnes of oil / ha (BHERING, 2011).

Its oil can also be used as a lubricant for machinery, fuel, replacing diesel oil, coal, tar, among others, stressing that the palm tree has great potential for oil production with extensive application in the industrial and energy sectors<sup>56</sup>.

The leaves of *Macaúba* are used as animal feed or raw material to obtain fibers for the production of fishing lines, ropes and nets. Petiole of the leaves, then separate into strips, they are made baskets, baskets and hats (MACHADO *et al.*, 2010). Bhering (2011) also highlights the use of the leaves as fodder and textile fibers.

The pulp and flour, taken from its fruits are rich in vitamin A and beta-carotene, which can be utilized in the manufacture of juices, ice cream, cakes, breads and pastries<sup>57</sup>. Amaral (2007) adds the use of the pulp in the manufacture of chewing gum, liquors and cooking oil.

The pulp cake, residue left on pressing of the pulp, consists of ash, extractive, protein, lignin, fiber and sugar, being richer in these last two. Due to its chemical composition, the residual cake of pulp may have various destinations, such as industrial boiler fuel (heater power = 4706 Kcal / kg) as a fertilizer (is rich in potassium, sodium, calcium and phosphorus), or as ingredient in feed for ruminants (SILVA *et al.*, 2008). Machado *et al.* (2010) point out that the ash is being incorporated into the concrete in construction to minimize the use of cement.

The skin and pulp pies proved poor in protein, but rich in fiber, can be used for soil fertilization, as well as heat input to the boilers and foundries (SILVA *et al.*, 2008).

The endocarp is a very hard and tough lignified tissue. Because of its high gross calorific value (5104 kcal / kg) emphasizes the impor-

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56 Available in: <<http://www.todafruta.com.br>>. Accessed in: Feb.15. 2015.

57 Available in: <<http://www.cerratinga.org.br>>. Accessed in: Mar.04. 2015.

tance of its use as fuel, either in direct form or in carbonized form. Carbonization of the endocarp may provide an excellent quality of charcoal<sup>58</sup> when compared to coal, especially as regards its low ash, no sulfur, high density and controllable fixed carbon and volatile matter (SILVA *et al.*, 2008). The hard Endocarp can easily replace the gravel concrete or be used as material for making handicrafts (AMARAL, 2007).

The stipe (trunk) is used as wood fence post, boards, slats, troughs for water rafters for construction of houses and barns, etc. (AMARAL, 2007). Your core is obtained the palm heart, widely consumed by residents of regions where this species is abundant. Cooked and fermented, it produces a wine appreciated in the countries of Central America (MACHADO *et al.*, 2010).

Besides *Macaúba* protect roots against soil erosion<sup>59</sup>, they can still be used as diuretic. Its sap can be used to combat fever (SOUZA, 2013).

According to Pio Correa, in the Diamantina region is used the outer covering *Macaúba* coconut in making ornaments and handmade ornaments such as rings, cufflinks and chains<sup>60</sup>.

Research has shown that the peel, dried and crushed, can be used as valuable resource in combating child malnutrition, to have iron content four times higher than the “multimix” in addition to reasonable concentrations of calcium and phosphate. Thus, the bark *Macaúba* can replace some components of this food supplement normally distributed by the *Pastoral do Menor*<sup>61</sup> (Minor Pastoral), such as sunflower seed and peanut, scarce in the northeast region in the dry season, during which increases child malnutrition (BHERING, 2011).

According to the *Grupo de Mulheres Flor do Cerrado* (Cerrado's flower Women Group), oil *Macaúba* coconut has light texture, easily absorbed by the skin. It is nourishing and relaxing. Used in body massages, oil relaxes sore muscles, activates circulation and promotes the elimination of toxins, also relieving headaches. Incorporated into the cream and soap, is indicated for the treatment of chapped and dry skin. Used in the preparation of shampoo and conditioner for dry hair, devitalized and weakened tips, returns the brightness and nourish the hair strands.

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58 Charcoal of the endocarp is the product obtained by co-carbonization process thereof which is removed for processing almond.

59 Available in: <<http://www.macaúba-multivias.blogspot.it>>. Accessed in: Feb.25. 2015.

60 Available in: <<http://www.acaúba-belezadacaationga.blogspot.it>>. Accessed in: Feb.16. 2015.

61 The “*Pastoral do Menor*” (Minor Pastoral) is a Church's evangelizing action in Brazil that is guided by General Directives of the CNBB, assuming postures commitment with the poor and oppressed, always from the perspective of inclusion and human rights. The *Pastoral do Menor's* mission is to promote and defend the lives of impoverished children and adolescents and in risk situations, disrespected in their fundamental rights. Available in: <<http://www.pastoraldomenornacional.org>>. Accessed in: Mar.15. 2015.



#### 4.3.1.3 Characteristics of *Mutamba*

The “*Mutamba*” name is derived from the indigenous language *Tupi-Guarani* and means “hard fruit.”<sup>62</sup> Belonging to the family of the *Sterculiaceae*, the *Mutamba* (*Guazuma ulmifolia* Lam) is a “*pioneer*”<sup>63</sup> (pioneer) tree species, with an average height of 10 m and can reach 30 m in height and 60 cm in diameter in adulthood (FIG. 21). Its fruit is much sought after by birds and primates, their main seed dispersers (LORENZI, 1992).

Its trunk is straight to slightly tortuous, short, often branched at low altitude. The bark has thickness of up to 12 mm. Its crown is thick and wide, with horizontal and slightly overhanging branches with leaves grouped together in two rows along the branches. The leaves have 5 cm to 18 cm in length and 2 cm to 6 cm wide. The flowers are small, yellowish-white, measuring 5 mm to 10 mm long, slightly fragrant, with five petals. Flowering occurs from September to December. The fruits ripen from June to November (CARVALHO, 2007).



FIGURE 21 – *Mutamba* – Tree

Source: <[http://www.joaonavesdemello.blogspot.it/2012\\_09\\_01\\_archive.html](http://www.joaonavesdemello.blogspot.it/2012_09_01_archive.html)>

The *Mutamba* grows in open places, river banks and disturbed habitats. This species is not demanding for soil and inhabits both dry as

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62 Available in: <<http://www.colecionandofrutas.org>>. Accessed in: Mar.22. 2015.

63 “Pioneer are trees that require direct sunlight to develop and are able to grow in environments where water restrictions and poor soil fertility. Often have short life cycles, a few decades, for preparing the environment for their successors. They are usually found in clearings in the forest or on previously deforested areas and presently abandoned”. Available in: <<http://www.institutohorus.org.br>>. Accessed in: Mar.22. 2015.



moist sites, especially the sandy texture, however, does not tolerate low temperatures. It is more common in soils with pH greater than 5.5 (CARVALHO, 2007).

Naturally occurring in almost all of Brazil, from the Amazon to the Paraná state. This species is very commonly found in the *Cerrado* and in secondary forests (MEIRA; MARITNS; OLER, 2009).

The wood of this tree is very susceptible to termites and dry wood termites, and it is not durable. However, it is of good durability when protected from rain and moisture. It is easy to be sawn and be worked with woodworking machines, with a good finish (CARVALHO, 2007).

The density (apparent density) of the timber is moderately dense ( $0.50 \text{ g.cm}^{-3}$  at  $0.68 \text{ g.cm}^{-3}$ ). It can be used in various ways, as interior works, carpentry in general, lining for interiors, carpentry, crates, heels for shoes, coffin and laminates, cooperage (manufacture of barrels) in rifle butts, cables tool, poles and violins. In Puerto Rico, it is mainly used for posts. With a calorific value of 18,400 kJ / kg and 0.98% ash content, excellent fuel is considered mainly for firewood (CARVALHO, 2007).

Among its phytochemical constituents were found: isoquinoline alkaloids, saponins, starches and tannins (CARVALHO, 2007). The pharmacological action includes the astringent properties, purifying, healing, antiseptic, diaphoretic, anti-syphilitic, desobstruente liver and sudorific. As phytotherapeutic indications include: healing of wounds and ulcers, desobstruente liver in the treatment of skin diseases, syphilis, bronchitis, asthma, coughs, pneumonia and other diseases of the respiratory system. The phytocosmetic indications stand treatments for hair loss, dandruff and seborrhea, destroying parasitic diseases of the scalp (TESKE; TRENTINI, 1997).

The bark of the trunk of this plant produces tough fiber bast<sup>64</sup>, high quality and wide use in rope making and the manufacture of fabrics. Bark and fruits are used to aid weight loss (CARVALHO, 2007).

Its bark has action of astringent, against gonorrhoea and pectoral. The macerated bark is applied to prevent hair loss and to fight the parasitic diseases of the scalp (CAMPELO, 1988). The cooking of the bark is used against skin diseases and syphilis. The *Mutamba* peels are also used in shampoo manufacturing. The syrup, extracted from the bark, is displayed against bronchitis (CARVALHO, 2007). The tea is used for the peels sudorific as Brazil, and is also employed in cases of fever, cough, bronchitis, asthma, pneumonia, and liver problems (GALINA, *et al.*, 2005).

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64 Bast or phloem, is the tissue of vascular plants in charge of the sap produced by the stem to the roots and reserve organs.

In the sugarcane region of Ceará, the mucilaginous extract *Mutamba*, obtained by cooking pieces of its stem, is widely used in the manufacture of handmade raw brown sugar, such as clarifying agent of sugarcane juice during the boil (LORENZI; MATOS, 2002).

Popularly, the peels and leaves of *Mutamba* are utilized in several countries in South and Central America in cases of gastrointestinal problems, kidney disorders, alopecia, cough, fever and skin problems (GALINA, *et al.*, 2005). In traditional medicine in Peru, the tea of its bark and leaves is used to treat kidney and liver diseases and dysentery. In Guatemala, it is used primarily for the treatment of gastrointestinal problems, which has been clinically tested in a study conducted in 1990 (CARVALHO, 2007).

The *Mutamba* flowers produce a good amount of nectar, a source of honey tasty, very nice and high quality (CARVALHO, 2007).

*Mutamba*'s roots and leaves are used in folk medicine in all regions where this plant is found, based on popular tradition. In Belize, located on the northeast coast of Central America, tea from its leaves is used against dysentery and diarrhea, for the treatment of problems related to prostate and uterine stimulant as to facilitate delivery. The infusion of the leaves in internal use, has diaphoretic action, anti-syphilitic, sudorific and purging (GUARIM NETO, 1984).

Its fruits are edible and contemplated whatever if they are fresh, dried, raw or cooked. Its flavor resembles of dried fig. In Mato Grosso, when dried, the fruits are used to prepare teas and are considered a great replacement of mate tea (GUARIM NETO, 1984). The fruits of *Mutamba* are highly prized by monkeys and other animals. For this quality and rapid growth, it is very important to plan for the degraded areas and essential recovery programs in heterogeneous plantings used for restoration of permanent preservation areas. This species can be used in soil conservation programs on land with steep slope (FARIAS *et al.*, 1993). Crushed, the fruits are consumed as candy or used to manufacture liquor<sup>65</sup>.

The essential oils from leaves and fruits due to its pleasant aroma, has a very high demand for flavoring environments and perfumes (NUNES *et al.*, 2005).

The *Mutamba* also serves to cellulosic pulp producing up to 44% cellulose. The *Mutamba* can be used successfully in urban trees, avenues, parks and gardens, due to its good branching and beautiful canopy, providing good shading (LORENZI, 1992). It is recommended for soil conservation programs on land with steep slope and natural revegetation gullies (FARIAS *et al.*, 1993).

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65 Available in: <<http://www.colecionandofrutas.org>>. Accessed in: Mar.11. 2015.

This species may also, surprisingly aid the treatment of individuals infected with the human immunodeficiency virus (HIV). Dr. Gouveia has been testing the *Mutamba* tannin molecules with the intention of finding an effective drug against HIV. In an interview, the doctor explained that has segmented treatment to two people with HIV and clarified that because it is a natural remedy, has no contraindications and no ethical-moral impediment in its continuity. Treatment for people with HIV only lasts thirty days. As the drug is not chemically manipulated, the doctor offers a simple recipe on how to prepare the product handcrafted for consumption. Patented in 2010, Dr. Gouveia research that according to him, is already released by the National Patent Office has drawn the attention of infectious disease specialists from various parts of Brazil and the world, seeking to carry out the treatment of seropositive patients<sup>66</sup>.

According to the *Grupo de mulheres Flor do Cerrado* (Cerrado flower Group of Women), the bark of *Mutamba* contains a mucilage (a kind of gel), which has action to soften and moisten. It is recommended for normal, dry and sensitive skin. Used as a cream and soap to nourish, regenerate damaged tissue, heal cracks, soften and refresh the skin. In shampoo and conditioner can be used for all types of hair. Has penetrating acting against hair loss, seborrhea and disorders of the scalp.

#### 4.3.1.4 Characteristics of *Pacari*

The *Lafoensia Pacari* A. St.-Hil. (*Lythraceae*) is an arboreal plant, popular known as “*Pacari*” or “*Dedaleiro*” (FIMRO *et al.*, 2014) (FIG. 22). The term “*Pacari*” is from indigenous origin (*tupi-guarani*), that means “tree of precious wood” (POTT; POTT, 1994). And the term “*Dedaleiro*” refers to the flower base that is used as thimble (LIMA, 2013).

This plant is found in Central America and South America, and observed in the Brazilian *Cerrado* (CABRAL; PASA, 2009), in the states of Bahia, Goiás, Minas Gerais, Maranhão, Mato Grosso and Federal District (CARVALHO, 1994).

Its dispersion is wide, but discontinuous, never forming large populations. It produces annually lot of viable seeds (SENEME, 2010).

The bark of the stem presents itself as a set of scales and consists of multiple layers of thin shells reddish yellow color, with the outer surface in the form of scars and internal surface with fibrous enough (CARDOSO, 2013).

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66 Available in: <<http://www.AIDS-portalnorte.com.br>>. Accessed in: Mar.09. 2015.

The species presents intense sprouting in spring. The summer period and early fall the trees have fully formed crowns. Among the winter and spring presents a significant decrease of the leaves which in turn are composed, opposite, entire, smooth and shiny (REGO, 2009).

The tree can reach up to 30m high. Flowers, exposed above the canopy erect or slightly inclined, have petals of yellow-white color, with



FIGURE 22 – *Pacari* – Tree

Source:<<http://www.apremavi.org.br/noticias/apremavi/491/Pacari-ou-dedaleiro-um-remedio-por-natureza>>

numerous stamens fairly large anthers and exude unpleasant odor. All these suggest that floral attributes of this tree pollination occurs mainly by bats, even with continuous production of nectar capable of attracting insects and other pollinators animals. The fruits are conspicuous capsules with winged seeds which favors the spread of species through the wind. Its wood, being moderately heavy, shows smooth to the touch and good durability (POTT; POTT 1994).

Among the active compounds present in this species are saponins, the stem bark; steroids and triterpenoids, present in the leaves, the heart and stem bark; the flavonoids present in the leaves, the heart and stem bark; tannins, found in the heart and leaves and especially in stem bark; and alkaloids, present in the leaves and stem. The bark has a high ellagic acid content and tannins (SANTOS; COELHO; PIRANI, 2009). However, according to Cardoso (2013), the sheets are shown with improved characteristics for use as raw material in obtaining and producing ellagic acid.

Flavonoids, triterpenoids, steroids and tannins, are used in the treatment of leishmaniasis. These are diseases caused by protozoa that can affect the skin, mucosa or viscera, are among the six endemic prioritized in the world (LIMA, 2013).

The toxicity of *Lafoensia* extract *Pacari* front of leukemic cells was noted by Marcondes, Weffort-Santos and Santos (2012). Preliminary results demonstrated killing of leukemic U937 cells by apoptosis, suggesting that this extract presents one or more substances able to contribute to the treatment of cancer patients, especially those patients with leukemia (MOREIRA, 2014).

Through a search, three pure substances have been identified (*Emotinas* G, F and D) and 12 extracts, having inhibitory activity of the RT of HIV-1 (the causative retrovirus Acquired Immunodeficiency Syndrome - AIDS), in plant extracts and substances isolated the *Pacari* (FERREIRA, 2010).

Within the bacteria believed to be major causes of hospital infections, the main species that have developed a high degree of antibiotic resistance are *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Enterobacter sp.*, *Acinetobacter sp.* and *Enterococcus faecalis*. These bacteria cause numerous infections, such as acute bacterial endocarditis, respiratory infections, bacteraemia, sepsis, acute and chronic osteomyelitis, acute purulent Pyomyositis, brain abscess, infections in joint prostheses, urinary tract, surgical site, in addition to causing hospital infection outbreaks. Among the 45 strains tested, the extract of leaves of *L. Pacari* showed bactericidal activity in 42 of them, which represents an 93.33% effectiveness. *L. Pacari* stem bark extract was also tested in 45 lines and had 86.66% efficiency in total (PORFÍRIO *et al.*, 2009).

Silva *et al.* (2012) observed potential antifungal in the crude extract of *Pacari* in *Candida* yeasts.

Between Guarani and Kaiowá indigenous people, the fruits of the plant are used to treat pneumonia (BUENO *et al.*, 2005). Popularly, this species is utilized as a tonic and febrifuge (MALHEIROS *et al.*, 2014).

The leaves and bark are used in traditional Brazilian medicine for the treatment of cancer, gastric disorders, inflammation and scarring, by infusion and maceration methods and are mainly administered by the oral (SOLON *et al.*, 2000).

Porfírio *et al.* (2009) have confirmed the antimicrobial action of leaves and bark of this species across the bacterium *Staphylococcus aureus*, in vitro tests. And Müller *et al.* (2007) have checked the activity against herpes simplex virus type 1.

The bark of *Pacari*, researchers derived an alcoholic extract is effective in the treatment and prevention of certain symptoms of asthma



in mice. This opened the prospect for the use of this plant in the treatment of allergic processes in humans<sup>67</sup>.

In Goiás and Mato Grosso states the stem bark, cooked, is popularly used as healing. Another way of preparation of the plant for healing is the maceration with the mash being used to wash wounds<sup>68</sup>.

Biological studies record the effectiveness of the aqueous extract of the bark of this species on acute carrageenan-induced peritonitis, immunostimulatory action on the production of antibodies against thymus-dependent antigen, inhibition of delayed hypersensitivity and dose-dependent immunosuppressant activity on the synthesis of antibodies anti-ovalbumin (ALBUQUERQUE; JULIANI, 1996).

Popularly, the stem bark extract is used for pain and inflammation, having shown sedative activity (GUIMARÃES *et al.*, 2010). Studies have shown that the active ingredients present in the stem bark has analgesic activity<sup>69</sup>.

Among the assets used in cosmetics, are the polyphenolic compounds, which are increasingly utilized in formulations for aged skin or as preventive aging, because they are powerful antioxidants<sup>70</sup> (RIBEIRO, 2006). Phenolic substances act, known as free radical scavengers<sup>71</sup> and therefore may be useful for the treatment of degenerative diseases and aging (PESSUTO *et al.*, 2009). Thus, the presence of substances with antioxidant activity in the inner bark of *Pacari* motivated research to develop products for the purpose of treatment or prevention of skin aging (CAMPOS; FRASSON, 2011).

The leaves of the plant extracts showed to be highly active against gram-negative bacteria *Pseudomonas aeruginosa* (Schroeter) Migula (ALVES *et al.*, 2000).

The antifungal properties of *Pacari* extracts, detected in studies, demonstrated the potential use thereof as an alternative to the methods adopted for the control of anthracnose on banana. The Anthracnose, caused by species of *Colletotrichum* is the main disease of fruit post-harvest and is considered a disease with high economic importance in the Northeast of Brazil (SERRA; SILVA, 2004). In post-harvest, the control measures, currently, consist mainly of fungicides. The restriction on the use of fungicides, due to phytotoxicity, residu-

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67 Available in: <<http://www.apremavi.org.br>>. Accessed in: Feb. 27. 2015.

68 Available in: <<http://www.apremavi.org.br>>. Accessed in: Feb.27. 2015.

69 Available in: <<http://www.fesbe.org.br>>. Accessed in: Feb.27. 2015.

70 Antioxidants are substances that fight free radicals.

71 "Free radicals are atoms or molecules produced continuously during metabolic processes and act as mediators for the transfer of electrons in various biochemical reactions, playing important roles in the metabolism" (PERSSONELE, 2004). The skin is a highly metabolic tissue and has the largest surface area of the human body, being the primary target to free radical damage.



al effects, action spectrum and resistance by the pathogen has led the search for alternative control methods such as use of biofungicides, plant extracts and essential oils. The results achieved in this line of research have proven promising for practical use in plant pathogens<sup>72</sup> control in diverse cultures (FRANCO; BETTIOL, 2000). The flowers and leaf extracts showed higher antifungal effect to the studied plant pathogens (PEREIRA, 2007).

The peels, seeds and wood, can be produced dyes to fabrics. Its wood can be used in construction, the manufacture of tool handles like firewood, planks in general and is widely used to make ox carts axes<sup>73</sup>. Lorenzi (1992) also highlights the use of wood in carpentry, in the manufacture of pieces for floors, fence posts and planks in general.

The tree has ornamental features and can be utilized in landscaping, especially in urban trees because they have no aggressive roots. It is recommended for mixed reforestation intended for vegetation recovery of degraded areas<sup>74</sup> and restoration of riparian forest on well-drained sites or periodic short duration floods (CARVALHO, 2003).

According to the *Grupo de mulheres Flor do Cerrado* (Cerrado's flower Group of Women), the stem bark is indicated as healing of skin wounds and mucous. The use of soap is suitable for oily skin, especially in the treatment of dermatitis and acne. Employed in the shampoo and conditioner eliminates the excessive oiliness of hair and combat the diseases of the scalp.

#### 4.3.2 Evergreen arrangements

The extraction of evergreens is important in generating income and employment in the village of *Galheiros*, located in the *Conselheiro da Mata* district in the city of *Diamantina*, at an approximate distance of 120 km from the town of *Serro*.

Currently, the Federal University of *Vales do Jequitinhonha* and *Mucuri* performs work related to the preservation of local culture and identity, in addition to maintaining an experimental cultivation field for research and conservation of species of evergreens in this region.

The production of handicrafts in *Galheiros* community, from evergreens, is a tradition that passes from generation to generation. This activity, learned from the grandparents of today's artisans, is the main source of income for entire families (FIG. 23), and still keeps alive.

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72 Phytopathogen is an organism, generally a microorganism that causes disease in plants to disturb their cellular metabolism.

73 Available in: <<http://www.apremavi.org.br>>. Accessed in: Feb.22. 2015.

74 Available in: <<http://www.apremavi.org.br>>. Accessed in: Feb.22. 2015.



FIGURE 23 – Family of evergreen handicrafts  
 Source: <<http://mistur4do.blogspot.com.br/2011/08/apanhadores-de-sempre-vivas-vale-do.html>>

These artisans they insist on practice proper handling of plants during the extraction of evergreens in the fields, in order to maintain the activity and let this know-how as a legacy for your children, grandchildren and great-grandchildren. In addition to the extraction, it also cultivates some species in the backyards of their homes.

The fields where are found the evergreens, about 10 km from *Galheiros* village, is well-known by artisans. They harvest about 200 kg of evergreens per year. Until today, they identified 107 species of evergreens in the region. The most common are *pé de ouro* (Golden foot), *jazida* (deposit), *pimentinha* (little spice), *espeta nariz* (poke nose), *capoeira*, *mundial* (world), *capim dourado* (golden grass), *abacaxi* (pineapple), *dourado* (golden), *amendoim* (peanuts), *botão martelo* (hammer button), *Maria tochinha*, *cocão*, *Estelinha e chuveirinho* (showerhead).

Crafts involve the flower arrangements, lamps, Christmas wreaths and angels (FIG. 24).



FIGURE 24 – Arrangement / Lamp / Garland / Angel

The arrangements of evergreens are produced with the following raw materials found in the region: i) evergreens, which form the bouquets; ii) a “ring” of *Pau Santo* (saint wood), one of the two parts that make up the decorative container (Ornamental flowerpots), that receive bouquets of evergreens; iii) a “disc” of *Piteira*, the other constituent part of the assembly Ornamental flowerpots, which acts as a base thereof. Already sisal, which makes the mooring of small bouquets, despite being acquired in *Diamantina*, comes from the city of *Valente* / BA, to about 1,100 km away from *Serro*.

Although the parts are developed individually, the marketing is done collectively. Prices are set by agreement. When there are orders, they are divided among the artisans.

The objects are well accepted in the market. Marketing takes place at the production site in the city of *Diamantina*, in fairs in which artisans participate, and in a store of furniture, housewares and objects decoration, present in various states of Brazil and the Federal District, the Tok & Stok store.

The pieces do not have packaging, are transported in cardboard boxes, accommodated in small trucks.

#### 4.3.2.1 Characteristics of Raw Materials Used

##### - *Sempre-vivas* (Evergreen)

The evergreens (*Helichrysum bracteatum*), one of the endemic species found in the region of Galheiros are one of the symbols of the *Cerrado* and *Rupestres* fields. As its name suggests, it is able to maintain the appearance (shape, color, texture) of “living” for many years, even after harvested and dried (LAZZARI, 2000). According Cutter (2010), this characteristic is a function of their tissues accumulate little water, and are formed by thick-walled cells, usually hard and lignified.

Its ornamental aspect, and consequent market value, offered to *Espinhaço*'s population an alternative income source after the decline of the gold and diamond cycle, around 1930, until then, had the main mining activity. Its extraction aimed at the craft and international trade (mainly to the United States, Japan and some European countries). Currently the trade of evergreens is restricted to internal trade.

Since the 1940s the city of *Diamantina* is considered as the most important center of production and marketing of evergreens, where, even today, converge the evergreens collected in Minas Gerais and even of Bahia.

The evergreens produce small solitary flowers, but very ornamental and of various colors (white, yellow, pink, orange, red, violet). They adapt very easily anywhere and can grow on dry, wet or even swampy



soils, but always exposed to the sun. They are very resistant both to climatic conditions as pests and diseases. They also have great ease in multiply on contact with a suitable substrate or by means of a small portion of the stem, either from a single sheet.

Local soil where they are usually found have sandy texture, acid pH, low levels of nutrients and organic matter on which agricultural production is limited (MOREIRA, 2010).

Most evergreens found in this territory are the *Eriocaulaceae* family, however, are still *Poaceae* (*Gramineae*), *Xyridaceae*, *Cyperaceae* and *Velloziaceae*, all belonging to the genus *Syngonanthus* ou *Comanthera* (FIG. 25).

The management of evergreens starts soon after the first rains. The artisans of the region burn the fields in order to increase their productivity. According to Bedê (2006) the sequence “fire-collection” seems to combine the strong stimulus to reproduction attributes and minimization of conflicting demands between reproduction *versus* growth and survival, while reducing their mortality. These plants are resistant to fire thanks to its underground stem, which is still alive after the fire, and the top, burned, resurfaces after the first rain.



FIGURE 25 – Evergreens



FIGURE 26 – Collection of evergreens

At the time of flowering evergreens (March to June) is common to find entire families in the field harvesting the plant (FIG. 26). The inflorescence collection predates the formation of fruits and seeds, which, according to Bedê (2006), saves the plant from the energy costs of this investment.

The collection technique is very simple, however, must be conducted with the following criteria:

- Remove a flower at a time;
- Do not harvest the mature flowers, as they must remain in the camps as seeds;
- Do not boot the roots, because they will be reborn in the next season;
- Do not harvest the whole field;
- Do not allow the animal creations trample on the fields.

After collection, the evergreens are gathered into bouquets and placed in the sun to dehydrate. After dried, they are ready to be worked.

The remains of the stems of evergreens are used as fertilizer. The broken flowers (during transport and production of arrays) are thrown on the fields, to sowing them.

#### - **Pau Santo (Saint Wood)**

The *Kielmeyera Mart* gender, endemic to South America, comprises about 47 species, 45 native of Brazil (BARROS, 2002). Among the species of the genus *Kielmeyera Mart*, the *Kielmeyera coriacea Mart*, the *Clusiaceae* family, popularly known as “Pau Santo” (Saint Wood) (FIG. 27), can be found throughout Brazil, especially in the *Cerrado* areas (BARREIRA *et al.*, 2002).



The *Pau Santo* has crooked branches with thick bark of cork that unfolds easily. Its leaves, up to 22 cm long, are alternated, and concentrated in apex of the branches. Its inflorescences are at the end of the branches and have few flowers with white petals and golden-yellow stamens. Its fruits are dry, like capsule, which releases large amounts of winged seeds (REDE DE SEMENTES DO CERRADO<sup>75</sup>/ CERRADO SEEDS NETWORK). The trees bloom in early rainy season, from October to December, and fruits during the dry season, from November to September (ALMEIDA, 1946).



FIGURE 27 – *Pau Santo* – Tree  
Source: Hugo Filipe e Samuel.  
Available in: <<http://www.hugo-filipelima.blogspot.com.br>>

Wood *Kielmeyera coriacea* is very resistant and durable. According to Rios (2011), it is considered to mid basic density, with values from 0.40 to 0.50 g / cm<sup>3</sup>. The longitudinal variation of the density of this

wood decreases slightly from the bottom to the top. Statistically, its average basic density is higher at the time of 0% trunk, with a value of 0.49 g / cm<sup>3</sup> and lower the height of the trunk 100%, with a value of 0.40 g / cm<sup>3</sup>.



FIGURE 28 – *Pau Santo* – Bark  
Source: Hugo Filipe e Samuel.  
Available in: <<http://www.hugo-filipelima.blogspot.com.br>>

The bark of this species is thick, approximately 1.5 cm thick, from the base to the apex, slightly soft to the touch and light brown color (FIG. 28). It consists of an outer bark (cork) called rhytidome and an inner bark, called phloem (RIOS, 2011). According to Ferreira (1974), the corticate material can represent up to 75% by volume.

75 Available in: <<http://www.rsc.org.br>>. Accessed in: Sep.17. 2014.



The cork is a plant tissue that develops in the plant as a protective tissue and scarring (FORTES; ROSA; PEREIRA, 2004; GLÓRIA; GUERREIRO, 2003; GRAÇA; PEREIRA, 1990). Cork also shows levels of mineral compounds, expressed as ash or inorganic constituents (FORTES; ROSA; PEREIRA, 2004).

The structure of the wall of suberous cells cork has a different chemical constitution of the wood, due to the presence of suberin (GRAÇA; PEREIRA, 2000). The Suberin of cork of *Kielmeyera coriacea* also include an aromatic compound found in small quantities, called ferulic acid (MIRANDA *et al.*, 1998). Due to the smell surprisingly strong and sweet when burned, the *Pau Santo* is also used as incense and incense burner (FIG. 29).

Fortes (1989) describe various properties of the cork, as a low deformation resistance, high energy absorption capacity (impact), large energy dissipation capacity (vibration), and good fire resistance. Strong, Rosa and Pereira (2004), stand still, buoyancy, elasticity, impermeability to liquids, low density, thermal, acoustic and electrical insulator (FORTES; ROSA; PEREIRA 2004).

The same authors present the main uses of cork, both in its original form as reduced to rubble and aggregate, as new substances: thermal insulation (refrigerators, heaters, stoves, etc.), caps, shoes, life jackets, carpets, insoles, among others. They state that waste is recovered in the linoleum industry and manufacturing of chip-board panels, whose main applications the coating floors, the wall cladding and the manufacture of frozen panes (FORTES; ROSA; PEREIRA, 2004).

The anatomical and chemical structure of *Kielmeyera coriacea* cork is quite similar to that of the larger species worldwide producer of cork, the *Q. suber* (RIOS, 2011). According to Rizzini and Mors (1976), his cork material is lightweight and easily sep-



FIGURE 29 – Incense and incense burner of *Pau Santo*. Source:

a) <[http://www.cibeletramea.blogspot.com.br/2012\\_05\\_01\\_archive.html](http://www.cibeletramea.blogspot.com.br/2012_05_01_archive.html)>

b) <<http://www.coiotereal.pt/Incenso-Pau-Santo>>

c) <<http://www.campodotenenteabc.blogspot.com.br/2012/10/formula-de-incenso.html>>

arated from the bark of trees. The operation of a cork may be carried out in cycles of five to six years, when its stem has 15 to 20 cm in diameter. Rivers (2011) noted that, in general, natural regeneration in *Kielmeyera coriacea* field, after 6 months of withdrawal of bark, was high.

According Cortez *et al.* (1999), *Pau Santo* is a rich plant xanthone, substances that exhibit various pharmacological properties with antitumor, antifungal, antibacterial, anti-inflammatory and tuberculostatic.

Andreo and Jorge (2006) emphasize the essential oil potential of the various parts of *Pau Santo* for use in the national pharmacopoeia, depending on the biological activity of their compounds. Soluble wood oil, for example, is used in various sunscreen formulations. Already at high levels of phenolic compounds of extracts and partitions leaf and inner bark (such as flavonoids, anthocyanins, tannins and phenolic acids) provide a good antioxidant and antimicrobial activity. Moreover, the authors highlight the physiological properties of phenolic compounds such as antiallergic, anti-arteriogenic, anti-inflammatory, anti-thrombotic, vasodilating and cardioprotective (ANDREO; JORGE, 2006).

According to Martins (2012), the popular knowledge about the use and effectiveness of medicinal plants for treating various diseases is quite old. Until today, we can see the commercialization of these plants in fairs and markets of many communities and large cities.

In the Brazilian *Cerrado*, the *Pau santo* has been used by people for the treatment of various diseases such as schistosomiasis, leishmaniasis, malaria, infection by bacteria and fungi, among others (PINE *et al.*, 2003).

The results presented by Martins (2012), based on the analysis and quantification of chemical constituents of the aerial parts of rosewood, as well as the antioxidant activity of its extracts, confirmed the correct use of this plant by the populations of the *Cerrado*.

According to Ferreira (1996), flower and fruits are used by florists for making ornamental arrangements.

In *Galheiros*, the bark of the *Pau Santo*, found in large quantities, is used by craftsmen as one of the parts constituting the Ornamental flowerpots (decorative container) of evergreens arrangements (FIG. 30). Such a piece called “ring” comes from the extraction of further materials to the death of the plant, which

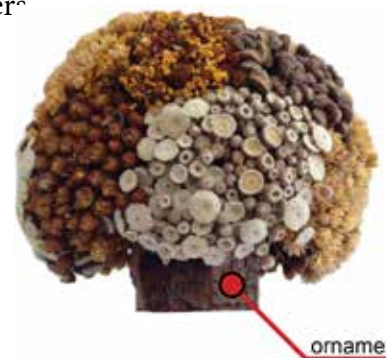


FIGURE 30  
Ornamental flowerpot



FIGURE 31 – Bark of *Pau Santo*

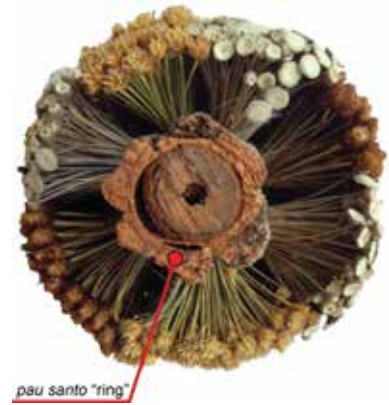


FIGURE 32 – “RING” ornamental flowerpot

falls on the ground and rots (FIG. 31). Over time therein turns into powder, facilitating the loosening of bark. After collection, the material is cut to length, forming a “ring” hollow (FIG. 32).

It is important to emphasize that there are no remains of *Pau Santo* in the production of ornamental flowerpots, as it is cut at the size they will be used.

#### - *Piteira*

The *Agavaceae* family, originally from Mexico, refers to the time of the Maya, where indigenous peoples used it as raw material to generate hundreds of products that have transformed throughout its history (LA PITA ESCUELA<sup>76</sup>).

The American Agave L., commonly known as *Piteira* or *Pita* (FIG. 33), is one of the species of the family *Agavaceae* found within in the *Cerrado* (CASTRO, 2006).

These succulent plants adapt to conditions of scarcity of water and nutrients, are very resistant to drought and high temperatures. With nearly 300 species, it is characterized by formation of rosettes of fleshy large and thick sheets (appropriately to collect and channel the water), and typically possess large root to capture the greatest possible amount of water. All this water is stored in the leaves as standby for flowering. The flowers produce a lot of nectar with which attract natural pollinators: birds, bats and insects. When they are mature at the beginning of the rainy season, the capsules explode releasing their seeds. After flowering, the rosette that produced the floriferous stem dies. The flower stem grows up to 1.5 meters per week, reaching 1.8 to 12 meters high. This stem develops when



FIGURE 33  
*Piteira* – Tree  
Source: <<http://www.pixabay.com/pt/aga-ve-inflorescência-aga-vengewächs-186372/>>

<sup>76</sup> Available in: <<http://pitaescuela.org>>. Accessed in: Sep.21. 2014.



the plant has 7 to 30 years old. The fruit, capsule-shaped, has black seeds, flattened and numerous. From 2% to 5% of the leaf is made up of fibers, approximately 95% is biomass. Generally, the expanded sheet containing fibers throughout its length, an important characteristic for use in the production of sisal fibers. With the cutting of all the core sheet is exposed, where the greatest amount of sugar. The nucleus extract a juice called “Aguamiel”, which can be transformed into healthy sweeteners in the form of syrup. This nutritional juice contains about 70% fructose and 90% carbohydrates, and have more calcium than cow milk, a total of eight four distinct minerals and vitamins. The “Aguamiel” is about 20% sweeter than sugar obtained from sugar cane or beet sugar and can be used by diabetics (LA PITA ESCUELA).

The *Piteira* is a very hardy plant, resistant and does not require special care. Its leaves are large, up to more than two meters long and a handbreadth or more wide, arranged in rosette of gray-green color, with spiny margins and a strong black thorn at the tip. Its flowers are standing in dense groups, arranged in long stems with up to nine meters, and yellow-green color. It multiplies easily, especially by the many offshoots that produces bulbils and some that arise in flower stalks (VIEIRA, 2002).

Due to the rapid growth of the plant, about 1.5 meters per week, the stem develops at the same time a very hard cork, like the bamboo, and a fibrous material inside. This wood is very light, easy to cut and work with a number of natural colors. As the *Piteira*'s life cycle is completed after its flowering, since the wind spread the seeds, the timber stem can only be collected when the plant is dead, so it is a sustainable resource (LA PITA ESCUELA).

There are several uses of the *Agavaceae* family plants such as: hedges, landscaping, pharmaceutical, ethanol, biogas, bio-oil, butanol, methane, bio-polymers and agglomerates, using the whole plant; compost with the leaves and the core; fence and insulation, with the leaves and the stem; needle and thread, with leaves and thorns; treatment of rheumatism and internal injuries, soap and shampoo manufacturing, with leaves and roots; tiles for ceilings and fertilizers, with the leaves; channels to collect rain water, crafts, musical instruments, furniture, beams on building roofs, scaffolding, ladders and ditches to carry water, using the stem; boat glider, ferry and glass cover to replace the cork with the stem and the core; bioplastics, pulp, paper, ropes, baskets, brooms, brushes, carpets and fabric for clothing, from the fibers of the leaves (LA PITA ESCUELA).

Studies have shown plants with new active ingredients that present themselves as candidates for use in insect control. Among the insects of medical interest, the family *Culicidae mosquitoes* that are currently the most attention in public health, for having anthropophilic habits and serve as vectors protozoa, helminths and viral diseases, thus

taking, large epidemiological value. The main diseases transmitted by these vectors are dengue fever, yellow fever, lymphatic filariasis and heartworm. In addition, the control and combat of culicids have difficulties related to various factors, and genetic plasticity is one of the most important. This factor enabled culicids generations rapidly acquire resistance against the insecticides substances used improperly. Through a research study performed by the Castro Jr. (2008), it has been found satisfactory larvicidal activity of American Agave for the culicids *Ae. aegypti*, *In. stephensi* and *Cx. quinquefasciatus*, in its 4<sup>th</sup> stage (DAHARAM SHAKTU *et al.*, 1987). It was recorded mortality above 50% at a concentration of 1250 ppm of this species. Such activity takes place through the active ingredient steroidal saponins (CASTRO JÚNIOR, 2008).

Cultivation, industrialization and marketing of coffee are of great importance for Brazil, which is the world's largest producer and major consumer. However, phytosanitary problems are intensified and various insects, mites and diseases are causing damage to this crop. The coffee hosts numerous species of insects and mites, causing frequent losses. The red-mite coffee, the *Oligonychus ilicis*, had its first reference in Brazil in 1950 in São Paulo attacking coffee *Coffea arabica* L. It was once referred to as the second plague in importance for Conillon coffee (*Coffea canephora* Pierre & Froehner) in the state of Espírito Santo. To feed, the *Oligonychus ilicis* pierce cells and absorb part of the cell content, giving the leaves a tan appearance. The control of these pests is based on the application of chemical pesticides. However, despite of the ease of use and rapid effect, many of them are highly toxic and some have a serious resistance problem, and can have negative impacts on the environment and man. An alternative to using these products, less impact, are plant extracts, which affect behavior and metabolism of pests and diseases, which can cause death or its impracticability. The results of a study aiming to assess the mortality of the coffee red mite by topical plus residual effect after spraying with aqueous extracts of plants from the southern state of Minas Gerais, showed that the aqueous extracts of *Piteira* showed reliable control of the coffee red mite, the *O. ilicis* (MARAFELI, 2009).

The *Piteira* was also identified in an ethnobotanical<sup>77</sup> study of medicinal plants, as one of several species used in folk medicine in in the *Cerrado* vegetation complex. This research was conducted with descendants of indigenous healers grandparents, African or both, aged between 56 and 72 years. The infusion of fresh leaves are indicated as purifying, and his poultice for treating scabies. Since the infusion of dry leaves, in powder form, they are recommended for

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<sup>77</sup> The Ethnobotany includes all studies concerning the mutual relationship between traditional populations and plants. Presents basic characteristic study of direct contact with the traditional population, seeking an approach and experience that allow gaining the trust of them, rescuing so all possible knowledge of the affinity relationship between man and the plants of a community.

diseases of the kidneys and liver. As diuretic, suggests the use of root infusion (COTTON, 1996).

Because of its active principles, glycosides and hecogenin saponins, the *Piteira* is used to treat anemia, bronchial catarrh, wounds, liver, bleeding, jaundice, swelling of the legs, bowel inflammation, skin irritation, leprosy, bluish spots fall hair, kidneys, seborrhea, syphilis, coughs, and wash the eyes in case of irritation and inflammation<sup>78</sup>.

In the region of Paranaíba Delta in the state of Piauí - Brazil, a group formed exclusively by women, organized in *Associação Maria dos Agaves – Trançados em Fibras* (AAMT) (Maria of Agaves Association - braided in fibers), working for over 15 years with braided *Piteira*. The master artisan group, now 66 years old, lives of the handcraft for 35 years. With the income from the crafts, educated their daughters, who are now also artisans and are part of the Association. The pieces developed by the group involve decorative products and utilities such as wallets, headbands, placemats, napkin rings, centerpieces and tray cloths (SPANISH AGENCY TO INTERNATIONAL COOPERATION FOR DEVELOPMENT, MINISTRY OF TOURISM).

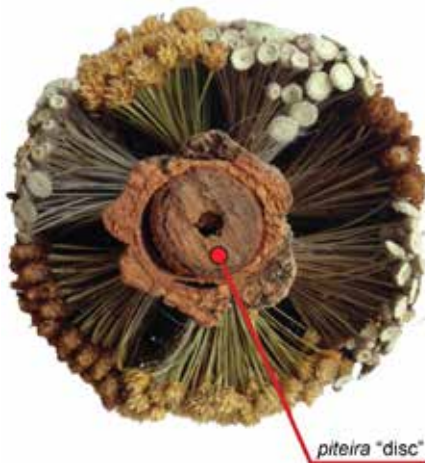


FIGURE 34  
"Disc" ornamental  
flowerpots

Already in *Galheiros*, artisans use wood from the stem of the *Piteira* as one of the set pieces that form the Ornamental flowerpots of arrangements of evergreens, called "disco". This plant is abundant in the region. The process of the material after the extraction is plant death. After collection, the wood is cut to length, forming a "disc" massive. This is fitted under pressure in one end of the "ring" of *Pau santo*, acting as a base Ornamental flowerpots (FIG. 34).

Importantly, there is no leftover of *Piteira* in the production of Ornamental flowerpots, as it is cut at the size it will be used.

#### - *Sisal*

The *Agave sisalana*, popularly known as "sisal" (FIG. 35), as well as the *Piteira*, is from the *Agavaceae* family, originally from Mexico. This species occurs between sheets 200 and 250 during the cycle. The leaf epidermis consists of a waxy cuticle, which easily repels water. Internally, the sheets are formed by a fabric composed of palisade cells. Below this, is parenchyma, spongy tissue that is where are located the fibers, hard and thick. Each sheet contains 1000 to 1200 the fiber strands. Commercial fibers, called "mechanical", are responsible for maintaining the rigidity of the sheet and makes up 75% of total fiber leaves. Sisal supplies 70% of the world market for hard fibers. However, only 3 to 5% of its weight in fibers are utilized.

78 Available in: <<http://www.plantasquecuram.com.br/ervas/pita.html#.VBbkMkvA66l>>. Accessed in: Sep.20.2014





FIGURE 35 – Sisal

Source: <<http://www.silagebahia.blogspot.com.br/2013/01/desempenho-de-ovinos-alimentados-com.html>>

The rest, called “shredding residues” represent about 15% of mucilage (or pulp), 1% sleeve (short fibers), and 81% juice (sap chlorophyllated) (EMBRAPA, 2008).

According to Souza *et al.* (1998), the main use of the sisal fiber (FIG. 36) is in the manufacture of agricultural yarn (twines), or twisted yarns made from parallelized individual sisal fibers, weighing a uniform length, treated for rodents, mold and rot. Its basic function is to tie cereal hay bales.



FIGURE 36 – Sisal fiber. Source:

<<http://www.bahiamercantil.com.br/?p=7647#&panel1-3>>

However, traditionally sisal fiber is made into ropes, strings and bags, as well as being used as raw material in the manufacture of various types of handicrafts such as carpets, bags, brooms, furniture, brushes, decorative objects and decor general.

Its fiber is also used in the manufacture of cellulose pulp, which gives rise to Kraft paper, high strength, as well as other types of fine paper, cigarette filters, sanitary napkins, diapers, etc.

According to Joseph, Medeiros and Carvalho (1999), in the last decade there was a rapid development in the area of composites reinforced with natural fibers. Cellulosic fibers possess several characteristics which make their advantageous use as low cost, low density, specific resistance and high modulus, are nonabrasive, and therefore do not wear out the process equipment, are not toxic, can be easily modified by agents chemical, are abundant and comes from renewable sources. Its mechanical properties are comparable to other commonly used reinforcements. In this context, sisal stands out because their composites have high impact resistance and moderate flexural and tensile strength when compared to composites reinforced by other vegetable fibers.

Lozzi *et al.* (2010) believe that the use of plant resources for the production of polymer composites is an alternative of great technological importance as it is a renewable, recyclable, biodegradable and low cost. For countries with strong agricultural economy like Brazil, the use of natural fibers as a source of raw materials for the reinforced polymer industry, it is an important way of expanding the possibilities of exploring its sources of natural raw materials with added value.

In addition to these uses, we can see many others in various sectors. In the pharmaceutical industry, for example, the sap of sisal leaves is used as an input in the partial synthesis of cortisone drug, as it contains hecogenin. In the fabric industry, sisal accounts for half of the total production of textile fibers. Sisal fiber can be a substitute for glass and synthetic fibers, with the technical advantages in applications requiring less severe mechanical stress.

Passos, Dias and Cruz (2005) believe that other uses may be increased in polypropylene composites that have properties suitable for applications in automotive, furniture, appliances and electronics, and ornamental pieces and utensils in general.

However, the “shredding of waste” can also be availed. The “anchors” sisal, for example, are used in construction for polishing ceramic coatings and the composition of “pasta” to the manufacture of plasterboard lining. This sector sisal may have other applications, such as in the construction of residential houses, in order to provide greater resistance to composites, besides the replacement of asbestos in the composition of tiles to cover industrial and residential proper-

ties, whose studies are being conducted at the Federal University of Paraíba (SILVA; BELTRÃO, 1999).

According EMBRAPA (2008), can produce sodium pectate and wax from the waste of defibration. The pulp leaf, in turn, is used as fodder or fertilizer. In addition to these uses has been widespread practice of using sisal mucilage in animal feeding, as this has crude protein and significant energy value.

Brazil is the largest sisal producer in the world. It is grown on a large scale in northeastern Brazil due to its perfect adaptation to the semi-arid climate and drought resistance. According to Jorge (2004), Bahia is responsible for about 94% of national production. Currently, “sisal region” of the state consists of 74 municipalities with 194 107 hectares, occupying approximately 600,000 people in activities involving cultivation, crop maintenance, harvest, refining, processing the fiber and industrialization.

According Bandeira and Silva (2006), the exploitation of sisal concentrates, usually in areas of small producers, with a predominance of family labor, is therefore important man in the fixing agent to the northeastern semi-arid region.

In *Galheiros*, artisans use the sisal rope to tie number of flowers, forming the bouquets of evergreens (FIG. 37), as these are resistant to traction, has low density, it is inexpensive, renewable and biodegradable. Despite the material is acquired in Diamantina, it comes from the city of Valente / BA.

Importantly, there are no sisal remains in the production of bouquets of evergreens, as they are cut at the size they will be used.

#### 4.3.3 Utilities and decoration products of *Capim Dourado* (Golden Grass)

The art of weaving the golden grass was initiated by the *Xerente* indigenous ethnic group in the region of Jalapão (Tocantins), around 1930. Since the late 1990s the pieces of golden grass became well known and sold in Brazil and outside (SAMPAIO *et al.*, 2011).

In São Gonçalo do Rio das Pedras, Serro district, far 31 km from it, the craftsmen produce pieces with the golden grass (FIG. 38 a),



FIGURE 37  
Bouquets of evergreens  
Source: <<http://www.sonianovaes.blogspot.com.br/2008/01/que-nomes-en-graados.html>>



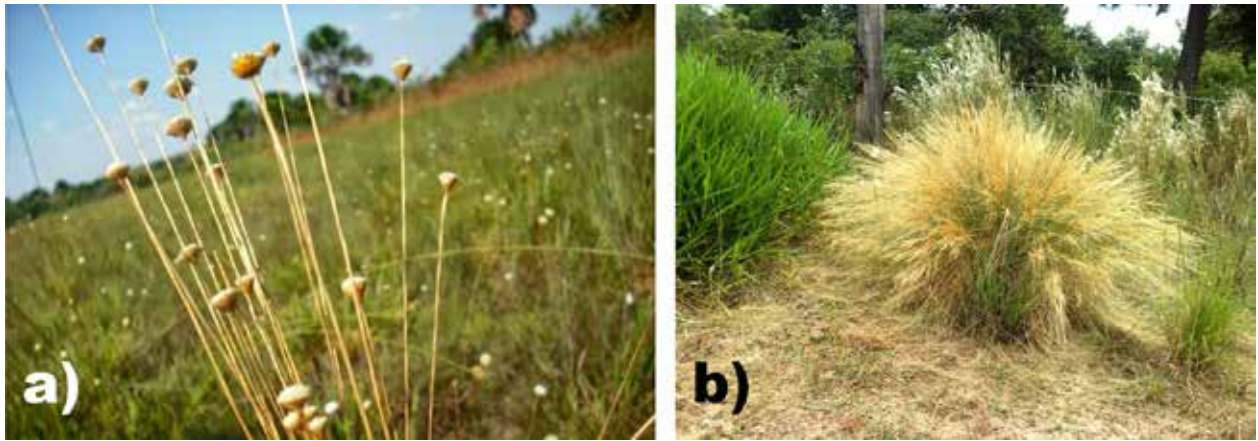


FIGURE 38 – *Capim Dourado* (Golden Grass) and *Barba-de-Bode* (Beard-of-Goat Grass)  
 Source: a) <<http://www.flaviohap.blogspot.com.br>>  
 b) <<http://www.oextensionista.blogspot.com.br/2013/06/barba-de-bode-por-ir-cirilo-jose.html#.VCryjb7A66k>>

which are found in the region of Capivari, located 12 km from São Gonçalo do Rio das Pedras. The *capim* “*Barba-de-bode*”<sup>79</sup> (“Beard-of-goat” grass) (FIG. 38 b) is also employed in the objects according to their availability in the region and similarity with the main raw material, the golden grass.

The collection of grasses occurs during the months of September, October and November, before the rains, when the stems are ripe. At this time the seeds of the plants have fallen and, during the rains, will germinate again. The removal of the stems is carried out carefully so that the rosette is not torn. The flowers are removed and left in the same place, where they will germinate, grow and produce new plants. After collection, the stems are placed in line of bags for transport to the workplace.

The production of handmade objects from these grasses is a tradition that passes from generation to generation for more than 40 years in Mr. “João” family. Such activity is considered as an income supplement. The craftsmen are careful to practice the proper handling of plants during the extraction in the fields, in order to maintain the activity and let this know-how as a legacy for future generations.

The process of manufacturing the products is very simple. After collecting the grasses in the fields, they are transported to the workplace and exposed to the sun to dry. Its flowers are removed and separated to then be disseminated in the fields where they were taken. Then the rods are grouped and stitched with cotton thread (FIG. 39), acquired in *Diamantina*, about 35 km away from *São Gonçalo do Rio das Pedras*. When Mr. “João” learned his craft from his mother, the pieces were sewn with drawn lines of sugar bags.

<sup>79</sup> The characteristics of “beard-of-goat” grass are specified in clause 4.1.24.4 of this thesis.



FIGURE 39 – Manufacturing of the products

Among the pieces produced by the artisans are: baskets, pots, sous-plat, coasters, fruit bowls, lamps, jewelry boxes, mandalas, jewelry and decorative objects (FIG. 40).

The marketing of objects is carried out at the place of manufacture, in inns, restaurants and shops in the area. Do not use packaging. When there are orders to other locations, the pieces are sent by mail.

Importantly, the few stems left over are used as fertilizer for vegetable gardens, and spools of thread are donated to the community to be used in manufacturing dolls.

#### 4.3.3.1 Characteristics of *Capim Dourado* (Golden Grass)

The *Syngonanthus nitens*, better known as *Capim Dourado* (Golden Grass) is one of the treasures of the *Cerrado*. Despite its name, this is not a grass, *i.e.*, does not belong to the grass family and is actually one of the species marketed as evergreens belonging to the family of *Eriocaulaceae*, as well as grasses *Barba de bode* (Beard-of-Goat) (*Aristida pallens*) and *Jazida* (*Comanthera centauroides*).





FIGURE 40 – Handcraft with golden grass

The Golden Grass is an endemic of the *Cerrado* plant, which flows into swamps of paths. These occur at the bottom of lowlands where the terrain is more soaked, being composed of two types of vegetation: forests, usually with high and Buritis trees and swamps, which are located around these forests, with lower plants and more grounders. They can be found in *Mato Grosso*, *Mato Grosso do Sul*, *Goiás*, *Tocantins*, Federal District, *Bahia* and *Minas Gerais*, also in *São Gonçalo do Rio das Pedras*, *Serro* district (SAMPAIO *et al.*, 2011).

According Sampaio *et al.* (2011), each standing golden grass is a rosette (or shoe, or potato), which grows close to the ground, and has three or four centimeters wide. Usually the rosette is hidden under all other grasses, and it is she who produces the scapes (stems or fillets, or shreds) that shine like gold. Each rosette generally produces two scapes per year, however, can produce up to some 20 scapes / year. They can live for many years and produce scapes several times



during his lifetime. On top of scapes spring chapters (or small head) that produce flowers, fruits and seeds. The fruits, inedible, involve the seeds that guarantee the perpetuation of the species. Each chapter contains up to 60 seeds which, due to their small size (less than 1 mm) and its color (brown), have an appearance of dust. To germinate, these give rise to another plant.

In order to prevent the extinction of species, the Tocantins Nature Institute set rules for the taking of scapes of golden grass used in the manufacture of handicrafts (Ordinance 092/2005, republished as Decree 362/2007), namely: i) stems may only be collected after 20 September, *i.e.*, only after seed maturation; ii) the fruits should be cut and scattered on the ground after the harvest; iii) the scapes of Golden Grass can not leave the region in nature, only in craft form (CERRATINGA)<sup>80</sup>.

Until then, the Golden Grass is used only in the production of handicrafts in terms of its brightness, like gold. However, this technique aroused interest of researchers. Determined to find out what generates the golden color of the plant, physicists at the Federal University of Paraná (UFPR) conducted a series of sophisticated analysis, which paved the way for new and unusual applications of the plant.

The Golden Grass only has this color when it is dry. Therefore, the researchers analyzed the dried plant with electron microscopy for clues<sup>81</sup>. The first test that looked for the presence of metals that could give a golden hue, was not successful. Thus, the physical started an analysis of the geometry of the plant. “In nature there are other materials that reflect light golden such as butterfly wings, for example, where it generates color are structures on the surface of the wings, small scales which cause the light play and is reflected this fantastic way” explains an author of the study, physical Wido Schreiner. However, the analysis did not reveal this type of structure in the golden grass, which was shown to have a very smooth surface, which explains its luster, but not your color.

The results began to make sense when researchers began the study of the chemical components of the plant, when they discovered that the Golden Grass contains flavonoids that interact especially with the sunlight. “We found that these flavonoids absorb the light spectrum of blue, violet and ultraviolet. When white light, which contains these spectra, focuses on the grass, flavonoids absorb these

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80 Cerratinga is a website developed by the NGO Society Institute, Population and Nature (ISPN), which operates in eco-social field with focus on people and traditional communities, family farmers and their organizations. The ISPN works in partnership with the *Cerrado* of Central Cooperative, with Agendha NGOs and the Bodega sustainable products biome Caatinga. Available in: <<http://www.cerratinga.org.br>>. Accessed in: Mar.02.2014.

81 Available in: <<http://www.cienciahoje.uol.com.br/revista-ch/2014/312/brilho-unico>>. Accessed in: Nov.08.2014.

colors and left the red spectrum, which generates the golden color”, explains Schreiner. The answer opened the possibility of using the flavonoids of the Golden Grass in a totally unexpected field. The ability of light-absorbing substance can be utilized for the production of tests for the diagnosis of various diseases, such as AIDS and hepatitis. In these tests, the causative organism of the disease proteins is inserted into a drop of blood from the patient to verify that this is infected. If he ever had contact with the disease, will have specific antibodies to it, and these will bind to proteins, attesting that the person is infected.

To detect the relationship between proteins and antibodies, laboratories added to proteins fluorescent molecules the microscope stand. Currently, the fluorescent molecules used in Brazil are imported, but could be replaced by the flavonoids of golden grass. “We have a chance to have a national, natural product and easily accessible”, said Schreiner, who initiated the study of the possibility of application along with researchers from the National Institute of Science and Technology in Diagnostics for Public Health. “The Golden Grass is a national plan that could serve as raw material. Many scientists are more concerned in studying things out that the country itself; with this study, we highlight the importance of giving value to what is genuinely Brazilian”.

#### 4.3.4 Utilities and pieces of decoration of *Capim Barba-de-bode* (beard-of-goat grass)

The *Capim barba-de-bode* (“beard-of-goat” grass) (*Aristida pallens*) is one of the endemic species found in the region of Boa Vista de Lages, one of the towns of Serro, distant 35 km of this.

The art of braiding “beard-of-goat” grass in this village is a very old activity, passed from generation to generation since the formation of the community. But until then, the goal was just fabricate products for everyday life, such as chicken nest and basketry.

However, in 2005, it was established the *Grupo Estrela do Campo* (Star Field Group) in order to promote economic and social development of the community through this know-how and availability of raw materials (beard-of-goat grass).

Currently this group, formed by women artisans, produce baskets, fruit trees, souplat, bottle rack, mandalas (FIG. 41). This is the main activity and source of income of the same.

The raw materials used in the manufacture of the pieces are grass beard-of-goat (collected all year), scraps of fabric (donated by a textile factory in the region with some frequency) and cotton thread (acquired in the city of Serro or *Diamantina*).



FIGURE 41 – Handcraft with Beard-of-Goat Grass

The manufacturing process is simple. After collecting the grass artisans leave it exposed to the sun (FIG. 42 a) for it to dry. The rods are grouped and stitched with cotton thread. The work is carried out jointly in the town Social Center (FIG. 42 b), where all organized materials. (FIG. 42 c).

Small fabric scraps are used as filling for pillows, the line is used to fill rag dolls, and the grass is used as fertilizer in the garden.

The sale of spare parts takes place at the *production site (Social Center)*, in the cities of *Serro, Diamantina and São Gonçalo do Rio das Pedras*. The products have no packaging.



FIGURE 42 – a) Home drying / b) Social center / c) Materials



#### 4.3.4.1 Characteristics of *Capim Barba-de-bode* (beard-of-goat grass)

The grass *Aristida pallens* (*Poaceae* family), better known as *capim "barba-de-bode"* ("beard-of-goat" grass) is very common in the Brazilian *Cerrado* (FIG. 43).



FIGURE 43 – Capim *Barba-de-Bode* ("Beard-of-Goat" Grass)

Grasses gather features that stand out as an evolved and diversified group of plants. Have efficient photosynthetic performance under different conditions, they are efficient in the production and dispersion<sup>82</sup> of diaspores<sup>83</sup>, have fasciculated root system, and produce stolons<sup>84</sup> and rhizomes<sup>85</sup>. All these attributes make grasses appropriated for the recovery of degraded areas, as well as feeding for livestock.

The "beard-of-goat" grass is undemanding as to soil fertility and moisture (MINISTRY OF ENVIRONMENT, 2009). Among its active ingredients highlight the oligosaccharides<sup>86</sup>.

Oligosaccharides (formed by joining two or more monosaccharide molecules by glycosidic linkage) are soluble carbohydrates which act as prebiotics, *i.e.* stimulate the growth of beneficial intestinal microflora. They are classified as Dietary fibers low in calories. The oligosaccharides are not digested or absorbed by the stomach. However, after passing

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82 Dispersion: name given to the mechanisms or means used by plants to reach new places.

83 Diaspores or dispersion units: seeds, fruits, whole plants or plant parts.

84 Stolon: type of stem creeping.

85 Rhizome: type of stem, root-shaped, growing horizontally, usually underground, rich in nutrient reserves.

86 Available in: <<http://www.fitoterapica.com.br>> e <<http://www.plantasquecuram.com.br>>. Accessed in: Nov.02. 2014.

through the stomach and small intestine, entering a fermentation process that stimulates the growth of *Bifidobacterium spp.* and *Lactobacillus spp.*, beneficial organisms to colon health. Thus, the oligosaccharides are for the balance of intestinal flora and selective nutrition of beneficial bacteria; elimination of pathogens (*E. coli*, *Salmonella* and *Clostridium sp.*) and food contaminants, reducing the risk of colon cancer; decrease triglycerides; maintaining stable blood glucose; favoring the absorption of nutrient, increasing the bioavailability of minerals and vitamins; improvement of fecal volume and intestinal transit; strengthening the immune system; and in cases of engorgement<sup>87</sup> (liver). Furthermore, it can be used as a diluent and aperient<sup>88 89</sup>.

The decoction of the leaves and roots of the beard-of-goat grass is used against cold and to assist the birth of teeth (DE SOUZA, DE MORAES; RIBEIRO, 2005), his syrup against chronic bronchitis, the infusion of the root is indicated for the kidney, bladder and phlegm gonorrhoeas<sup>90</sup>. Externally applied in cataplasms on the liver<sup>91</sup>.

#### 4.3.5 Ceiling lining, Basketry and *Taquara* mat

The art of weaving the *Taquara* in *Capivari, Serro* the town distant 32 km of it, is passed from generation to generation since its institution. This activity, according artisans of the region began with the making of baskets for domestic use due to its abundance in the region.

Currently, the artisans produce roof lining, baskets and mats with this material (FIG. 44), in order to supplement the family income.



FIGURE 44 – Ceiling lining, Basketry and *Taquara* mat

87 Engorgement: distension of a vessel in the organism.

88 Increases or whets the appetite, help the body to prepare for digestion, producing more spittle and gastric juice to get the food.

89 Available in: <<http://www.fitoterapica.com.br>>, <<http://www.plantasquecuram.com.br>> and <<http://www.sonutricao.com.br>>. Accessed in: Nov.02. 2014.

90 Gonorrhoea: purulent infection of mucous membranes, especially the urethra and vagina.

91 Available in: <<http://www.portofm.portoamazonas.com>>. Accessed in: Nov. 02. 2014.





FIGURE 45 – Summary of making process

The collection of *Taquara* carried out by the artisans, takes place in the waning moon. The same highlight harvesting only those mature as they spring up again and, after six months, will be grown enabling new collection. In addition, they gather only enough material to fabricate the piece that will be worked immediately.

The production process is fairly simple. After collecting the *Taquara* in the region, the stems are placed on the animal's back and transported to the workplace (homes of their own artisans) and dried in the sun. The artisans “open” to *Taquara*, with a machete, and “beat” its two halves, with hammer to remove the nodes and leaves it flat. After this procedure, the *Taquara* is ready to be twisted (FIG. 45).

As the artisans have enough experience, there is almost no leftover material. The little that remains is discarded in the woods near their homes.

The roofs liners are produced only on demand, it is necessary prepares them with the dimensions provided by the customers, depending on the area to be covered. Once ready, the liners are wrapped and transported by them customers. The installation is performed with nails and finishing with wooden frames. This product receives orders from *São Gonçalo do Rio das Pedras, Milho Verde, Belo Horizonte, Governador Valadares* and *São Paulo*, and the region itself.

The sale of mats and baskets is performed on-site production in hotels and shops of *São Gonçalo do Rio das Pedras, Milho Verde* and *Diamantina*. Do not use packaging.

When asked, the artisans have expressed that this new generation (children and grandchildren), despite having learned the activity as children, has no interest in continuing with the tradition, believing that it is not a good source of income and work is very “heavy”.

### 4.3.5.1 Characteristics of Taquara

*Taquara* is one of the popular names for bamboo *Bambusa tuldooides* (FIG. 46). Botanically, it is classified as *Bambusae* - family *Graminae* (*Poaceae*). It is considered a woody plant, monocotyledon, belonging to the angiosperms (PEREIRA, 2012).

According to Hidalgo-López (1974), bamboo has about 50 genera and 1250 species. They are found in greater abundance in the hot and rainy areas of tropical and subtropical regions of Asia, Africa and South America. Most species (62%) are native to Asia and the Americas (34%). In Brazil are 89% of all genera and 65% of all species of bamboos known in America. The authors point out that among the introduced species in Brazil, *Bambusa* genre is one that stand out (FILGUEIRAS; SANTOS-GONÇALVES, 2007).

Bamboo is a predominantly tropical plant, perennial, renewable, and growing faster than any other plant, taking on average 3-6 months to a shoot reaches its maximum height of up to 40 m (PEREIRA, 2012). It grows well in most soils, however, the most suitable are those fertile, loose and well drained, with pH between 5.0 and 6.5 (DE OLIVEIRA, 2006).

According to Pauli (2001), bamboo is an efficient carbon fixation, converting it through photosynthesis in cellulose, hemicellulose and lignin.

Janssen (2000) states that the structural properties of bamboo outweigh the wood and concrete, can be compared to steel, depending on the strength relations / density, and stiffness / density.

According to the same author, bamboo culms are characterized by cylindrically shaped and present a internodes sequence (hollow portion containing air) separated transversally from each other by diaphragms that appears externaly as nodes (solid part), from where branches and leaves (FIG. 47).

These diaphragms are to provide increased rigidity, flexibility and resistance stems.

The bamboo culm is born with its final diameter, ie, never increases radially as with wood. This diameter is larger near the base, and decreases with height towards the tip. The annual spring stalks stretching continuously from 20 cm to 1 m daily, depending on the species. The birth of new culms is given asexually, by branching rhizomes, which are also responsible for storing nutrients for the plant. According to Pereira (2012), *Taquara* in this branch is the bush type in which the stems are born and develop grouped to each other, and may contain from 30 to 100 units (FIG. 48).



FIGURE 46  
*Taquara - Touceira*  
Source: <<http://www.succulentsandmore.com>>

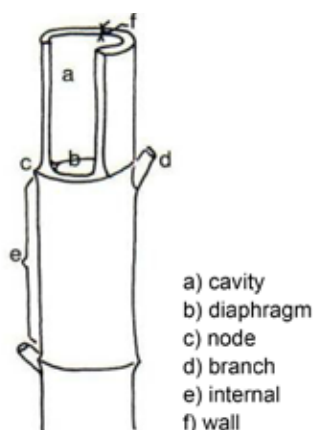


FIGURE 47  
Section of a bamboo colmo  
Source: Janssen (1998)

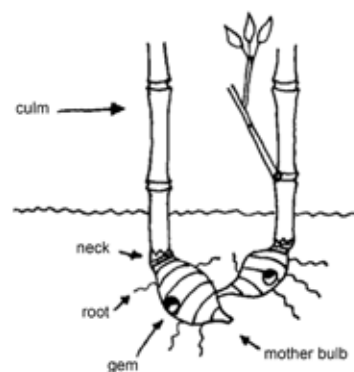


FIGURE 48  
Rhizome paquimorfo or bush type  
Source: <<http://www.bambubrasileiro.com>>

According to Liese (1998), the main chemical constituents of the stem of bamboo are cellulose (55%), hemicellulose, lignin (25%) and, in smaller amounts, resins, tannins, waxes and inorganic salts. Its properties are determined by its anatomical structure: in the internal cells are axially oriented, while in the transverse nodes appear interconnections between them.

So overall, culm comprises about 50% of parenchyma (responsible for storing water and nutrients), 40% fiber (mainly responsible for the resistance of the stem and 60 to 70% of its weight) and 10% of conductive fabric (DE OLIVEIRA, 2006).

The bamboo should be extracted in the dry season since, as have a lower amount of moisture at this time, they are lighter, which facilitates transport, in addition to having smaller amount of sap, which makes them less attractive to fungi and insects (SALGADO, 1992). According to Oliveira (2006), the bamboo will have a shelf life of 1 to 3 years if left untreated, and 10 to 15 when handled and used.

Bamboo has excellent mechanical properties, which are mainly influenced by the moisture content of the stem and the amount of fiber (PEREIRA, 2012). According to Liese (1998), the variation in the stalk strength properties is much higher in the horizontal direction than vertically. The density of nodes is greater than the internodes, however, its tensile strength, flexural, compressive and shear are lower.

From results of several researchers, Hidalgo-López (1974) describes the parts of the stem due to its distinctive strengths:

- Throughout the stem: the mechanical properties change from top to bottom of the stem. If the useful height of the stem is divided into three parts, the top is generally more resistant to compression and bending of the central and lower parts. The central portion is more resistant to traction. Since the bottom of the stem, commonly has lower mechanical strength values.
- In the domestic: the fibers are shorter near the node and longer at the center of the internal hence the toughest part occurs in the central region.
- On the wall of the stem: the bulk density and tensile strengths and thatched wall compression increase from inside to the outside, so the toughest region is the outer third, and the weaker the inner third.

The *Taquara* has tensile strength of 111 MPa to compression of 34 MPa, flexural strength of 93 MPa and shear strength of 54 MPa.

According to Janssen (2000), the bulk density is the most important mechanical property. For most bamboos its value is around 700 to 800 kg / m<sup>3</sup>. The features *Taquara* density 1100 kg / m<sup>3</sup> (saturated), 660 kg / m<sup>3</sup> (dry) and 650 kg / m<sup>3</sup> (anhydrous).

Bamboo can change its dimensions depending on the moisture variation. According to Beraldo *et al.* (2004) during the bamboo culm drying problems arise linear dimensional variations, which are variable depending on the considered axis. The *Taquara* has the following dimensional variations: 11.7% radial, axial 0.4% by volume and

22.2% (BERALDO; ZOULALIAN, 1995). De Oliveira (2006) points out that the drying and storage of the stem should be conducted according to end use.

Generally, bamboo moisture content is inversely proportional to its shear strength. Resistance to transverse shear the bamboo fiber is around 30% of its flexural strength. Since resistance to longitudinal shear the fibers is about 15% of its compressive strength (PEREIRA, 2012).

Resistance to bamboo traction is high. In some species can reach up to 370 MPa. Thus, the use of bamboo can be considered as a good substitute for steel, especially when considering the ratio between its tensile strength and its bulk density (PEREIRA, 2012).

Historically, bamboo has accompanied humans providing food, shelter, tools, utensils and a myriad of other items due to its versatility, lightness, strength, ease to be worked with simple tools, beauty to the natural or processed, as well as having excellent physical, chemical and mechanical. Currently, it is estimated that contribute to the livelihoods of over a billion people (PEREIRA, 2012).

In Asian cultures of China, Indonesia and Japan the use of bamboo is traditional. In South and Central America it is also solidified his job due to its local abundance (DE OLIVEIRA, 2006). However, according to Neto *et al.* (2009), bamboo still suffers prejudice in Brazil, as many consider it as a second-rate material.

In Occidental history, as noted by Pereira and Beraldo (2008) stand out two remarkable uses of bamboo: the first filament used in a light bulb by Thomas Edison and the construction of one of the first aircraft Santos Dumont (Demoiselle model). Hidalgo-Lopez (1974) pointed out a monument that inspired an entire line of construction in the Occident: the majestic Indian monument Taj Mahal, with its dome framed in bamboo. The author also emphasizes that, currently, the ancient bamboo jobs have risen as applications in pharmacy, chemistry and medicine. In this context, the bamboo is indicated for prostate treatment and slimming (AMORIM, 2009).

In Brazil, bamboo employment, except for paper production, is limited to handicrafts, fishing pole, manufacture of furniture, and production of edible shoots (PEREIRA; BERALDO, 2008). Beraldo, Azzini and Carvalho (2003) believe that the limited use of bamboo in the country is associated with the lack of agronomic knowledge and specific technology, as occurred in the past in relation to eucalyptus. Already in countries like Colombia, Ecuador and Bolivia, their use in construction is already an established practice and arising out of popular knowledge (DE OLIVEIRA, 2006).

Bamboo can have several jobs in the age of the stem and the species. Culms aged between 1 and 2 years are generally used for making crafts, especially those who need that bamboo is twisted, such



as baskets and baskets. Canes with three years or more are considered mature and must be used for any purpose requiring greater resistance (DE OLIVEIRA, 2006).

According to Pereira (2012), due to its physical and mechanical properties, bamboo is suitable for use in the development of traditionally made from wood products. The products made from laminated bamboo, for example, floors, panels and plywood, cables for manual or agricultural tools, kitchen utensils and bathroom furniture and components of the furniture industry, pipes, buildings and components of construction are possible be explored through the thatched processing chain. The author also points out that bamboo can be used in the restoration of riparian forests, and also as a protective and environmental regeneration.

With regard to their physico-botanical characteristics, bamboo has a high resistance to traction and compression efforts, offering advantages for use in dwellings structures, bridges, ladders, furniture, and objects in general. Since bamboo is pliable, it can be curved in the presence of heat (DE OLIVEIRA, 2006).

Farrelly (1984) cited several applications of bamboo as, for example, paper, food, textiles, a plethora of household objects, musical instruments, tools, applications in medicine, pharmacy, chemical and other industrial fields, coal, charcoal batteries, fuel, aircraft, products made of bamboo processed as toothpicks, cotton swabs, floors, ceilings, plates, boats, farm equipment, soil protection, erosion control, wind barrier, ornamentation, environmental regeneration, carbon sequestering, kiosks, houses, scaffolding, windmill, water wheel, ropes, surfboard, bicycle, among many others.

According to Silva *et al.* (2012), among the main species of bamboo used for therapeutic purposes based on the popular knowledge, there is the *Bambusa tuldoides*. Its leaves have been used in traditional Chinese medicine to treat fever and detoxification for over 1000 years. Extracts of its leaves, rich in chlorophyll, can be used in food as a powerful antiseptic food. Some studies have reported the ability of these constituents in preventing or delaying the development of some cancers, and also provides anti-inflammatory activity, as well as improved circulation and control of allergic reactions. According Dharmanada (2004), this plant can be used to treat epilepsy, fainting and unconsciousness when combined with hyperthermia and various diseases of neurological origin. The same author showed the presence of flavonoids in the plant, which may be applied as antioxidants.

The community “Fraternidade Umuarama”<sup>92</sup> (“Brotherhood Umuarama”) located in *São Roque* in the state of São Paulo, use the Bamboo *Bambusa tuldoides*, found in the region, such as: i) main source of

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92 Available in: <<http://www.fraternidadeumuarama.org>>. Accessed in: Jan.02. 2015.



coverage for the soil – retains moisture, reduces rain ground pressure and competition between plants; ii) dry matter for use in dry compostable toilet; iii) management of vegetation by smothering – avoids the use of chemicals; iv) preparation of piles of organic compounds – prevents slurry waste and provides more constant temperature in the stack; v) half-and-half with manure goat – increases the yield and facilitates the application; vi) the ground fodder below cabril (stable for goats) – avoids wasting the urine and prevents the arrival of flies.

According to Neto *et al.* (2009), much of the most common use of bamboo stems from tradition in rural areas, where they are used fences and small buildings like chicken coops, pens, gates, small rustic shelters, *taperas* (housing village or old house) and cages, mainly due to availability and low cost. The author points out that among the more traditional forms of bamboo, the manufacture of fishing rods is undoubtedly the oldest.

Bamboo *Bambusa tuldooides* can still be used: i) the execution of construction elements – closing panels, roofs, ceilings, window frames, roofing, bridge constructions; ii) the conservation of ecosystems – used as windbreaks, assisting in increasing water springs, the holding capacity of roots or rhizomes, and combating erosion – planting on slopes; iii) handicrafts – making baskets, mats, fishing poles, kites, jewelry, decorative objects, musical instruments (flutes instruments and components); iv) making of furniture – manufacture of furniture and rods with different diameters and with numerous processing operations such as, for example, fire folding; v) irrigation and drainage – drainage of land from greatly simplified construction of water distribution networks, easy maintenance and durability; vi) on vessels – produced on stems beams, using the buoyancy of the water due to the voids of the stems; vii) the construction of small rural dwellings (NETO *et al.*, 2009).

Neto *et al.* (2009) point out that one of the great possibilities of application of bamboo in rural buildings is the use of greenhouses to structures (FIG. 49) and nurseries, because the high cost in the acquisition of conventional greenhouses hinders access to the countryman to this technology. Another possibility, cited by Beraldo, Azzini and Carvalho (2003), is its use as noise barriers<sup>93</sup> to reduce noise. In preliminary tests conducted at the Agronomic Institute of Campinas, the barriers built with bamboo *Bambusa tuldooides* were able to reduce the noise from a truck (110 dB to 50 dB).



FIGURE 49 – Greenhouse ecological developed by the centre of reference in agroecology *paranaense*  
Source: <<http://www.cpra.pr.gov.br>>

93 Noise barriers are able to minimize the propagation of sound waves through a particular medium. Typically, the more dense material will have the best perform.

#### 4.3.6 Bags of Corn Straw

In *Pedra Redonda*, in the town of *Serro*, distant 15 km from the even, the art of weaving corn husks has been passing from generation to generation for over 40 years. However, according to the artisan “Dona Araci” (Mrs. Araci), young people no longer interested in the activity.

Mrs. Araci produces bags (FIG. 50) with corn stover that she cultivates, along with her husband, in order to supplement the family income. In addition to corn, they plant beans, coffee, cassava and sugarcane for consumption and sale.



FIGURE 50 – Bags of corn straw

Artisans harvest the corn when it is dry and takes them to their homes. Subsequently, cut straw, water with a little water to become soft and to reels off. The straws are wound in one another to obtain a higher strip and facilitate the work. The weaving is carried out a wooden structure (FIG. 50). A small amount of straw is left is thrown into planting to turn into fertilizer.

To color parts of the bags, the artisan uses a dyer of fabrics, water-soluble. According to the Security Information Sheet of Chemical Products (FISPQ<sup>94</sup>) of this, its chemical nature is a solid mixture of sodium chloride, azo dye / dye stilbene and dispersant; there are no harmful ingredients; and the product can cause eye irritation (if any contact with them), respiratory tract (by inhalation), and the digestive tract (if swallowed).

The bags are produced by *Dona Araci* in his spare time. Once ready, they are sent to the *Serro*, which is traded on *Chica da Silva* Shop, along with other crafts of the region. There is no packaging.

94 FISPQ number 001/2009. Name of product: *Tingecor*. Available in : <http://www.guaranyind.com.br/consumo/corantes/tingecor/> >. Accessed in: Jan.18. 2015.

#### 4.3.6.1 Characteristics of Corn straw

According to Barros and Calado (2014)<sup>95</sup>, corn for more than 8000 years, is grown in many parts of the world like USA, China, India, Brazil, France, Indonesia, South Africa, etc. Its great adaptability allows its cultivation in tropical, subtropical and temperate climates.

At the time of the time of discovery of the Americas, corn was already the staple food of all civilizations of the continent. Of the more than 300 races of maize identified in the world, nearly all had their direct or indirect origin in pioneering works of pre-Columbian civilizations (INFORMATION COUNCIL ON BIOTECHNOLOGY, 2006)<sup>96</sup>.

Corn is the third most cultivated cereal in the world. In Brazil, corn is one of the three most consumed cereal, ensuring the survival of many families that use it (BRAZILIAN COMPANY OF AGRICULTURAL RESEARCH - EMBRAPA)<sup>97</sup>.

According to the balance and supply of corn report in the world, provided by the Ministry of Agriculture of Brazil (2004)<sup>98</sup>, world production was close to 620 million tons in 2004 and it is estimated that production is close to 700 million tons for 2005. Brazil stands out as the third largest producer with an output of 47.8 million tons.

In the botanical classification, corn belongs to the *Gramineae* order, *Poaceae tribu Maydeae* family, *Zea* gender and *Zea mays* L. species (FIG. 51). This plant is used in Human food and animal feed, due to its high nutritional value, containing almost all known aminoacids, except lysine and tryptophan. The seed corn, rich in proteins and enzymes, germinate in 5 or 6 days when the temperature and moisture conditions are favorable. In the vegetative stage and flowering, the optimal temperatures range from 24° to 30° C. Depending on weather conditions, proper water supply, nutrient availability and soil characteristics and fertility of the same, corn can reach up to two feet tall. Its stem is an erect stem, usually unbranched, with nodes and internodes, which are spongy and relatively high in sugar.

The corn plants are considered narrow leaf by its length is much greater than the width. The leaves are ar-

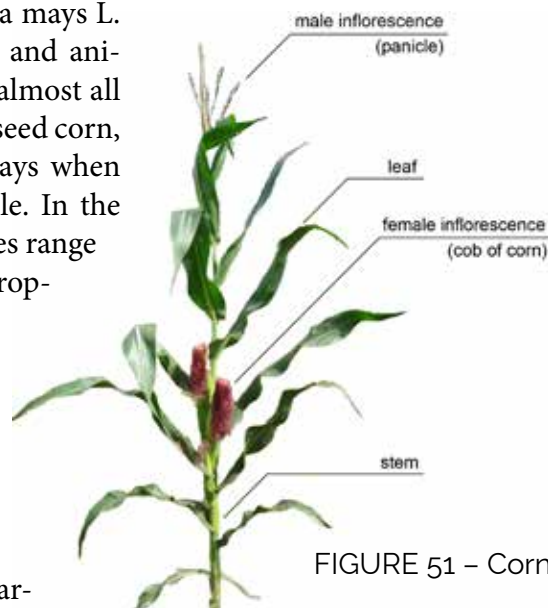


FIGURE 51 – Corn

95 Available in: <<http://www.dspace.uevora.pt/rdpc/bitstream/10174/10804/1/Sebentamilho>>. Accessed in: JAN.08. 2015.

96 Available in: <[http://www.cib.org.br/pdf/guia\\_do\\_milho\\_CIB](http://www.cib.org.br/pdf/guia_do_milho_CIB)>. Accessed in: JAN.08. 2015.

97 Available in: <<http://www.cnpms.embrapa.br/receitas/index.html>>. Accessed in: JAN.08. 2015.

98 Available in: <[http://www.agricultura.gov.br/pls/portal/docs/PAGE/MAPA/ESTATISTICAS/AGRICULTURA\\_MUNDIAL/10.5.C.XLS](http://www.agricultura.gov.br/pls/portal/docs/PAGE/MAPA/ESTATISTICAS/AGRICULTURA_MUNDIAL/10.5.C.XLS)>. Accessed in: JAN.07. 2015.

ranged alternately and set forth in nodes. Corn is a monoecious plant, *i.e.*, has the male and female organs on the same plant in different inflorescences, while the male grouped in panicle (flag), located at the top of the stem, and the female in axillary spikes. The panicle containing male flowers, can reach 50 to 60 cm long and may have varying color, greenish or often being deep red.

Each flower consists of three stamens and pollen production can last for about 8 days. Each panicle can produce about 50 million pollen grains. When the tassel is issued, the growth of shoots of corn ceases and root growth is greatly reduced. The female inflorescence called spike or cob is constituted by a shaft, over which it has and where the wells are developed spikelets in pairs, each spikelet being formed by two flowers, fertile and sterile other. Each flower has an ovary with one egg from the ovary and develops the style-stigma. The stigma-style set will be the “hair” or also called “corn beard”. Flowering occurs normally between 50 and 100 days after sowing, and is primarily affected by temperature. Pollination is no more than the transfer of pollen grains from anthers of the male flower to the stigma of the female flower.

In corn, self-pollination is only about 2%, for this reason it is said that this plant is cross-pollinated. The dehiscence and dispersal of pollen grains usually occur 2 to 3 days before the style-stigma issue, favoring thus cross-pollination and both the release of pollen to the male flowers as the receptivity that pollen by “beards”, which occurs for several days, often between 5 and 8 days, and sometimes extend up to the 14th day, which guarantees all ears pollinated. After pollination occurs fertilization itself, resulting in the formation of the grain (BARROS; CALADO, 2014)<sup>99</sup>.

According to the engineer José Luis da Silva Nunes<sup>100</sup>, the rate of development of the corn crop could be adjusted by several factors, such as temperature, water content and soil fertility, solar radiation and photoperiod<sup>101</sup>, however, the temperature is the factor dominant.

Corn is especially rich in carbohydrates (sugars), mainly starch, which characterizes it as energy food. This fraction corresponds, on average, 72% of the grains, but other important nutrients are present such as lipids (4.5%) and dietary fiber (2.0%). Some vitamins are also found in corn (in particular B1, B2, and E), and

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99 Available in: <<http://www.dspace.uevora.pt/rdpc/bitstream/10174/10804/1/Sebenta-milho>>. Accessed in: Jan.08. 2015.

100 Available in: <<http://www.agrolink.com.br/culturas/milho/caracteristicas.aspx>>. Accessed in: JAN.08. 2015.

101 Photoperiod is the relationship between the length of days (illuminated period) and night (dark period).

the pantothenic acid and some minerals (mainly phosphorus and potassium). Another nutrient that stands out as a constituent of the maize grains are proteins whose levels reach, on average, 9.5%<sup>102</sup>.

100 grams of this food has about 360 kcal, 70% from carbohydrates, 10% proteins and 4.5% lipids. Higher than the nutritional qualities of corn, only even its versatility for use in food. Besides supplying much of the nutritional needs of the population, corn is an excellent food in natura supplement in the form of maize flour, cornmeal, grits, polenta, couscous, etc., and also as a component for the manufacture of candies, cookies, breads, chocolates, jams, ice cream, mayonnaise and even beer (COUNCIL OF INFORMATION ON BIOTECHNOLOGY, 2006)<sup>103</sup>.

According to Ribeiro (2014), the use of corn for grain in animal feed (cattle, poultry and pork) represents the largest share of consumption, and in Brazil ranges from 70% to 90% of total production. Although the percentage intended for human consumption is not as large in relation to its production, it is a major cereal, especially for the low-income population.

Cruz *et al.* (2011) point out that corn also has great social importance, mainly because in Brazil, much of its producers depend on their production for a living, have small areas of land and few technical resources.

Its derivatives are used in the composition of various products in the food industry as margarine, salad dressings, edible oils and breads. It also has properties widely used in the chemical, pharmaceutical, paper, textile, among others (PAES, 2006).

Corn can be processed and used by two main processes (dry and wet) for production of products such as ground corn meal, pelletized corn germ meal, pre-gelatinized flour, corn grain, coarse cornmeal, corn gluten, corn gluten meal and corn bran. In addition to the feed, corn can be used in the form of whole plant silage (COUNCIL OF INFORMATION ON BIOTECHNOLOGY, 2006)<sup>104</sup>.

According to Goes, Silva and Souza (2013), the “maize straw” (thatched mixture, cob, corn and plant leaves crushed with corn husks) is excellent for making silage because it has good forage production per area and good amount of sugars to lactic acid, essential to the process. Also, this grain crop residue can be used as a source of fiber in the diet of ruminants.

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102 Available in: <<http://www.cnpms.embrapa.br/receitas/index.html>>. Accessed in: Jan. 08. 2015.

103 Available in: <[http://www.cib.org.br/pdf/guia\\_do\\_milho\\_CIB](http://www.cib.org.br/pdf/guia_do_milho_CIB)>. Accessed in: Jan.08. 2015.

104 Available in: <[http://www.cib.org.br/pdf/guia\\_do\\_milho\\_CIB](http://www.cib.org.br/pdf/guia_do_milho_CIB)>. Accessed in: 08 jan. 2015.



EMBRAPA<sup>105</sup> advises leave straw and plant debris on the soil surface, and only prepares it to receive the seed only at sowing line (called “direct seeding”) has several positive effects on the environment: reducing the use of source inputs fossil, as fuel and fertilizers; protects the soil, preventing soil erosion; keep needed moisture to plants; avoids contamination of the water sources that supply the cities; and improves the physical, chemical and biological soil; reduces the impact of agriculture and agricultural machinery on the ground, it is not necessary to use any method of preparation. This system also allows you to produce better quality seed and enables an increase in soil organic matter, reducing emissions of gases responsible for the greenhouse effect.

The hydrated corn serves as the fermentation medium for the production of penicillin and streptomycin, and other applications in the pharmaceutical field. Corn glucose syrup is used in the manufacture of cosmetics, pharmaceutical solutions, greases and resins. In addition, corn starches enter the formulation of cleaning products, photographic film, plastics, rubber tires, paints, fireworks, paper and fabric (COUNCIL OF INFORMATION ON BIOTECHNOLOGY, 2006)<sup>106</sup>. Müller and Trauthaman claim that the stigmata (“corn hair”) are indicated in cases of treatment for cystitis, urethritis, kidney stones, and is diuretic. According to Vieira *et al.* (2012), the “waste” of corn (cob and straw) can be further leveraged to manufacture high-fiber foods.

On the other hand, the corn stover is employed in various craft activities. According to the artisan Cícero Carlos<sup>107</sup>, the art of working with the corn straw is too old. In the Middle Ages the floor of the house was coated mats made with straw placed on dirt. Europe took advantage of the chaff from the wheat, grown in Tuscany, in the making of hats. France employed chayote straw. Japan used colored straws (XVI century) in boxes with decorated caps and were widely used in furniture upholstery. In Brazil, the craft using this fiber excelled in *Minas Gerais* and *Santa Catarina*. Currently, almost all states work the straw with particular characteristics.

In *Patos de Minas*, known as “corn city”, corn stover that was crushed and for animal feed has become raw material for the development of handicrafts through the *Associação das Marias Artesãs* (Association of Artisans Marias). Currently, this group of 20 women, created with the aim of rescuing ladies who were discouraged and virtually abandoning the craft, free receiving raw materials from local businesses, and produces parts as sacred images, bags, jewelry boxes, dolls, or-

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105 Available in: <[http://ccw.sct.embrapa.br/?pg=bloguinho\\_default&codigo=165](http://ccw.sct.embrapa.br/?pg=bloguinho_default&codigo=165)>. Accessed in: 17 jan. 2015.

106 Available in: <[http://www.cib.org.br/pdf/guia\\_do\\_milho\\_CIB](http://www.cib.org.br/pdf/guia_do_milho_CIB)>. Accessed in: 08 jan. 2015.

107 Available in: <<http://www.biblio.info/cicero-carlos-fala-sobre-a-cultura-da-arte-de-palha/>>. Accessed in: 08 jan. 2015.

naments, carpets, placemats, roses and tulips. Some of them have gone even to have a higher income than men in the region. But, the Group of Artisans *Andorinhas* (Swallows), formed by women of the settlement of *Frexeiras*<sup>108</sup> (located in city of *Batalha*, interior of *Piauí*), is walking up the corn planting and harvest the straw, which in turn are separated by textures. “Each one is appropriate for a particular job. The thick stock used to make the thin and to make sandal. So the work goes to family income. The money helps a lot”, says the artisan Maria José de Carvalho Resende (50 years).

The group also makes dolls of typical backlands characters. The families of this settlement surviving family farming, consume what they sow. In the fields while their husbands work in the field and plant other crops, besides corn that is destined for animal consumption and marketing, women use the leftovers region<sup>109</sup>.

In *Juazeiro*, in the state of *Ceará*, the making of corn husk dolls is a past activity father to son for three generations. The dolls produced craftsman Cicero Carlos, express feelings and location daily<sup>110</sup>.

In the city of *Itararé* / SP, known as “land of corn and beans”, the craftsman Antonio Aristides Almeida prepares sacred figures in corn husks to refuse these crops for 16 years. The activity involves the whole family, harvesting vines and other materials properties such as ranches and farms for, along with corn stalks, to produce the parts. The craftsman does not use poison in corn husks, believing that many children may contact parts, intoxication or presenting an allergic reaction. To combat the natural fungi straw, the craftsman boils all of them for at least half an hour, and only use the third straw corn (the one that is closest to the ear), and therefore less contact with pesticides. Currently, the craftsman has an arrangement with the Superintendent of Artisanal Work in Communities (SUTACO<sup>111</sup>), which gets much of its production and sells at various locations in Brazil and some from abroad<sup>112</sup>.

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108 The Frexeiras settlement was created by the National Institute of Colonization and Agrarian Reform (INCRA) in 2000, where live 80 families in an area of 1800 hectares..

109 Available in: <<http://www.revistarural.com.br/edicoes/item/5416-milho-a-arte-quevem-da-palha>>. Accessed in: Jan.08. 2015.

110 Available in: <<http://www.biblioo.info/cicero-carlos-fala-sobre-a-cultura-da-arte-de-palha>>. Accessed in: Jan.08. 2015.

111 The SUTACO is an autarchy linked to the Department of Economic Development, Science, Technology and Innovation - SDECTI with the responsibility to provide opportunities to generate income to artisans and promote local development in an economically viable way, socially just and environmentally responsible. The local authority also rescues traditional forms of expression of the Paulista people, the “know-how” of people and communities of diverse characteristics, and follows current trends of craft production. Source: <<http://www.sutaco.sp.gov.br/sutaco.html>>.

112 Available in: <<http://www.jornalcidadedeitarare.com.br/102/Artista-transforma->

According to Moreira (2005), another market that has stood out in the use of corn stover is the hand-rolled cigarettes, especially in *Minas Gerais*, where the product is configured as one of the icons of the rural tradition. We can cite as an example the most famous manufacturer of this product: *Souza Paiol*, located in *Pitangui* interior of *Minas Gerais*. The company currently produces 600,000 packs per month, provides work for 1,200 families from seven cities in the region, as well as prisoners City *Pompéu*, housewives and retirees. According to the manufacturer, these cigarettes are completely natural, because the ingredients do not receive any additional mixing.

Making corn husk cigarette is also a tradition that lasts more than 40 years in Sales de *Oliveira* City in the state of *São Paulo*. The activity was initiated by a resident, who made cigarettes to “pass the time”. Currently, there are 50 manufacturers of the product in the region, employing around 2,500 people, who work in their homes. The corn that gives this straw can be harvested by hand, and the seed is given by the “haystack” the farmer in exchange for straw. The whole process is handmade, from harvesting, for machine harvesting the grain, but tears straw<sup>113</sup>.

## 4.4 Step 2 – Understanding the Territory

Recording and analysis of all inputs and outputs of activities (production systems) of *Serro* Territory, investigated during the field research, in order to support the new project matter and energy flows of the same.

### 4.4.1 *Cerrado* Fruits Cosmetics system

The following schemes show the current iconographic production process of cosmetics produced with *Amesca* (FIG. 52), *Macaúba* (FIG. 53), *Mutamba* (FIG. 56) and *Pacari* (FIG. 57). These allow you to view all input and output system, and highlights the “negative” points system. Important to remember that, according to the systemic approach, the “negative” points are considered as opportunities for change.

All “negative” points of this system, shown with red triangles warning, are explained below in order to clarify its scope and comprehensiveness.

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palha-de-milho-em-arte-sacra>. Accessed in: Jan.08. 2015.

113 Available in: <<http://www.abagrp.org.br/cidadesDetalhes.php?id=61>>. Accessed in: Jan.09. 2015.

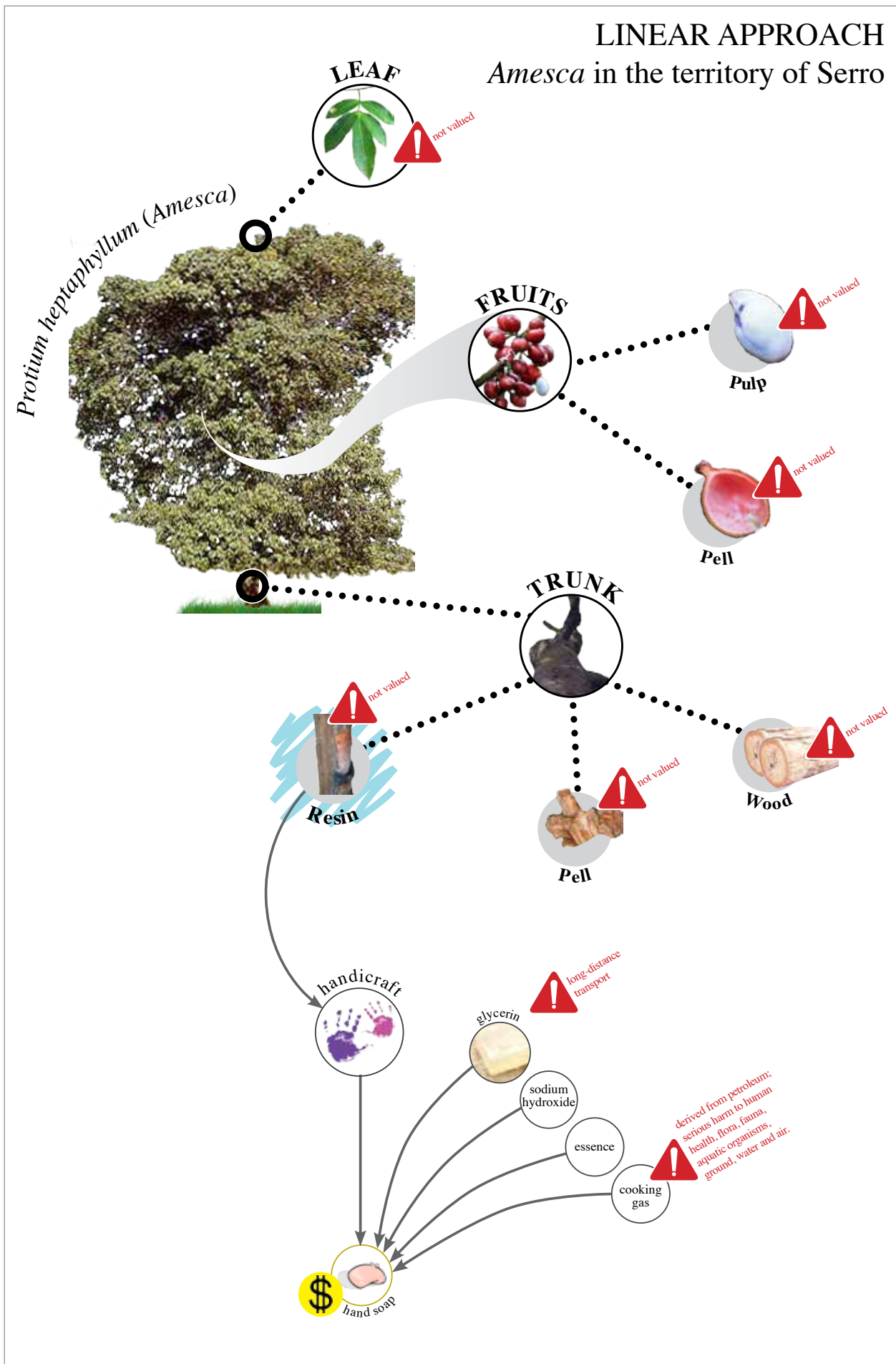


FIGURE 52 – Iconographic Scheme of the System Cosmetics Fruits of Cerrado | Amesca

### **Not Valued**

By ignorance of its characteristics, the inherent values of this element are not considered. Consequently, that is despised, not used in the system.

### **Undervalued**

For lack of all the characteristics only of the element the potential is enhanced in the system. Soon, the same is not used in all its fullness.

### **Transport for Long Distance**

Among the various activities developed by man, production and energy use are considered more cause negative environmental impacts. Within the industries that consume fossil fuels, transport, particularly by road, it is the most prominent worldwide (DE MATTOS, 2001). This sector differs from others by dependence on a single fuel type, derived from petroleum, which represents about 97% of the total energy consumed in transport, while the residential and industrial sectors employ various types of fuel (BTS 1999).

In this context, it is noteworthy that not only the end use of petroleum fuels is highly impressive, but its entire production chain. This encompasses the set of activities related to exploration, production, refining, processing and transportation. The exploration, exploitation and production on land cause changes that lead to increased soil degradation. At sea, there is a continuing risk of the occurrence of oil spills, affecting all the fauna and marine flora. During the extraction process, transport and distribution occurring methane leakage (CH<sub>4</sub>). Refiners are characterized as air pollution sources emitting mainly aromatic compounds, particulate matter, nitrogen oxides, carbon monoxide, hydrogen sulfide, sulfur dioxide and hydrocarbons. They also contribute to the contamination of groundwater, the issue of contaminated liquid waste (ammonia, sulfides and other substances) (MACHADO, 2012).

It is estimated that every barrel of oil extracted produces around 436 kg of CO<sub>2</sub> (RAVAGNANI, 2007), which causes the petroleum industry is known as one of the emitters of CO<sub>2</sub> in the atmosphere (MACHADO, 2014). Thus, the transportation sector presents strong correlation with the increase in emissions of greenhouse effect anthropic origin gases (DE ANDRADE, MATTEI, 2011). In addition, the sector is a major contributor to the local pollution, emitting gases such as carbon monoxide, nitrogen oxides, sulfur oxides, aldehydes and particulate matter (DE MATTOS, 2001), also contributing to global climate change, acid rain, high levels of noise and vibration (GONÇALVES; MARTINS, 2008).

The gases responsible for the so-called “greenhouse effect” are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), sulfur hexafluoreto (SF<sub>6</sub>) the chlorofluorocarbons (CFC<sub>s</sub>) the



hidrofluocarbonos (HFCs), perfluorocarbonos (PFCs) and water vapor ( $H_2O$ ). Mingling with the atmosphere, they do behave like a greenhouse, retaining solar heat close to the earth's surface. Such natural greenhouse effect, *i.e.* it was not potentiated the activity of man, results in an average temperature of the earth around  $15^\circ C$ , which allows a favorable condition to many forms of life, as it enables the existence of liquid water, ingredient essential for life (DE MATTOS, 2001). However, in excess, the greenhouse effect causes overheating, which can lead to tragic consequences, as part of the melting ice caps and therefore the rise in sea levels, flooding the coast of continents. According to the Intergovernmental Panel on Climate Change (IPCC), between 1970 and 2004 there was an increase of 70% in emissions of gases that cause the greenhouse (GHG) (MARTINS, 2008).

The burning of fossil fuels in the world is a major cause of carbon dioxide, the major greenhouse effect gas. However,  $CO_2$  production is inherent in the oil combustion process and its derivatives, because this involves the oxidation of the fuel, making the carbon in the carbon dioxide product and hydrogen in water (DE MATTOS, 2001). We can cite as an example that in addition to the consumption of oil products, a truck to run 1000 kilometers consumes about 330 liters of diesel. In this path, it will release into the atmosphere almost 900 kilos of carbon dioxide, *i.e.*, almost one kilogram of  $CO_2$  per kilometer (GONÇALVES; MARTINS, 2008).

In the 2001 IPCC report, it was revealed that the overall level of  $CO_2$  emissions in 2000 was 6.5 billion tons. In the biennium 2001/2002 and 2002/2003,  $CO_2$  levels increased more than 2 ppm (part per million). In previous years, this growth rate was 1.5 ppm, which was already a high factor (GONÇALVES; MARTINS, 2008).

The increase in  $CO_2$  concentration in the atmosphere causes the retention of heat that must be dissipated in space and makes global average temperature rise (GONÇALVES; MARTINS, 2008), affecting terrestrial ecosystems. The effects can be observed in the distribution and composition of flora and fauna, due to numerous variables which maintain the existing biological balance. There are also changes in temperature and consequently the rainfall patterns in the flow of water in the river flows, soil humidity, evaporation, finally, the variables participating in the fundamental relations of nature (PACHECO; HELENE, 1990).

Sulfates and fine particles, which decrease the visibility can reduce the intensity of solar radiation. Since HC and  $NO_x$  can cause a decrease of ozone in the stratosphere, causing depletion of the ozone layer that protects the planet (MOTA, 2005). However, ozone located in the stratosphere (between the heights 12-25 km) plays a key role in maintaining balance on Earth by absorbing ultraviolet (UV) radiation with wavelengths between 240-320 nm (nanometers) which are harmful to humans and the environment. Without

this protective ozone layer, arise various problems, including erythema (sunburn) and skin cancer, kerato-conjunctivitis (photochemical inflammation caused by UV rays), cataracts, weakening of the immune system, reduced yields, ecosystem degradation oceans and reducing fishing (DE MATTOS, 2001).

Since air pollutants, involving the emission of gases and solids in the atmosphere at rates that exceed the capacity of the atmosphere to dissipate them, bring many health consequences, such as: i) eye irritation – often associated with exposure to aldehydes and photochemical oxidants, common phenomenon in large cities, especially in its industrial areas; ii) cardiac effects – pollutants such as carbon dioxide and lead are absorbed through the bloodstream and can both be direct and / or indirect effects on the cardiovascular system; iii) respiratory problems – usually air pollution has been characterized as a causative agent or aggravating diseases of the respiratory system such as chronic bronchitis, emphysema, lung cancer, bronchial asthma and upper respiratory infections (MARIANO, 2001).

In this context, acid rain is also characterized as a consequence of the large amount of pollutants in the atmosphere. The pH of rainfall is normally slightly acidic (approximately equal to 5.65) due to the dissolution of gases, especially  $\text{CO}_2$ . Release of gases in the atmosphere from sources emitting pollutants, especially  $\text{NO}_x$  and  $\text{SO}_x$ , contribute to the increase in acidity of the water to form acid rain. These compounds, into the atmosphere, turn into sulphates and nitrates, and when combined with water vapor to form sulfuric and nitric acids, which in turn, cause acid rain, the pH of which is less than 5.65 (MOTA, 2005).

The Brazilian array of transportation exhibits excessive concentration around the road transportation, both for freight transport and for passenger transport (DE ANDRADE, MATTEI, 2011), depending on the model of economic development from the 1940s and 1950s. According to Bartholomew and Caixeta Son (2002), this sector “[...] is responsible for handling about 60% of the total volume transported in Brazil, consuming, therefore, about 90% of the total fuel demanding for the transport sector”.

On the other hand, the Brazilian energy matrix has advantages over the use of renewable energy compared with other countries. In Brazil, about 15.5% of the energy consumed in the transport sector comes from renewable biomass sugarcane (ethanol anhydrous and hydrated). However, the transport sector still accounted for about 33% of  $\text{CO}_2$  emissions in 1999 (MINISTRY OF MINES AND ENERGY, 2000).

Important to remember that the whole issue involving the production and oil consumption is strongly linked to living standards and consumption of the population.

### Oil derivative (Cooking Gas)

The Liquefied Petroleum Gas (LPG), better known as “cooking gas”, is obtained by the refining of petroleum, a nonrenewable resource, *i.e.*, a finite resource that scale time-human, once consumed can not be renovated. Its composition is basically propane ( $C_3H_8$ ) and butane ( $C_4H_{10}$ ), and has a heating value of 28,000 kcal / m<sup>3</sup>.

About 98% of 46.5 million households in Brazil have access to LPG. Its penetration in rural areas is around 93% (IBGE, 2002). The consumption of LPG per capita is approximately 31.35 kg / year. The most common form of marketing is bottling in canisters of 13 kg (SANGA, 2004).

Crude oil is a complex mixture of hydrocarbons, which features varied contamination of sulfur, nitrogen, oxygen and metals. The exact composition of this mix varies significantly depending on their source reservoir. The refining step is the heart of the oil industry, as without separation into its various components, the oil itself, has little or no practical and commercial value. From an environmental point of view, oil refineries are large pollution-generating. They consume large amounts of water and energy, produce large amounts of liquid discharges, releases many harmful gases into the atmosphere and produce solid waste treatment and disposal difficult (MARIANO, 2001).

The oil refining consists of a series of processing through which passes the raw mineral, for obtaining derivatives. Such processing steps include physical and chemical separation, which cause large distillation fractions. These fractions are then processed through another series of separation and conversion steps that provide the final oil derivatives. Refine oil is thus separate the desired fractions and process them to give them finish, so as to obtain salable products. Among the pollutants emitted by oil refineries, eight of them stand out (MARIANO, 2001):

1) Sulfur (SO<sub>x</sub>): Sulfur is a chemical naturally present in the oil. Sulfur oxides are produced during the burning of fuels for heat generation and energy during regeneration of the catalyst used in the catalytic cracking process and desulfurization process. These oxides are irritant gases and their effects are due to the formation of sulfuric acid and sulfurous acid, when in contact with moist mucous membranes, combining rapidly with water. Acute poisoning results from inhalation of high concentrations of oxides. The absorption by the nasal mucosa is very fast, and approximately 90% of all inhaled oxide is absorbed in the upper airways, where most effects occurs. After the absorption, it is distributed throughout the body, reaching the tissues and brain. There has been intense irritation of the conjunctiva and mucous membranes of the upper airways, causing shortness of breath, discomfort, purplish ends, quickly followed by disturbance of consciousness.

Death can result in laryngeal spasm reflex, which causes a glottic edema with consequent withdrawal of the air flow to the lungs and congestion of the lungs, appearing pulmonary edema and shock. Pneumonia can be a complication following acute exposure to the substance. Bronchoconstriction and wheezing may arise. At low concentrations, coughing is the most common symptom. The skin, contact with pressurized liquid causes burning due to low temperature. Furthermore, allergic reactions due to hypersensitivity can occur. Sulfur oxides penetrate the gut, diluting the saliva and form sulfurous and sulfuric acids. The teeth lose their luster, and come the yellowing enamel, dental erosion and gum disorders. After being swallowed, the sulfur oxides are absorbed, causing changes such as metabolic acidosis, reduced alkalinity and increased urinary excretion of ammonia. Other metabolic disorders have also been found disorders in the metabolism of proteins, carbohydrates and deficiencies in B and C vitamin<sup>114</sup>. The damage include acute necrosis of tissue, usually in response to a short exposure to high concentrations of gas, death may occur.

The toxicity of sulfur oxides on plants is well known, and can be observed in causing damage on cultivated and wild plants as well as in the reduction of yields. They occur also called hidden damage where crop losses occur in the absence of any visible signs of damage. Sulfur oxides still cause acid rain, which cause damage to vegetation, such as: i) yellowing of leaves; ii) premature defoliation; iii) reduced growth and productivity and even death; iv) changes in soil chemistry; v) raising the acidity of the soil, releasing some heavy metals and aluminum, making them more soluble; vi) can make the barren soil; vii) can prevent the activity of microorganisms, influencing the decomposition and nitrification processes. Acid rain also lead to the decrease in the pH of surface and groundwater, and consequently succeed: i) damage to the human consumption and other uses; ii) reducing the population of fish and other aquatic organisms, reflecting on recreational activities (fishing), economic and tourism; iii) increase the solubility of aluminum and heavy metals such as cadmium, zinc and mercury, many of them highly toxic, which can damage the health of people who feed on fish containing high concentrations of these in his flesh; iv) promotes the reduction of certain zooplankton groups, algae and aquatic plants, causing serious ecological imbalances. In this context, it stands out corrosion of historical monuments, statues, buildings, works of art and other materials.

2) Nitrogen oxides (NO<sub>x</sub>): Wherever a fossil fuel of any type is burned in a refinery, the nitrogen oxides are formed. As the NO<sub>2</sub> is relatively insoluble in water when inhaled reach the pulmonary alveoli, where it becomes nitrous acid (HNO<sub>2</sub>) and nitric acid (HNO<sub>3</sub>), which are highly irritating to lung tissue, cough and labored breath-

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114 Available in: <<http://www.bohr.quimica.ufpr.br>>. Accessed in: Jul.02. 2015.

ing. When dissociating, nitric acid form nitrates and nitrites, which cause local tissue damage and systemic disorders. The gas concentration between 100 and 500 ppm can cause sudden death due to bronchial constriction, pulmonary edema and respiratory failure. Other possible causes of late death (weeks after exposure) involve lung infection, bronchitis or pneumonia. Eyes,  $\text{NO}_2$  causes conjunctivitis. Blood, nitric oxide binds to hemoglobin oxygen at the same site, resulting in a decrease in the transport of this.

In the cardiocirculatory system, failure may occur, appearing weak pulse and tachycardia, heart dilation and chest congestion. In the central nervous system,  $\text{NO}_2$  causes restlessness, lethargy, loss of consciousness, anxiety and confusion. In the digestive tract appear nausea and abdominal pain<sup>115</sup>. At high concentrations,  $\text{NO}_x$  can cause damage to vegetation causing irregular tissue damage near shore leaves, and contribute to increasing the acidity of the water, forming acid rain. Furthermore, there is also a synergy effects between  $\text{NO}_2$  and  $\text{SO}_2$  at low concentrations and which together cause changes in vegetation, and this fact often observed in urban and industrial areas. Nitrogen oxides are also the main components required for the formation of photochemical smog, whose appearance is that of a gray mist covering the contaminated regions. The photochemical contamination occurs as a result of appearance in the atmosphere of oxidizing agents, generated by the chemical reaction between nitrogen oxides, hydrocarbons and oxygen in the presence of ultraviolet radiation from sunlight.

3) Carbon Monoxide (CO): The combustion units, such as heaters, boilers and flares emit carbon monoxide into the atmosphere, albeit in amounts which generally are not regarded as significant. Moreover, in the catalyst regenerator of catalytic cracking unit are produced large amounts of CO. The major route of penetration is respiratory, and the CO diffuses rapidly through the alveolar membrane, reaching the bloodstream, where it binds to the hemoglobin of red blood cells, forming carboxyhemoglobin. This fact has immediate interference with the supply of oxygen to the cellular activity of tissues, the impossibility of carboxyhemoglobin carry oxygen.

Hemoglobin has a high affinity for CO, about 200 to 300 times that of oxygen, and thus small quantities of the substance in the air that is sufficient to manifest their toxic effects. Clinical effects of intoxication by CO depend on the concentration at which the individual was exposed, ranging from mild headache, dizziness, and even nausea, vomiting, coma and even death. It may also occur a reduction of visual acuity and manual dexterity. In fact, the CO can not be considered an atmospheric pollutant in the strict sense as it is found in atmospheres of pure natural way and, moreover, to enter the atmosphere is oxidized and becomes  $\text{CO}_2$ . However, the accumulation

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115 Available in: <<http://www.bohr.quimica.ufpr.br>>. Accessed in: Jul.02. 2015.



of the latter in the atmosphere has some risks, including a possible change in Earth's climate due to the greenhouse effect.

4) Hydrogen sulfide gas ( $H_2S$ ): The hydrogen sulfide gas is generated on the polymerization units of the caustic washing step, as in sour gas treating and sulfur recovery units. This is a highly toxic and irritating gas that acts on the nervous system, eyes and respiratory system. The substance intoxication may be acute, subacute or chronic, depending on the gas concentration in the air, the duration, the frequency of exposure and individual susceptibility<sup>116</sup>. From the moment in which the  $H_2S$  reaches the bloodstream, it is distributed throughout the body, producing systemic effects. In the central nervous system occur then excitement of depression; weakness; headache; nausea; vomiting; hyperexcitability; hallucinations; amnesia; irritability; delusions; drowsiness; weakness; seizures; death.

In the respiratory system occur, cough, expectoration sometimes bloody; rapid breathing; bronchospasm, sometimes acute pulmonary edema; rhinitis with loss of smell; bronchopneumonia; and tracheo-bronchitis. The annoying  $H_2S$  action on the skin and gastrointestinal mucosa causes itching and redness. In the eyes arise conjunctivitis, photophobia, lacrimation and corneal clouding<sup>117</sup>. Exposure to hydrogen sulfide causes scorching of plant leaves, and to combine with rainwater, giving rise to hydrogen sulphide, which in turn causes necrosis on the tops of the sheets, similar to other injuries by other acids or basic compounds. There is also the problem of the unpleasant odor that is in the environment, similar to rotten eggs.

5) Benzene, toluene and xylene (BTX): Benzene, toluene and xylenes are oil components, and are therefore present in many refining operations. The volatility of natural causes fugitive emissions are the major source of release thereof. Specific emission sources include the process of separation of these compounds. Benzene is a colorless liquid with a characteristic aromatic odor, highly volatile. Being very soluble, *i.e.*, it is rapidly absorbed from the respiratory tract by inhalation, due to their great affinity for fat is distributed and stored in fat-rich tissues, such as the central nervous system and bone marrow. The acute effect on airway irritation is the bronchi and larynx, coming cough, hoarseness and pulmonary edema. However, benzene acts predominantly upon the central nervous system, acting as a depressant of the same, leading to the appearance of fatigue, headaches, dizziness, convulsions, coma and death from respiratory failure. Benzene predispose to serious cardiac arrhythmia due to awareness of myocardial muscle.

Exposure to high concentrations (more than 20,000 ppm) is rapidly fatal. The benzene in the liquid can be absorbed through the skin,

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116 Available in: <<http://www.bohr.quimica.ufpr.br>>. Accessed in: Jul.02. 2015.

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which may cause annoying effects such as contact dermatitis, erythema (reddened areas) and bubbles due to its degreasing effect. Contact with the eyes causes a burning sensation, with damage to skin cells. Ingestion causes burning sensation in the oral cavity, pharynx and esophagus, cough and pain. The intake of this substance at a dose of 15 to 20 ml, can cause death in adults<sup>118</sup>. A common way in which chemicals promote acute poisoning, particularly in aquatic organisms is the narcosis. This occurs when a chemical substance accumulates in cell membranes and interfere with the normal operation of such membranes. The typical response to this phenomenon is a decrease in activity, reduced response to external stimuli and increased pigmentation in the case of fish. Toluene can be degraded by microorganisms. Xylene has a moderate mobility through the soil, which can persist for many years. The three compounds to evaporate, react with other substances in the lower layers of the atmosphere, thus contributing to the formation of ozone, and thus to the formation of photochemical smog.

6) Particulate matter: The biggest potential source of particulate matter emissions to the atmosphere is the regeneration unit of the catalytic cracking catalyst. The exhaust gases of the heaters and boilers may also contain particles, but in much smaller quantities. The extent of damage caused by particles varies with their chemical and physical properties, especially their average diameter. The effects of the particles on health are concentrated in the respiratory tract, and are associated with the particulate concentration, the time of exposure of the respiratory system and the ability to remove particles from the inhaled air. Taking into account non-toxic particles, some of the effects on human health can be: increase in the number of deaths due to bronchitis; increased mortality due to respiratory and heart disease; increased severity and frequency of respiratory tract diseases; and increased incidence of bronchitis. The particles, even higher, can jack physiological effects of irritant gases present in the air. A typical example of such synergism is the dramatic effect of the mixture of particles and sulfur dioxide. They can also function as catalysts and chemically transforming the initial pollutants, creating even more harmful substances.

They act as carriers for microorganisms (fungi, bacteria and viruses) and other organic substances, or adsorbed to minerals such as polycyclic hydrocarbons, known carcinogens, which are housed in their pores. Among fine particles, the coarser is retained in upper respiratory system. The finer the particles penetrate deeper, even reaching the pulmonary alveoli<sup>119</sup>. Several species of vegetation and varieties within species differ in their susceptibility to particulate pollutants. In general, as other air pollutants, pollution from particulate matter affect agriculture by reducing the value of the product (the quantity

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118 Available in: <<http://www.bohr.quimica.ufpr.br>>. Accessed in: 02.Jul. 2015.

119 Available in: <<http://www.bohr.quimica.ufpr.br>>. Accessed in: Jul.02. 2015.

and / or quality can be affected and the time of sale may be early or late) or increasing the cost of production (requiring the use of fertilizers, irrigation, among others).

Dust can cause both direct and indirect damage to vegetation. A variety of effects has been observed, including: reduction of crops without observing visible damage; increased incidence of disease; severe damage to the leaves of the cells; suppression of photosynthesis; and death of trees. Damage may result from the formation of a thick crust on the leaves, which suppresses photosynthesis and / or alkali / acid poisoning when producing such solutions with rainwater. This last factor causes changes in pH of the soil, often harmful to plants. This type of transmission can also reduce visibility, and create damage to transport causing accidents. Decreased visibility reduces visual range of objects and promotes the disfigurement of the landscape, the dirty clothes, buildings and monuments. Most small particles also serves as an excellent core in the formation of droplets of clouds, may cause increased rainfall downstream from large sources of emissions of particulate matter.

7) Acetylene, Butane, Ethane, Ethylene, LPG, Methane, Propane and Propylene (VOC's): Within refineries there are many sources of gaseous emissions that are predominantly made up of volatile hydrocarbons. These substances are classified as simple asphyxiating, and when present in high concentrations reduce the partial pressure of oxygen in the blood causing low oxygen. In an environment with low oxygen concentrations arise effects in the body. The concentration of oxygen in the air to prevent any symptoms of asphyxiation, should not be less than 18% by volume. Oxygen concentrations below 11% cause unconsciousness. Concentrations below 6% cause respiratory arrest and death<sup>120</sup>. The hydrocarbons containing up to four carbon atoms are gases at room temperature, and these are the more important from the point of view of air pollution, because they favor the formation of photochemical reactions contributing to the onset of photochemical smog.

8) Ammonia: Ammonia is formed from nitrogen compounds in crude oil and can be found in many units of oil refineries. Ammonia gas is often released in the distillation units, cracking and final treatment. Ammonia produces tissue injury, acting similarly to a corrosive alkali. It is very soluble in water and therefore operates in moist mucosa of the upper airways and eyes. It is an irritant to the nose and into the throat, causing coughing and difficulty breathing. In the eyes leads to tearing, eyelid edema, corneal ulcer, iris atrophy and blindness due to late cataracts and retinal atrophy. Airways its vapors cause pharyngitis, laryngitis, bronchospasm, chest pain, difficulty breathing and tracheitis.

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At high concentrations (2400 to 6500 ppm), ammonia acts on the lungs, causing acute swelling and choking, due to the involvement of the central nervous system, emerging respiratory arrest, changes in the rhythm and heartbeat. The contact of skin and mucous with liquid ammonia causes severe burns. In the digestive tract, irritation causes nausea, vomiting, burning sensation and swelling of the lips, mouth and nose. With the intake occur burns of the mouth, esophagus, and may also occur gastric perforation<sup>121</sup>. The affected vegetation acquires strong green color, becoming brown or green to dry. In some species may occur general darkening. However, damage to vegetation caused by ammonia are usually observed in accidental leaks of anhydrous ammonia which is used in agriculture as fertilizer. Acute damages are characterized by necrotic black spots along the edges of the leaves of sensitive plants.

Atmospheric emissions from refineries include fugitive emissions of volatile compounds present in crude oil and its fractions, emissions from fuel combustion in process heaters and boilers in, and emissions of the actual process units. Fugitive emissions occur throughout the refinery and escape of hundreds of potential sources of these emissions, which comprise valves, pumps, tanks, relief valves, flanges, among others. Although the leaks are usually small, the sum of all fugitive emissions of a refinery can be a major source of emissions of it (MARIANO, 2001).

The various process heaters used in oil refineries, to heat process streams or steam generation (boilers) for heating or rectification with vapor, may be potential sources of CO, SO<sub>x</sub>, NO<sub>x</sub>, particulate matter and hydrocarbons (MARIANO, 2001).

Most of the gas flows that leave the refinery process units contain variable amounts of refinery gas, hydrogen sulphide and ammonia. These currents are usually collected and sent to the gas treatment units and sulfur recovery in order to recover the refinery gas is used as fuel and elemental sulfur, which can be subsequently marketed. The emissions of sulfur recovery typically contain some hydrogen sulfide, as well as sulfur and nitrogen oxides. Other sources of emission derived from the periodic regeneration process of catalysts which can produce gaseous streams containing carbon monoxide, particulate matter and volatile hydrocarbons (MARIANO, 2001).

Liquid effluents generated in refineries vary greatly in quantity and quality, depending on the type of processed Petroleum, the processing units that make up the refinery in question, and the mode of operation of these units. In general, refineries produce a quantity of relatively proportional to the quantity of liquid effluents refined oil. In Brazil, the eleven refineries in the Petrobras system generate between 0.40 and 1.60 m<sup>3</sup> effluent / m<sup>3</sup> oil refined at the plant. This

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121 Available in: <<http://www.bohr.quimica.ufpr.br>>. Accessed in: Jul.02. 2015.

factor is lower for most refineries refining capacity, as well as for those most recently built (PIRAS, 1993).

Process effluents are commonly defined as any water or condensed vapor that has come into contact with oil, the latter in liquid or gaseous form, and can therefore contain oil or other chemical contaminants. Include acid solutions, exhausted soda wash water and crude oil derivatives, water from the desalting step, the resulting condensed vapor by distillation and rectification, as well as cleaning or steam regeneration process of catalysts. Moreover, the rain water may be contaminated or not, depending on the refinery where they are drained area. The oil can be found emulsified and non-emulsified with water (free) in the above effluents. In the desalting step, as well as cracking, sulfide usually appears as a contaminant. Phenol arises in effluents resulting from the catalytic cracking step, production of lubricants and solvents and the washing waters of the gasoline, following the caustic treatments. The taste and odor of the effluent are mainly caused by the presence of phenolic compounds, naphthenic, nitrogen and organosulfur. The main sources of these compounds are treatment operations for the removal of oxygenates, nitrogen and sulfur crude oil and derivatives as well as the decomposition products of distillation and catalytic cracking and water from the barometric condensers and desalination (MARIANO, 2001).

Water pollution has several negative consequences for the environment. These consequences can be sanitary, ecological, social or economic nature, namely: i) damage to the human supply, making it carry diseases; ii) harm to other water uses, such as industrial, irrigation, fishing and recreation; iii) worsening of good quality water shortages; iv) increase in the cost of water treatment, reflected in the price to be paid by the population; v) siltation of water sources, resulting in decreased water supplies and floods; vi) depreciation of marginal properties; vii) damage to fish and other aquatic organisms; viii) excessive proliferation of aquatic vegetation and algae; ix) landscape degradation; x) impacts on the quality of life of the population; xii) burying animals and fish eggs; xiii) an increase in turbidity of the water, reducing its transparency, leading to reduction of the photosynthetic activity; xiv) poisoning of aquatic organisms, reducing populations of surviving species, and severe changes in aquatic fauna and flora due to the heavy metals released along with the effluent; xv) impairments to use water effluent in agricultural irrigation and increased toxicity of compounds such as ammonia, heavy metals, hydrogen sulfide, due to changes in pH of the water; xvi) reducing the amount of dissolved oxygen with negative effects on the life of aerobic aquatic life, due to the rise in temperature of water used for cooling in refineries; xvii) elimination of some species of aquatic animals when salts concentrations of refinery effluents are high (MARIANO, 2001).

The solid wastes are generated in many processes of the refining and handling of petroleum operations, as well as effluent treatment step.



Solid waste typically generated in the oil refining industry include the mud from water separators and oil (API), the mud of the floaters the dissolved air and air-induced, the bottom sediments from the storage tanks of crude oil and oil products, oily sludge, clay treatment, biological sludge, sludge from cleaning of the heat exchangers and cooling towers, as well as solid emulsified in oil. The waste generated during the refining operations varies widely in composition and toxicity. Their characteristics depend on the productive process that generates as well as the type of raw oil and derivatives produced. The launch of industrial solid waste in the soil can cause many problems to the environment, such as: i) unpleasant aesthetic appearance and disfigurement of the landscape; ii) production of bad odors; iii) water pollution, the surface entrainment or the infiltration of debris to the water bodies; iv) release of toxic gases; v) air pollution (MARIANO, 2001).

In general, one can say that the primary air pollutants emitted by refineries are the sulfur and nitrogen oxides, carbon monoxide, particulate matter and hydrocarbons (which generally are fugitive emissions of volatile organic compounds, VOC's). Such pollutants are released in the storage areas (tanking), the process units in any leaks and the burning of fossil fuels units (furnaces and boilers) that generate heat and power for the refinery own consumption. Among its adverse effects, we highlight: i) the impact of pollutants on health - eye irritation, effects on the cardiovascular system and effects on the respiratory system; ii) impacts on metals (corrosion), marble-stones, paintings, textiles, rubber, leather and paper; iii) effect on visibility; iv) smells - as well as nuisance caused by the stench, the presence of a continuous emission source can cause a decrease in property values of neighborhoods; v) global effects of air pollution - acid rain and climate change; and vi) loss of welfare - all these factors, it is reasonable to assume that such phenomena exert a harmful influence on mental well-being, emotional and psychological people (MARIANO, 2001).

Noise pollution, specifically noise coming from the refinery, is mainly caused by equipment operation such as turbines, compressors and motors, as well as the flow of fluids at high speed through valves, transportation pipelines and ejector nozzles. The main consequences are: i) gradual loss of hearing; ii) annoyance, irritation and physical exhaustion; iii) sleep disturbances; iv) fatigue; v) cardiovascular problems; vi) stress; vii) increasing the quantity of adrenaline in the blood; viii) hyperstimulation of the thyroid gland; ix) reduction of the individual's efficiency and accidents in the workplace (MARIANO, 2001).

In this context, we can not ignore that there are some typical events that can potentially turn into major emergencies. These events form the basis of accident type for this type of industry, such as: i) release of flammable and / or explosive into the atmosphere as a result of holes or cracks in pipes, break joints flanges, loss of seals of compressors, loss of flame in the flare, and / or breaking of pump

seals; ii) the release of toxic gases into the atmosphere; iii) liquid and aerosol leaks with puddle formation or jet of fire; iv) equipment explosions due to air intake systems containing the heated hydrocarbon; v) bursts of proper equipment to hydrocarbon entry into air systems and / or steam; vi) steam explosions due to contact ultra viscous hot product with water; vii) explosion catalytic cracking unit converter fluidized bed of the regenerator due to reverse flow to the reactor; viii) explosion of boilers; ix) fires in coating materials or drainage channels with flammable product residues; x) fires in crude and derivatives tanks; xi) inputs toxic leaks, such as catalysts in the transport, storage, loading and unloading; xii) bursts of vessels and storage spheres, due to pressure; xiii) oil spills, with resulting contamination of the water body receiver; xiv) emergency natural causes, such as heavy rains and flooding, winds and tornadoes, blizzards and frost, electrical storms and earthquakes. Such accidents can have serious consequences for the environment, depending on its length as degradation of ecosystems, with damage to fauna and flora; impairment of water resources, which can cause damage to economic activities such as tourism and fisheries; and even death of people by poisoning or fires and explosions (SOUZA JÚNIOR, 1996).

All “negative” points of this system, shown with red triangles warning, are explained below in order to clarify its scope and comprehensiveness. The dots “Not Valued”, “undervalued”, “Transport for Long Distance” and “petroleum derivative (Cooking Gas)” were explained in the previous system: *Amesca*.

### **Derived oil (Mineral Oil)**

Mineral oil, also known as liquid paraffin, white oil or liquid Vaseline, is a byproduct derived from petroleum distillation, the gas production process. It is produced in large quantities, and therefore a low-cost product (AX, 2011). This is one reason to be widely used in the cosmetics industry, as well as having an adequate consistency to their duties.

The basic principle for obtaining the mineral oil is the removal of organic compounds considered as impurities which are present in crude oil derivatives, which are: unsaturations (olefins), sulfur, nitrogen, oxygen and aromatic hydrocarbons (RANGEL, 2010).

This is characterized by being a transparent, colorless and almost chemically inert oil composed mainly of alkanes (typically 15 to 40 carbons) and cyclic paraffins (KARASEK; WENZL; ULBERTH, 2010).

Mineral oil is produced in two degrees of purity: in technical grade and medical grade or food grade, the latter being a fraction of the mineral oil to which were extracted using solvents, aromatic hydrocarbons and subsequently subjected to hydrogenation to convert the aromatic hydrocarbon residue in saturated hydrocarbons (MACHADO, 2011).

# LINEAR APPROACH Macaúba in the territory of Serro

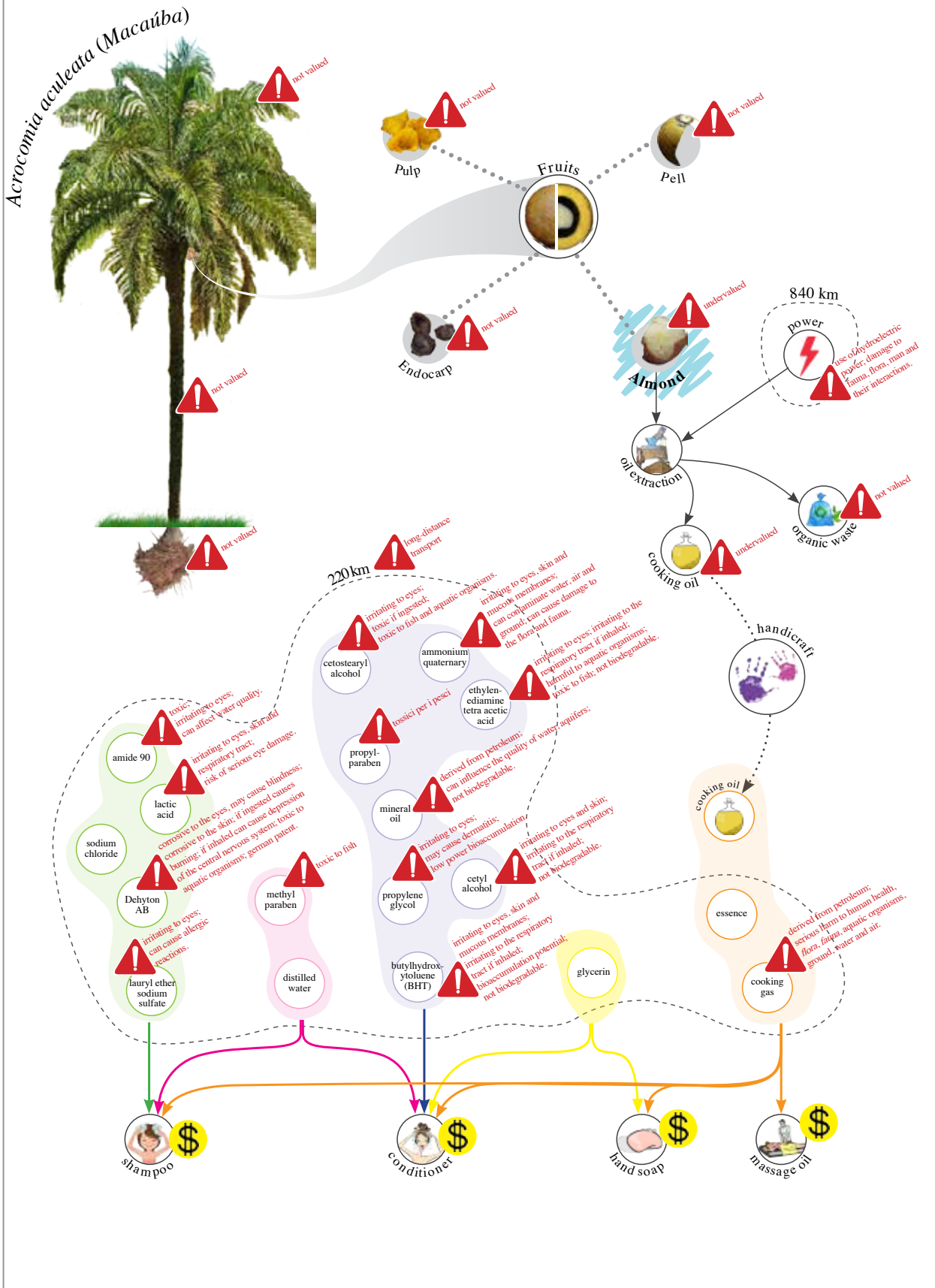


FIGURE 53 – Iconographic Scheme of the System Cosmetics Fruits of Cerrado | Macaúba

The medicinal mineral oil (used in the cosmetics industry) must have the following characteristics: be colorless, odorless (when cold) and tasteless. To this oil can be added antioxidants to enhance their stability when stored<sup>122</sup>.

Since it is highly refined or food grade mineral oil is considered to have low toxicity. Therefore, it must consist solely of saturated hydrocarbons and with a sufficiently high molecular weight so that the absorption by the organism is as low as possible, having in this case, an acceptable daily intake level of 10 mg / kg live weight (MACHADO, 2011).

However, recent studies have associated components (combination of hydrocarbons) increase in mortality from many cancers, such as lung, esophagus, stomach, lymphoma and leukemia. This is due to the presence of a compound called 1,4-dioxane, a carcinogen, as reported studies published in the American Journal of Industrial Medicine (Department of Epidemiology, School of Public Health, Los Angeles, CA October 2005) (FERREIRA *et al.*; 2014).

For being a flammable compound and for not being biodegradable, mineral oil accumulates in plant and animal tissues and may contaminate both soil and groundwater (BERTACI, 2014). Moreover, it can cause all the problems mentioned in the previous item “Oil Derived (Gas Cooker)” as it is also a derivative of petroleum.

### **Amide 90**

The Amide 90 (CAS 68603-42-9 In) is a liquid, viscous substance, yellowish in color and has no odor. Its pH ranges from 9.0 to 10.5 to 25° C. It is partially soluble in water. This product is toxic if swallowed and irritating to eyes. When spilled on the ground, by percolation, can affect the quality of groundwater waters limiting their use<sup>123</sup>.

### **Lactic acid**

Lactic acid (CAS 79-33-4) is a liquid substance, colorless to slightly pale yellow, with characteristic odor. Your pH is <2.0 at 25° C. It is soluble in water. This product is irritating to eyes and skin, as a risk of serious damage. The inhalation of droplets suspended in the air accuses respiratory irritation<sup>124</sup>.

### **Dehyton AB**

The Dehyton AB (CAS 77640-81-4), patented by a German compa-

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122 Available in: <<http://www.campestre.com.br>>. Accessed in: Jul. 06. 2015.

123 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.dipaquimica.com.br>>. Accessed in: Out.12. 2014.

124 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.superquimica.com.br>>. Accessed in: Out.11. 2014.

ny, is a liquid preparation, light-colored to dark amber, flammable, having a characteristic odor of alcohol. Its pH is 7. In eye contact is corrosive, causing pain quickly, burns and corneal damage, and may, cause permanent damage and blindness. Contact with the skin quickly causes pain, burning, redness, swelling and tissue damage. If swallowed, causes pain and severe burns of the mouth, throat and stomach. Inhalation of high vapor concentrations may cause depression of the central nervous system and narcosis. It is toxic to aquatic organisms<sup>125</sup>.

### **Lauryl ether sodium sulfate**

Lauryl ether sodium sulfate (CAS 68585-34-2) is a colorless to slightly yellowish aqueous solution with a characteristic odor. Their pH ranges from 6.0 to 9.0. It causes eye irritation with redness and tearing. It causes allergic reactions on the skin for prolonged or repeated contact. It is harmful if swallowed<sup>126</sup>.

### **Methyl paraben (Nipagin)**

Methyl paraben (CAS 99-76-3) is a substance fine powder, white to light yellowish, almost odorless. Its pH is 5.8. This product is toxic to fish<sup>127</sup>.

### **Cetostearyl alcohol**

The cetostearyl alcohol (CAS No 68439-49-6) is a mixture in the form of white flakes. Their pH ranges from 6.0 to 8.0 the 25oC. It is an irritant to eyes and skin. Ingestion causes a low toxicity. In tap water can undergo complete degradation in a short time. Thus, there is risk of rapid reduction of the dissolved oxygen, may become toxic means to fish and other aquatic organisms, even at low concentrations the product<sup>128</sup>.

### **Ammonium quaternary**

The quaternary ammonium (CAS 112-02-7) is a colorless aqueous solution yellow, with characteristic odor. Their pH ranges from 5.0 to 7.0. It is soluble in water. It is an irritant to the eyes, skin and mucous membranes. In large volumes can contaminate water, air, soil and cause harm to flora and fauna. Not readily biodegradable<sup>129</sup>.

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125 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.slb.com>>. Accessed in: Out.11. 2014.

126 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.usiquimica.com.br>>. Accessed in: Out. 11. 2014.

127 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.labsynth.com.br>>. Accessed in: Out.12. 2014.

128 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.dipaquimica.com.br>>. Accessed in: Out.12. 2014.

129 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.emfal.com.br>>. Accessed in: Out.12. 2014.



### **Ethylenediamine tetra acetic acid (EDTA)**

The ethylene diamine tetra acetic acid (CAS 60-00-4) is a solid, odorless substance. Its pH is ~ 2.5. It is irritating to eyes. It is a harmful product to aquatic organisms, toxic to fish. Not readily biodegradable<sup>130</sup>.

### **Propylparaben (Nipazol)**

The propylparaben (CAS 94-13-3) is a solid, white, with its own odor. Its pH is 5.8. It is toxic to fish<sup>131</sup>.

### **Propylene glycol**

Propylene glycol (CAS 57-55-6) is a liquid substance, colorless and odorless. Repeated or prolonged contact with the product can cause dermatitis. May cause mild eye irritation. It also presents low potential for bioaccumulation in aquatic organisms<sup>132</sup>.

### **Cetyl alcohol**

Cetyl alcohol (CAS No 36653-82-4) is a white solid and mixture, insoluble in water. It is an irritant to the eyes, can be irritating to the skin and inhalation causes respiratory tract irritation, and is harmful if swallowed. It is not biodegradable<sup>133</sup>.

### **Butylhydroxytoluene (BHT)**

The butylhydroxytoluene (CAS 128-37-0) is a substance in the form of granules, colorless to slightly yellowish. The product is irritating to the eyes and skin. When inhaled, it is irritating to the respiratory system. It is harmful when ingested. It has a potential for moderate to high bioaccumulation, and is not readily biodegradable<sup>134</sup>.

### **Using Hydropower**

The Brazilian energy matrix has advantages over the use of renewable sources of energy, compared to other countries. With 13.8% of the amount of fresh water available on the planet, is the country that has the world's largest water availability. Hydroelectric generation ensures the production of approximately 91% of the electricity consumed in Brazil (NATIONAL AGENCY OF ELECTRICITY, 2008).

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130 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.labsynth.com.br>>. Accessed in: Out.12. 2014.

131 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.labsynth.com.br>>. Accessed in: Out.12. 2014.

132 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.bandeirantebrazmo.com.br>>. Accessed in: Out.11. 2014.

133 Security Information Sheet of Chemical Products(FISPQ). Available in: <<http://www.viafarmnet.com.br>>. Accessed in: Out.08. 2014.

134 Security Information Sheet of Chemical Products (FISPQ). Available in: <<http://www.emfal.com.br>>. Accessed in: Out.09. 2014.

Hydroelectric power plants have the ability to transform kinetic energy into electrical energy from harnessing the movement of water. These consist basically of the dam, power house, spillway and uptake and transport of water system, and work together in an integrated way. The dam disrupts the normal course of the river and deflected it for a certain location forming large reservoirs that store water and allow the formation of large drops. These produce force, which is used to move turbines and drive the electric generator (PANZERA; GOMES; MOURA, 2010).

The power generated at hydroelectric plants can be considered clean, i.e., the generation process are not emitted pollutants into water bodies and the atmosphere. However a more careful analysis shows that this form of generation involves a profound impact on the natural environment in which it is inserted. This impact includes fauna, flora and man as well as their interactions, and often extends beyond the delivery of the plant for operation (MACHADO JUNIOR, 2014).

Among the social impacts, we can mention those caused by the relocation of families, as often occurs to flood entire cities, which causes the loss of part of their culture and their origins. These families are compensated and transferred to other locations, and suffer from upgrading to a new life (KOIFMAN, 2001). There are also indirect impacts such as loss of community ties, social networks, separation of families and communities, and flood sacred sites for indigenous and traditional communities. These losses can cause a lot of sadness, loneliness and depression (VIEIRA; VAINER, 2000).

The spiritual bonds and cultural practices, that help define their societies, are destroyed by the displacement and the loss of communal resources on which its economy is based. The arrival of hundreds of workers, heavy machinery, liquor, prostitution, diseases and violence that always accompany dam projects also pose a threat of destruction and disappearance of indigenous tribes (VIEIRA; VAINER, 2000).

In fact, no one knows to state accurately, how many people have been displaced so far by dams, but the estimate is between 40 and 80 million. However, most surveys consider to be affected by the projects, only those people who are displaced by filling the vessel and having a title of ownership, *i.e.* they are not accounted for: i) the upstream and downstream population dam; ii) the squatters, partners, sharecroppers, tenants, aggregates and employees of the flooded area; iii) people displaced because of other parts of the project (such as transmission lines and the house of machines); iv) families who lose their land or part of them, but remain with their homes; v) the people who use the commons for cattle grazing, collecting fruit, vegetables and timber; vi) people who have their access to schools, hospitals and trade obstructed due to the destruction of roads and flooding; vii) those whose economic activities depended on the displaced popula-

tion, such as flooded schools teachers and truck drivers who transported the population (VIEIRA; VAINER, 2000).

In the area of plant construction the local economy is changed, as the increased use of materials and energy inflate the costs thereof, financially hurting local residents (BORTOLETO, 2001). The region also faces the problem of waste increases both the garbage, the sanitary waste, due to the sudden expansion of the population, generated by the arrival of non-local workers (KOIFMAN, 2001).

The dams have several effects on fish life. The first and most direct is interference in their migration and reproduction. Dams alter river flows and create enormous obstacles (physical barriers) to the migratory cycle (spawning) and even for the survival of the species. The second is related to water temperature, which can cause some species disappear simply because of its failure to adapt to changing temperatures, in addition to changing the life cycles of aquatic life, such as breeding and metamorphosis. There is also the issue of concentration of pollutants in the reservoirs which causes to increase the variety and quantity of fish diseases. In addition, the introduction of exotic species in the lakes, which end up competing with native and even causing the native disappear completely from the tank and consequently the river itself (VIEIRA; VAINER, 2000).

The creation of the lake can also generate a change in the local micro climate, with changes in temperature, humidity and rainfall cycle. Many species of animals end up running away from their natural habitat during the flood. The estimate for this case is that only 1% of the species survive this change. In some situations tourism could also be affected, because besides the flora and fauna loss, dams and their lakes also destroy landscapes of rare beauty such as, *Itaipu* that flooded the *Salto das Sete Quedas* (Leap of the Seven Falls) (FIG. 54) (MACHADO JUNIOR, 2014). We also point out that the destruction of community productive bases (agriculture and fisheries) can generate a period, often long, food shortages, exacerbating hunger and malnutrition (VIEIRA; VAINER, 2000).

In their normal courses, rivers carry sediment from soil and existing rocks in its bed and its banks. When constructing a dam this process is interrupted. As the water runs very slowly in the reservoir sediments settle to the bottom and do not follow downstream. In order to recover the supply of sediments below the dam, river increases the erosion process margins. This process may deepen and widen the river bed, endangering works of infrastructure, as well as harm the water supply. Dams also influence the level of the river, both above and below, as it so there is a constant supply of water in the turbines, it is made water control in the reservoir and the water is released downstream. In times of drought the river below the dam is almost dry, because often the dam operators do not meet the legal standard to leave the river to its minimum flow. This affects not only biodiver-



FIGURE 54 – *Salto das Sete Quedas* (Leap of the Seven Falls) Before and after Itaipu

sity but also the water supply of the population and other economic activities (VIEIRA; VAINER, 2000).

In reservoirs, exposure of water to sunlight increases dramatically, which leads to evaporation and therefore increases the concentration of salts which poison the aquatic species (VIEIRA; VAINER, 2000).

People's health is also of concern because the parasitic diseases, especially schistosomiasis and malaria tend to increase. The yellow fever, dengue fever and filariasis<sup>135</sup> may also arise due to the favorable environment of the dams to create mosquitoes, snails and other animals that serve as transmitters of these diseases. Another problem is the accumulation of high mercury levels in the reservoirs. This mercury concentrates in fish. When used in feeding these fish bring a big risk to human health (VIEIRA; VAINER, 2000).

The installation of the dams cause flooding in large areas of forests and cause soil cover crops come in the process of decomposition. Consequently, local biodiversity is affected, occurring release of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) in the atmosphere, gases responsible for global warming and the thinning of the ozone layer (INATOMI; UDAETA, 2005). These floods also cause the destruction of several plant species, damage to wildlife, and cause significant hydrological impacts, such as changing the flow, current flow,

<sup>135</sup> The filariasis or elephantiasis is a disease caused by parasitic nematodes *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori*, that lodge in the lymphatic vessels causing lymphedema. Its transmitter mosquitoes of the *Culex*, *Anopheles*, *Aedes* and *Mansonia*, present in tropical and subtropical regions. When the nematode blocks the lymphatic vessel edema is irreversible. Available in: <<http://www.sobiologia.com.br>>. Accessed in: Jul.12. 2015.

increased depth, extending the bed, the elevation of the water table level and generating marshes (VECCHIA, 2012).

Almost all of Brazil is supplied through the National Interconnected System (SIN). The few exceptions are almost all located in the Amazon: they are isolated communities, fueled by oil thermal generation, the so-called isolated systems. The SIN is composed mainly by the basic transmission grid, which connects a vast portion of the country, by nearly 100,000 km of power transmission lines, which connect secondary transmission and distribution networks, which bring electricity to consumers (FIG. 55). In the Basic Network are connected generating units that produce electricity (Abbud, 2012). In this context, another serious problem is the use of sulfur hexafluoride ( $SF_6$ ) in transmission and distribution of electricity systems, and as dielectric in electronic components. This is a potent greenhouse effect gas and atmospheric great length (DE MATTOS, 2001).



FIGURE 55 – Energy logistics in Brazil



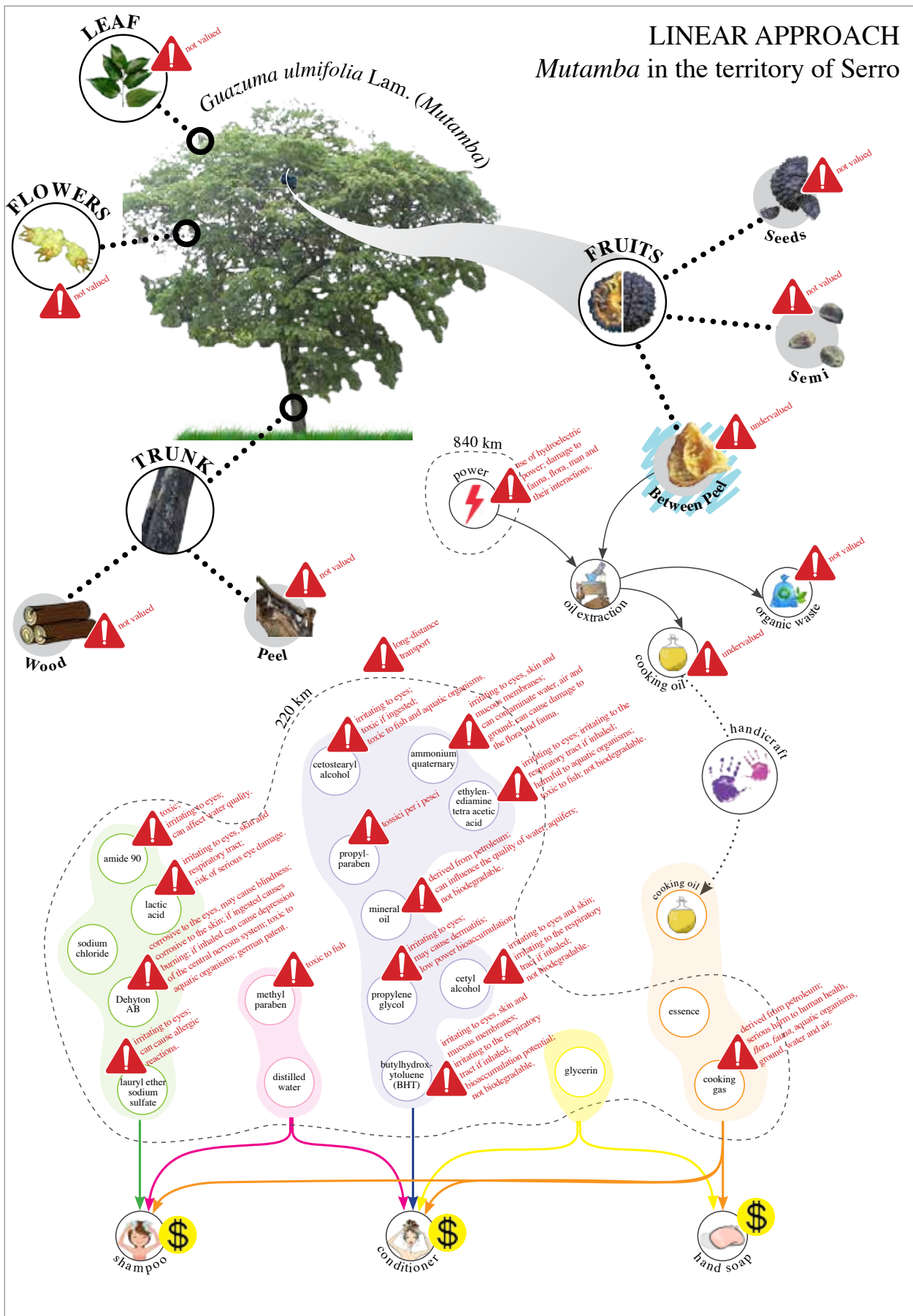


FIGURE 56 – Iconographic Scheme of the System Cosmetics Fruits of Cerrado | Mutamba  
All “negative” points of this system, shown with red triangles warning, were explained in the previous system: *Macaúba*.

# LINEAR APPROACH Pacari in the territory of Serro

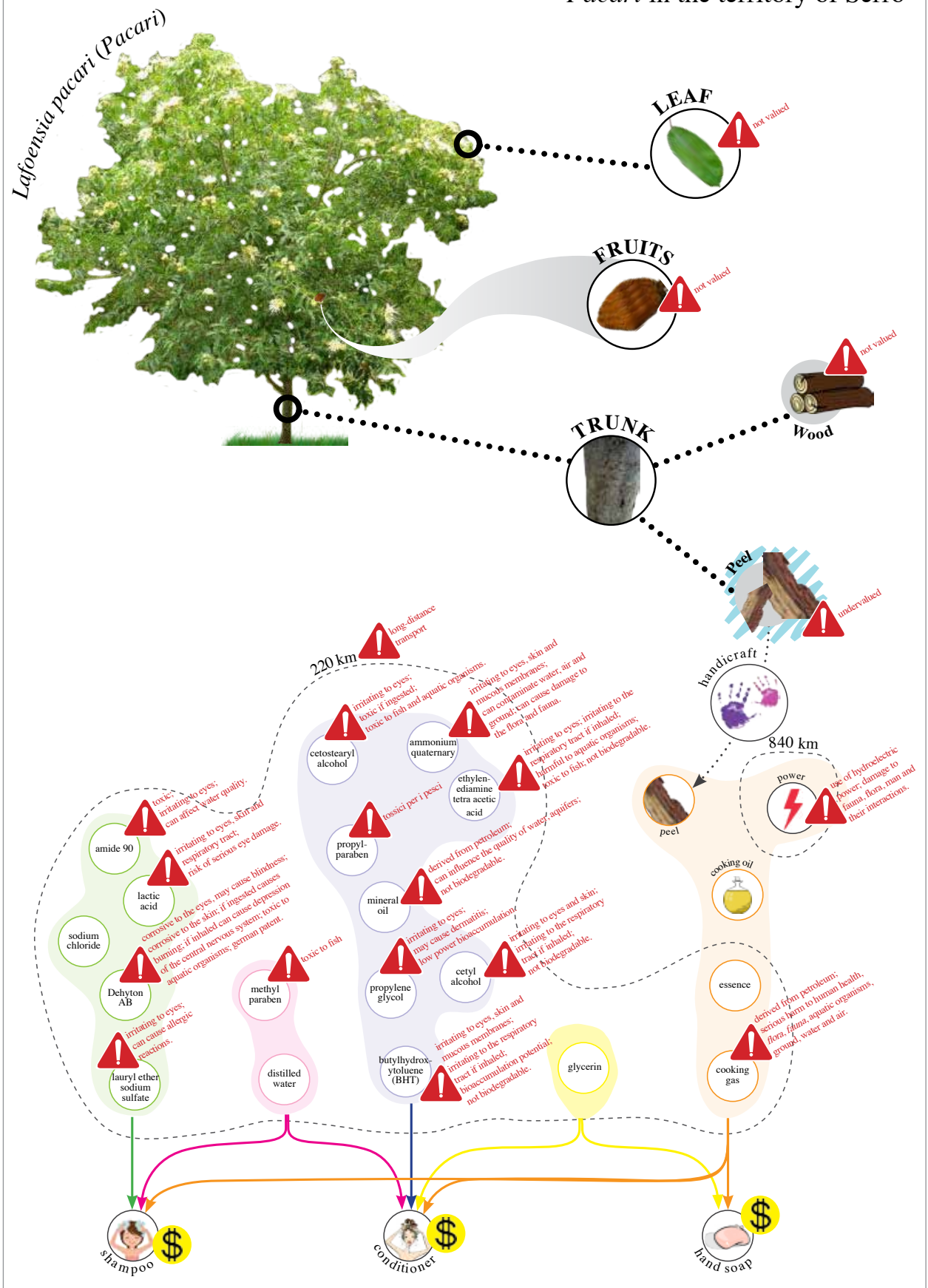


FIGURE 57 – Iconographic Scheme of the System Cosmetics Fruits of Cerrado | Pacari  
All "negative" points of this system, shown with red triangles warning, were explained in the previous system: *Macaúba*.

It is further the need for constant maintenance to further exploit, and to prevent loss of energy during the circulation in the big lines. The World Commission on Dams considered normal loss of 6% of energy in transmission. Brazil loses about 15%, according to the National Agency Electric Power (ANEEL) (COSTA, 2010).

#### 4.4.2 Evergreen Arrangements System

The following iconographic scheme shows the current production process of the Ever-living arrangements (FIG. 58). This allows you to view all input and system output, highlighting the “negative” points system. Important to remember that, according to the systemic approach, the “negative” points are considered as opportunities for change.

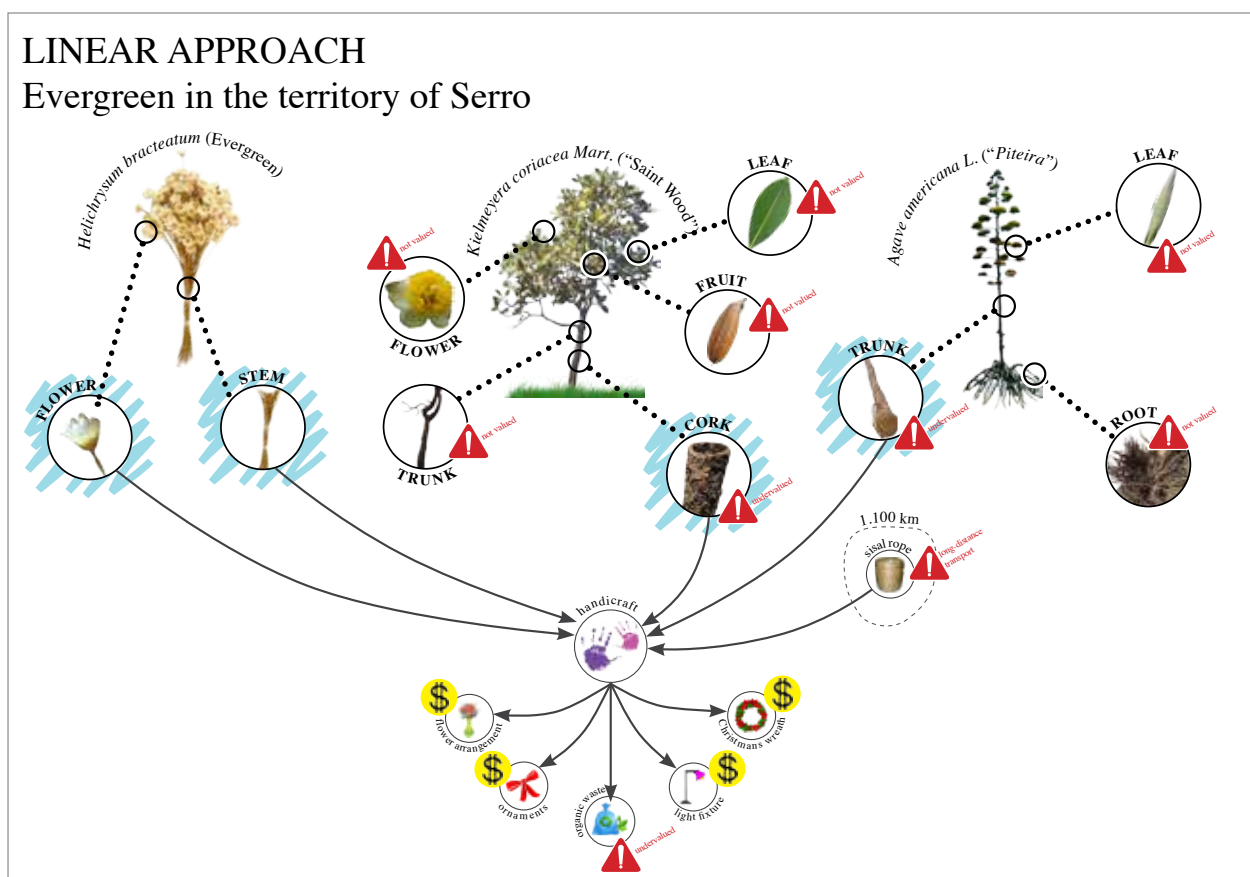


FIGURE 58 – Iconographic Scheme of the System Evergreen  
All “negative” points of this system, shown with red triangles warning, are explained below in order to clarify its scope and comprehensiveness.

#### ⚠ Not Valued

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

#### ⚠ Undervalued

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**! Transport for Long Distance**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**4.4.3 System Utilities and *Capim Dourado* (Golden Grass) decoration parts**

The iconographic scheme below shows the current production process of the utilities and Golden Grass decoration parts (FIG. 59). This allows you to view all input and output system, highlighting the “negative” points of the system. Important to remember that, according to the systemic approach, the “negative” points are considered as opportunities for change.

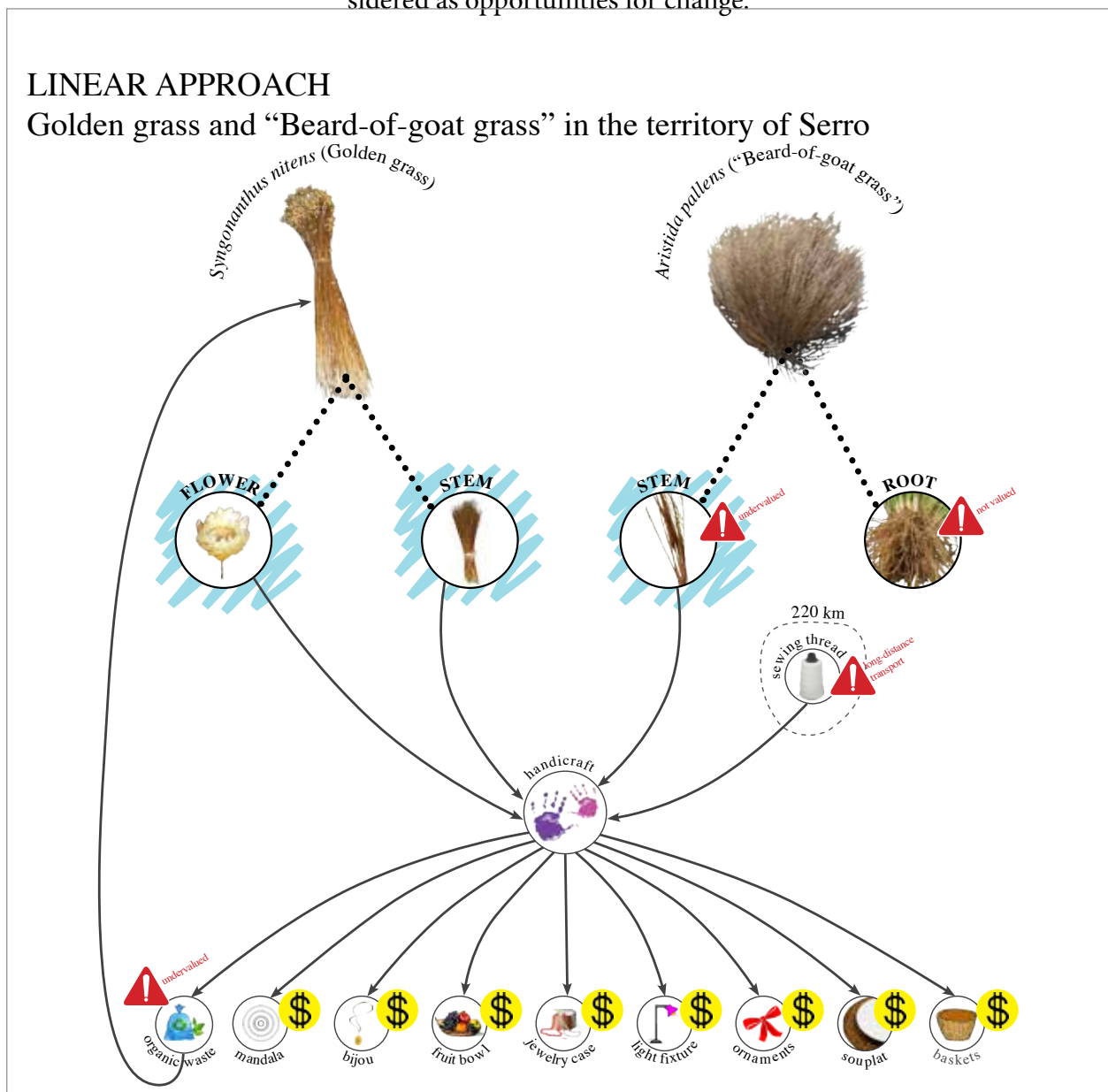


FIGURE 59 – Iconographic Scheme of the System “Capim Dourado” (golden grass) utilities and decoration parts. All “negative” points of this system, shown with red triangles warning, are explained below in order to clarify its scope and comprehensiveness.

**⚠ Not Valued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**⚠ Undervalued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**⚠ Transport for Long Distance**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

### 4.4.4 System Utilities and “*Capim Barba-de-bode*” (Beard-of-goat grass) Decoration parts

The iconographic scheme below shows the current production process of the utilities and decorative pieces of *Capim barba-de-bode* (Beard-of-goat grass) (FIG. 60). This allows you to view all input and system output, highlighting the “negative” points system. Important to remember that, according to the systemic approach, the “negative” points are considered as opportunities for change.

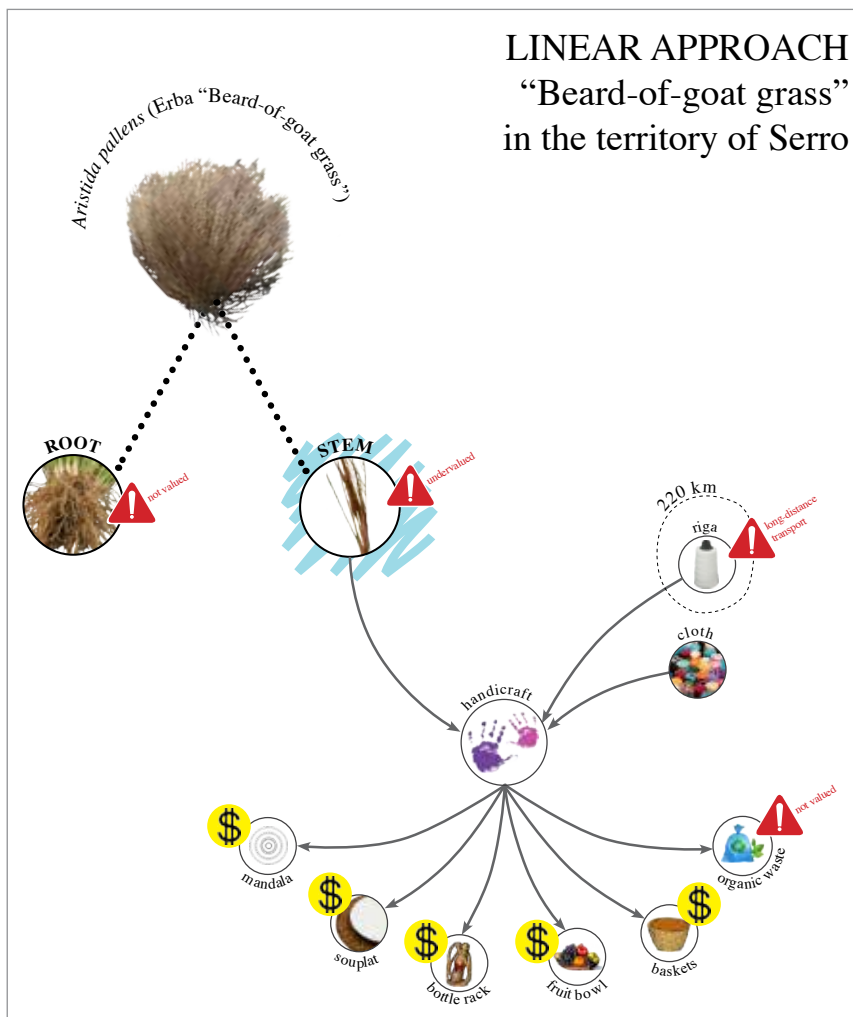


FIGURE 60  
Iconographic Scheme of the System “*Capim Barba-de-bode*” (beard-of-goat grass) utilities and decoration parts  
All “negative” points of this system, shown with red triangles warning, are explained below in order to clarify its scope and comprehensiveness.



**! Not Valued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**! Undervalued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**! Transport for Long Distance**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

### 4.4.5 Ceiling, basketry and mat *Taquara* System

The iconographic scheme below shows the current production process of the roof lining, basketry and mat *Taquara* (FIG. 61). This

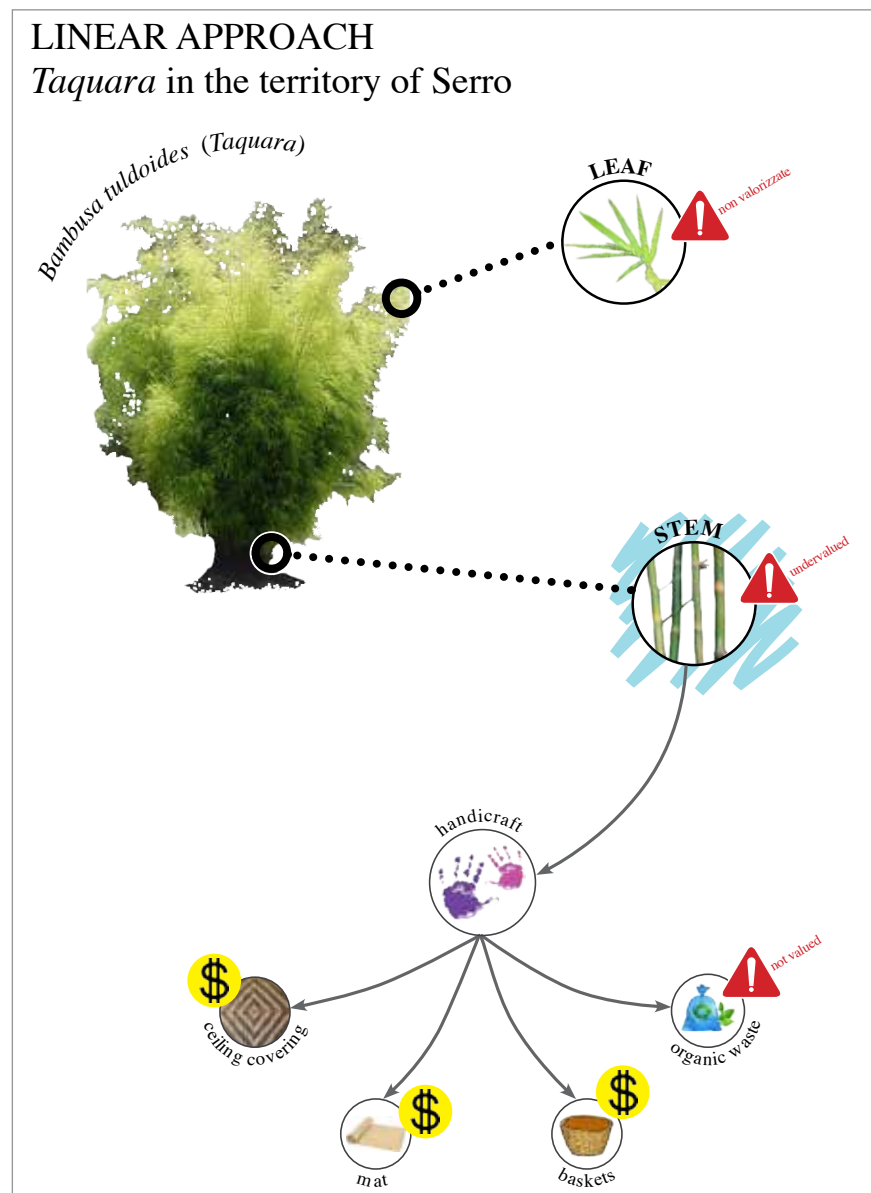


FIGURE 61  
Iconographic Scheme  
of the System Ceiling,  
Basketry and mat  
*Taquara*  
All “negative” points  
of this system, shown  
with red triangles  
warning, are explained  
below in order to  
clarify its scope and  
comprehensiveness.

allows you to view all input and system output, highlighting the “negative” points system. Important to remember that, according to the systemic approach, the “negative” points are considered as opportunities for change.

**⚠ Not Valued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**⚠ Undervalued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

**4.4.6 Bags of Corn Straw System**

The iconographic scheme below shows the current production process of the bags produced from corn stover (FIG. 62). This allows

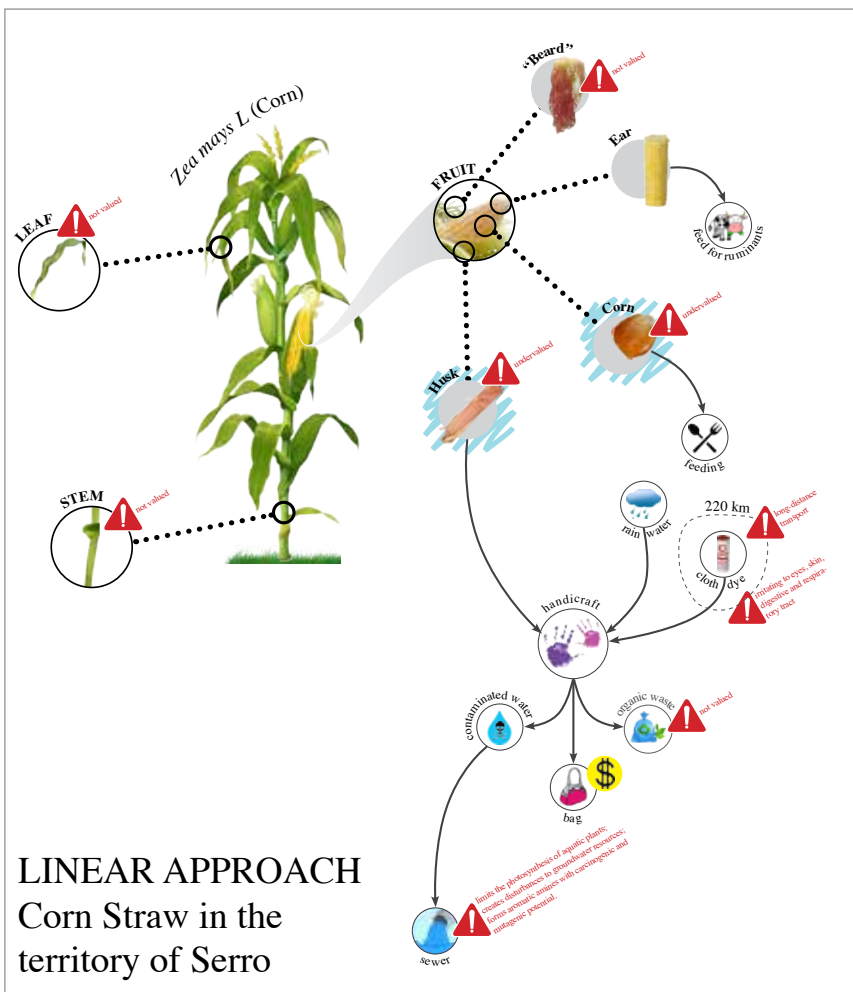


FIGURE 62 – Iconographic Scheme of the System Bags of Corn Straw. All “negative” points of this system, shown with red triangles warning, are explained below in order to clarify its scope and comprehensiveness.

you to view all input and system output, highlighting the “negative” points system. Important to remember that, according to the systemic approach, the “negative” points are considered as opportunities for change.

 **Not Valued**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

 **Undervalued**


Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

 **Transport for Long Distance**

Same as item “Long Distance Transportation” 4.2.1 System Cosmetics Fruits of the *Cerrado*.

 **Irritating to eyes, skin, digestive tract and respiratory**

According to the Information Sheet Security of Chemical Product (FISPQ)<sup>136</sup>, the dyer fabrics (“Tingecor” from Guarany company) is a solid mixture of sodium chloride, azo dye, stilbene dye and dispersant. The product can cause irritation to eyes, skin, digestive tract and respiratory tract.

 **Limits the photosynthesis of Aquatic Plants; Creates disturbances to Groundwater Resources; Aromatic amines way with potential carcinogen and mutagenic**

Synthetic colorants, derived from petrochemical products have a low cost of synthesis, stability, and range of colors, factors that make them favorable to the detriment of the natural for fabric industries. (MARCELINO, 2013)

The presence of dyes in wastewater can cause extensive damage to the ecological systems that receive surface water and create disturbances to groundwater resources (LEAL, 2011).

The quantitatively most important groups classified according to the chemical composition include azo dyes, antraquinônicos, ftalocianinos and triarylmethanes. The other groups are indigoid, nitro, polymethine, stilbene, sulfur, triphenylmethane dyes and heterocyclic, including several subgroups with heterocyclic systems. The azo dyes are the largest and most important group of dyes mainly due to its simple synthesis (MARCELINO, 2013).

Azo dyes of the type used in this case, have a higher toxicity because the reducing environment is presented as an enabling environment

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136 Available in: <<http://www.br.viarural.com>>. Accessed in: Out.12. 2014.

for the reductive cleavage of aromatic rings and consequent formation of aromatic amines with carcinogenic and mutagenic potential (MARCELINO, 2013).

It is estimated that during the manufacture and application of this type of dye, 10 to 15% is released to the environment primarily through the effluent dumps. The discharges of these effluents are visible to the naked eye, even in low concentrations (LEAL, 2011). This is not only an aesthetic issue, but may also limit the photosynthesis of aquatic plants, interrupting or changing the depuration of water bodies, since the azo dyes are known for their chemical stability and photochemical, which make them highly recalcitrant in natural environments (MARCELINO, 2013).



## 5 results and discussion



The construction of Holistic Relief, the conducting field research, the investigation of the characteristics of each resource used and the study and analysis of current productive systems of Territory of the *Serro* were bases to design the matter and energy flows of productive systems in question.

### 5.1 Step 3 – Design of Flows of Matter and Energy

The following iconographic schemes (FIG. 63, 64, 65, 66, 67, 68, 69, 70 and 71) present the flows of matter and energy of the nine productive systems of the territory of *Serro*, covered in this work.

As could be observed, the suggested productive systems value the local workforce, through the know-how of traditional communities, and employ resources (material and workmanship) from own territory.

It is worth highlighting the respect for the environment, especially when considering the output of the systems as input (resources) to other systems, by reducing the maximum distances between resource-production-consumption, and eliminating the use of harmful chemical inputs replacing them with natural and local products.

As a result, the quality of products is increased, both from a cultural and from an environmental point of view, still allowing the generation of several new activities (work), which implies income generation for the community of the *Serro* territory.

# SYSTEM APPROACH Amesca in the territory of Serro

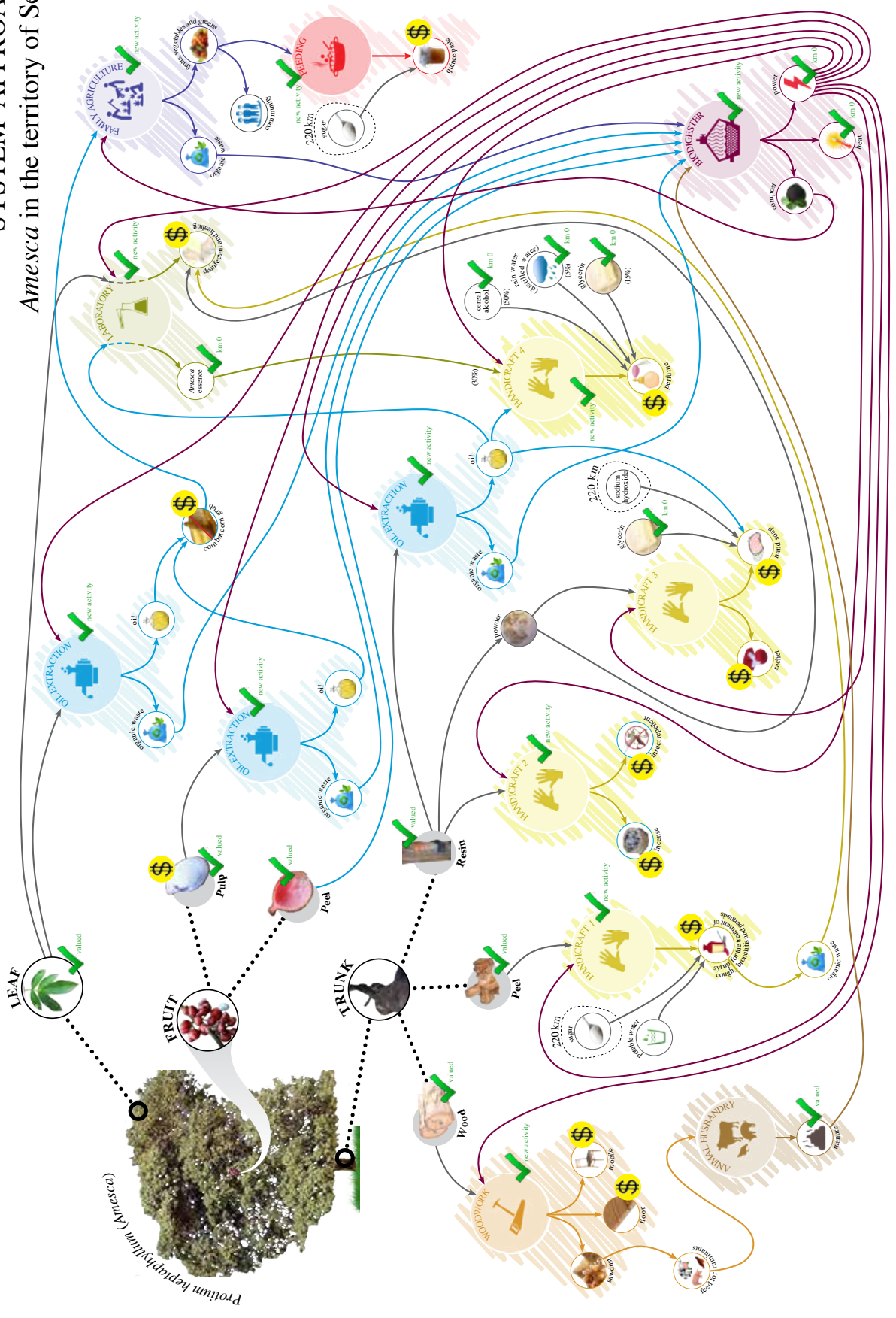


FIGURE 63 – Systemic approach of the Cerrado fruit | Amesca





**SYSTEM APPROACH**  
*Mutamba* in the territory of Serro

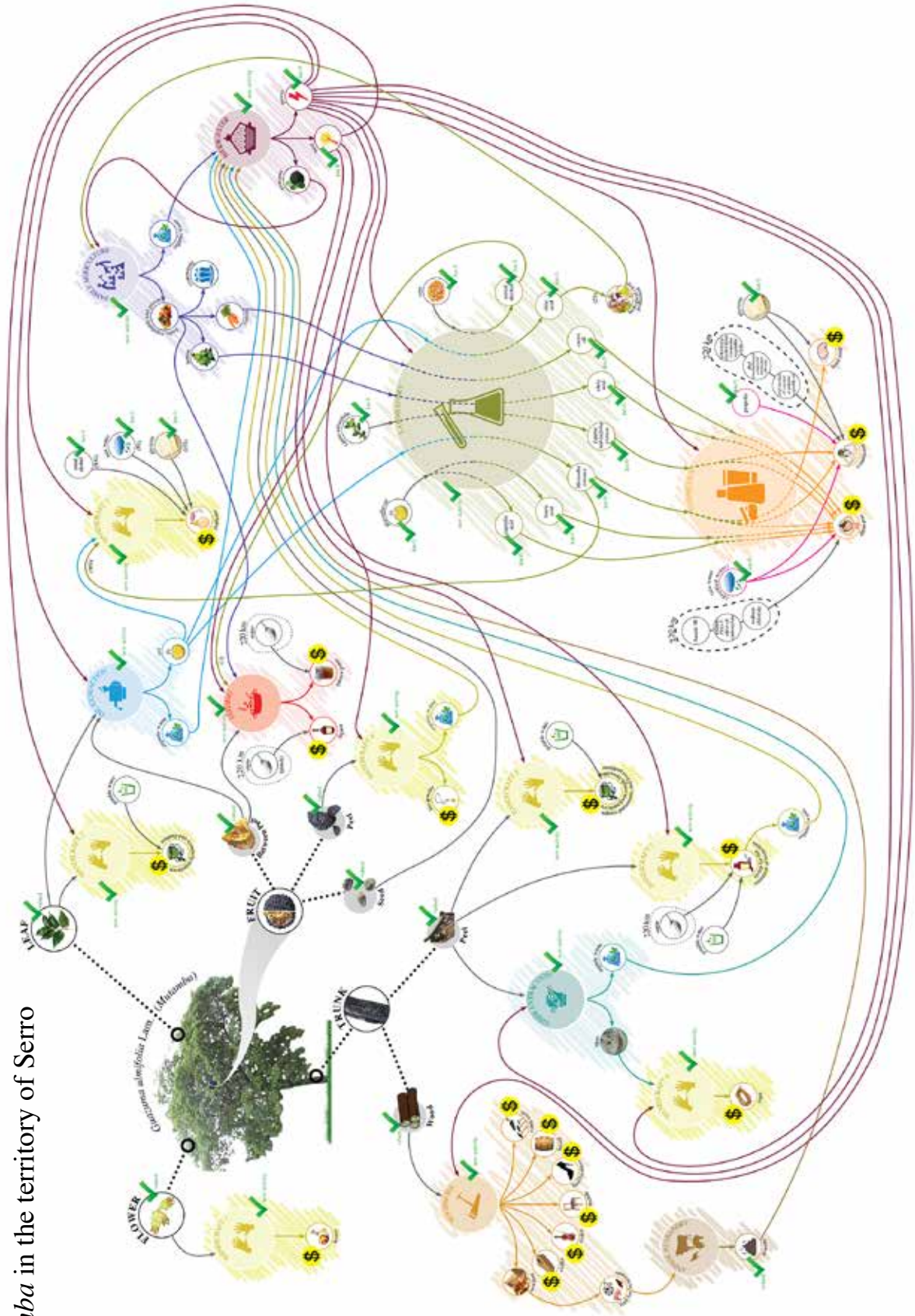


FIGURE 65 – Systemic approach of the *Cerrado* fruit | *Mutamba*





**SYSTEM APPROACH**  
Evergreens in the territory of Serro

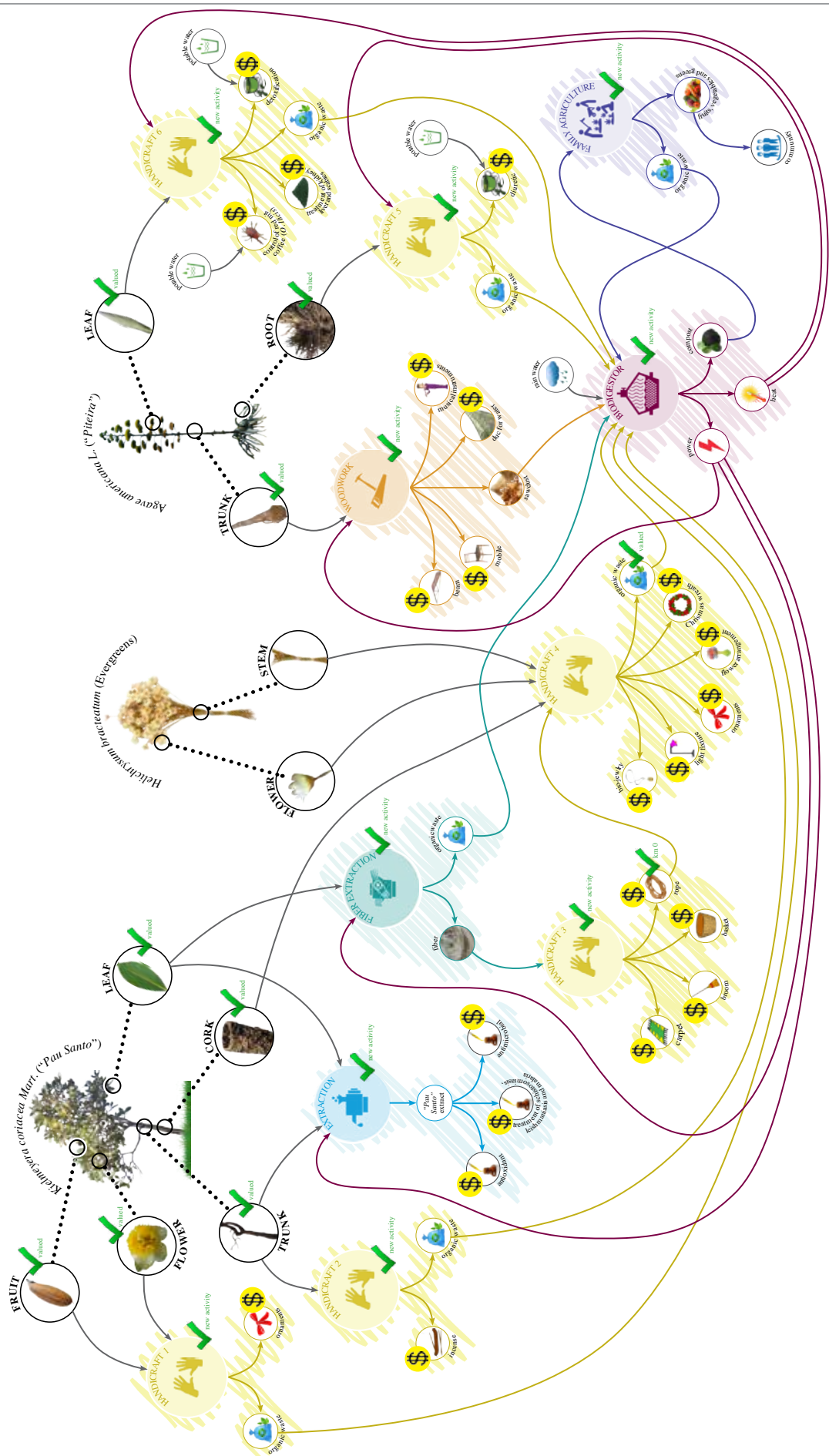


FIGURE 67 – Systemic approach of the *Sempre Vivas* (evergreens)









# SYSTEM APPROACH Corn Husk in the territory of Serro

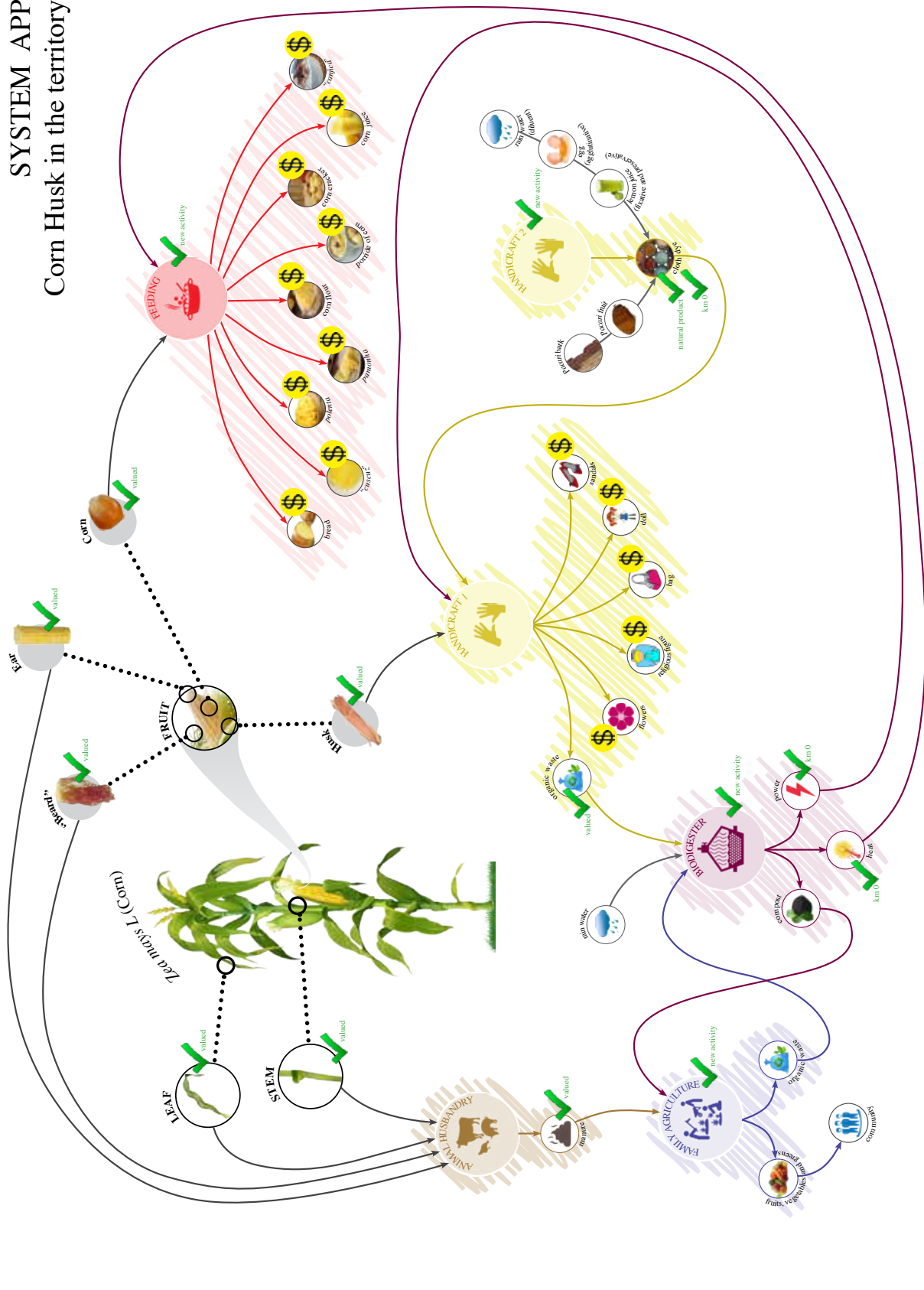


FIGURE 71 – Systemic approach da straw of corn



## 5.2 Step 4 – Confront

From the comparison between the current approach (existing products and activities in the territory) and systemic approach (possible products and activities to be developed in the area) we can see, in the latter, a significant increase in the quantity and quality of the products generated by the projects presented (FIG. 63, 64, 65, 66, 67, 68, 69, 70 and 71). This can be proven through of the following iconographic schemes (FIG. 72, 73, 74, 75, 76, 77, 78, 79 and 80):



FIGURE 72 – Confrontation between the current and systemic approach of the *Cerrado* fruit | *Amesca*

In the current approach (linear) there is one product and one activity. With the systemic approach of the territory can offer more 11 products, through nine activities, carried out by the own community, with local resources.

## Macaúba in the territory of Serro



FIGURE 73 – Confrontation between the current and systemic approach of the *Cerrado* fruit | Macaúba

In the current approach (linear) there are four products and an activity. With the systemic approach the territory can offer more 20 products, through over 13 activities held by the community, with local resources.

## Mutamba in the territory of Serro

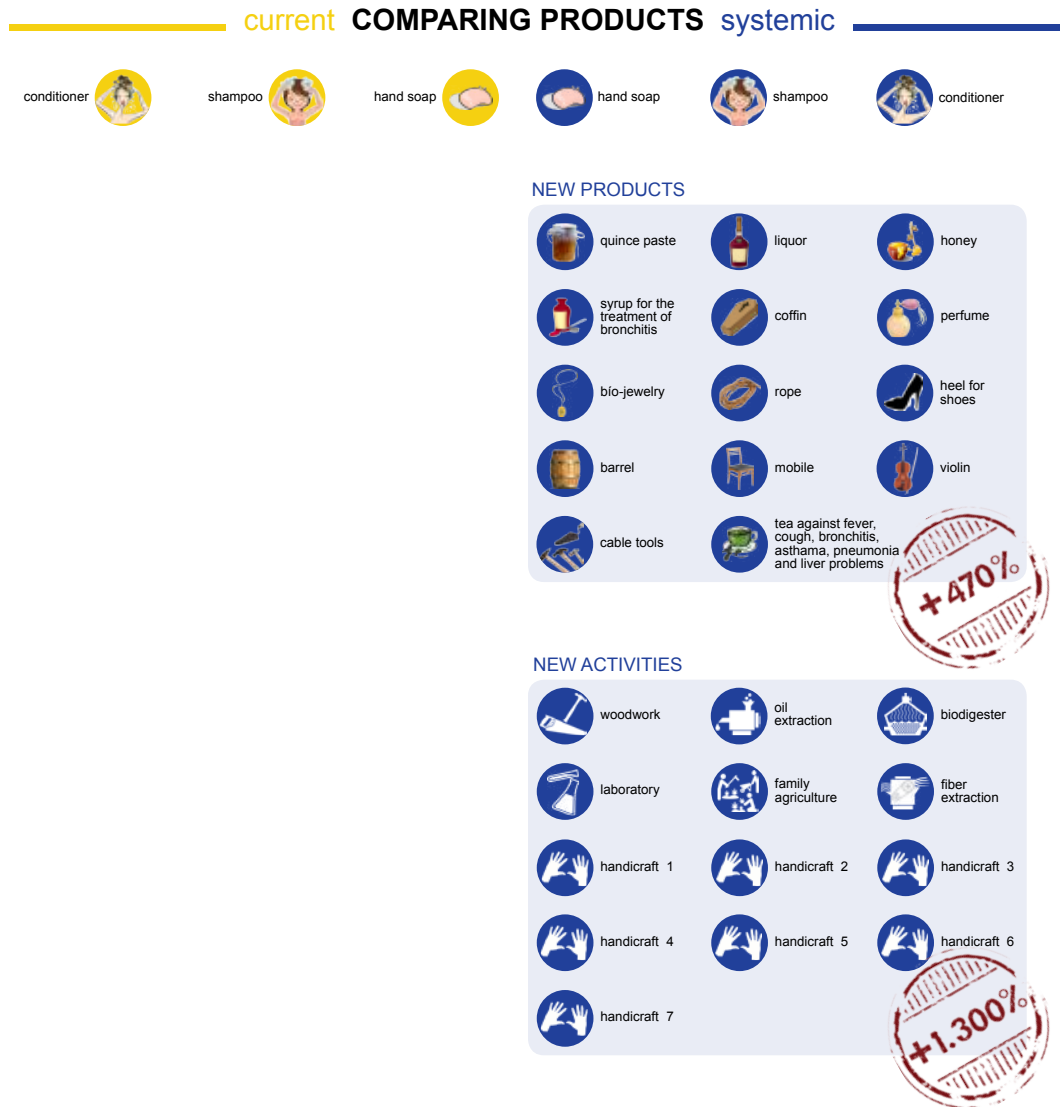
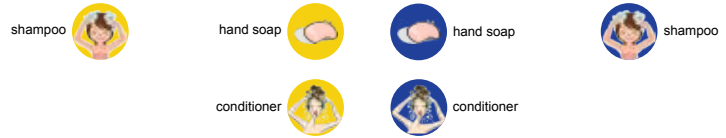


FIGURE 74 – Confrontation between the current and systemic approach of the *Cerrado* fruit | *Mutamba*

In the current approach (linear) there are three products and an activity. With the systemic approach the territory can offer more 14 products, through over 13 activities held by the community, with local resources.

## Pacari in the territory of Serro

### current **COMPARING PRODUCTS** systemic



#### NEW PRODUCTS



#### NEW ACTIVITIES



FIGURE 75 – Confrontation between the current and systemic approach of the *Cerrado* fruit | *Pacari*

In the current approach (linear) there are three products and an activity. With the systemic approach the territory can offer more 13 products, through over 10 activities held by the community, with local resources.

## Evergreens in the territory of Serro

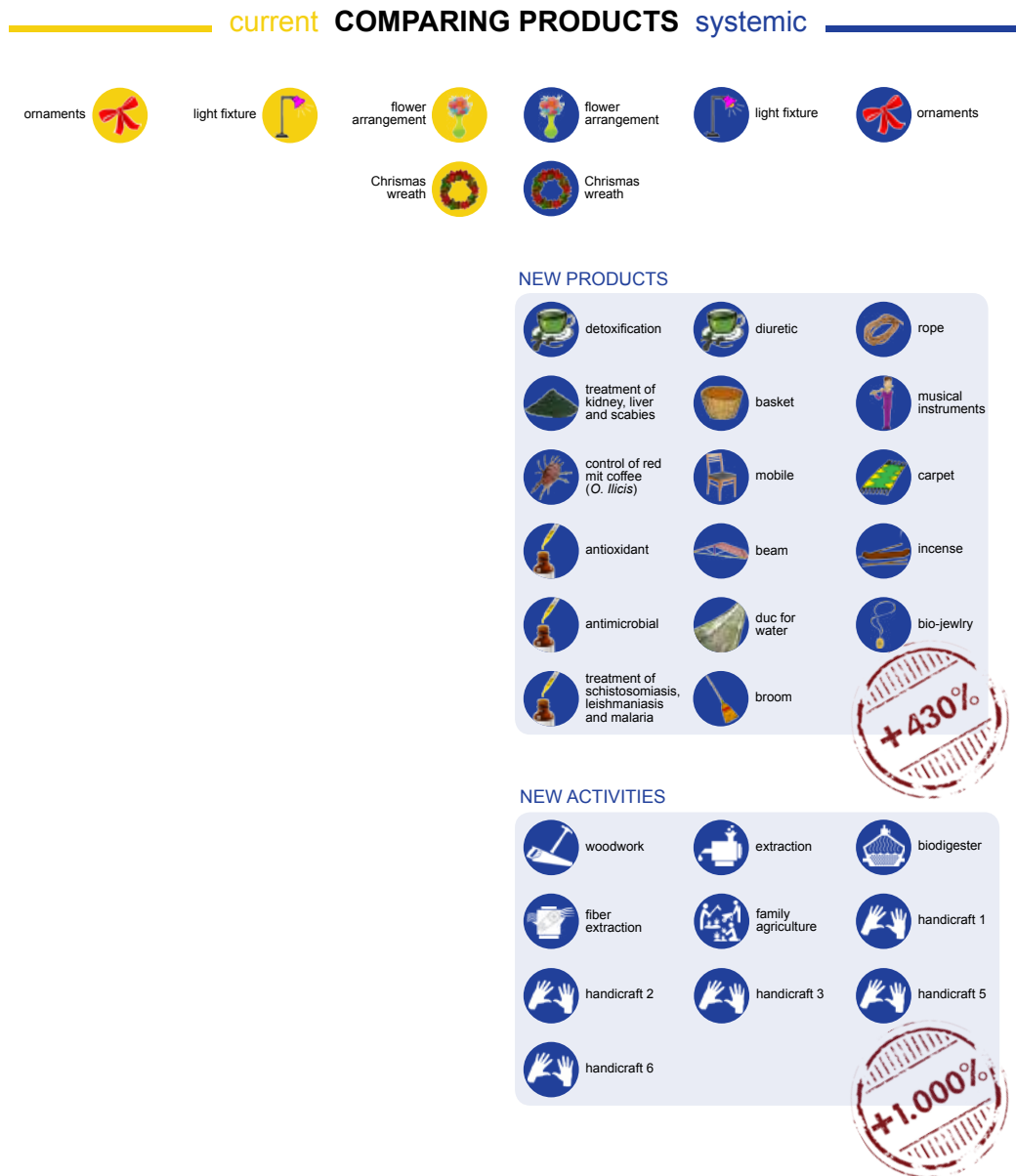


FIGURE 76 – Confrontation between the current and systemic approach of the *Sempre vivas* (evergreens)

In the current approach (linear) there are four products and an activity. With the systemic approach the territory can offer more 17 products, through over 10 activities held by the community, with local resources.



## Golden grass and “Beard-of-goat grass” in the territory of Serro

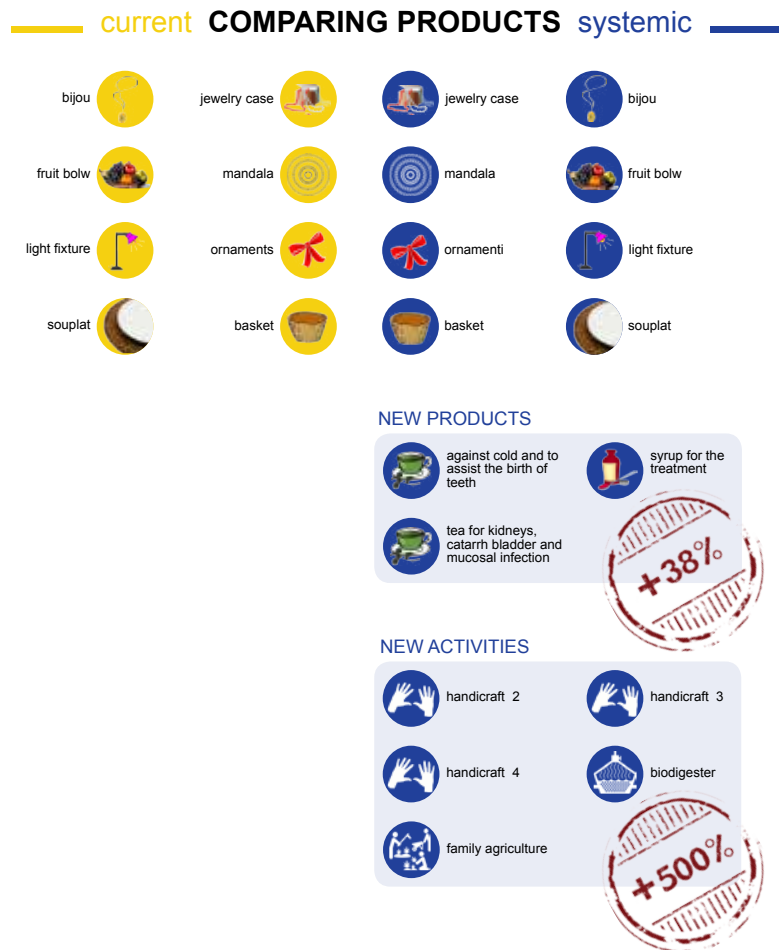


FIGURE 77 – Confrontation between the current and systemic approach of the *Capim dourado* (golden grass)

In the current approach (linear) there are eight products and an activity. With the systemic approach the territory can offer more three products through five more activities carried out by the community, with local resources.

## “Beard-of-goat grass” in the territory of Serro

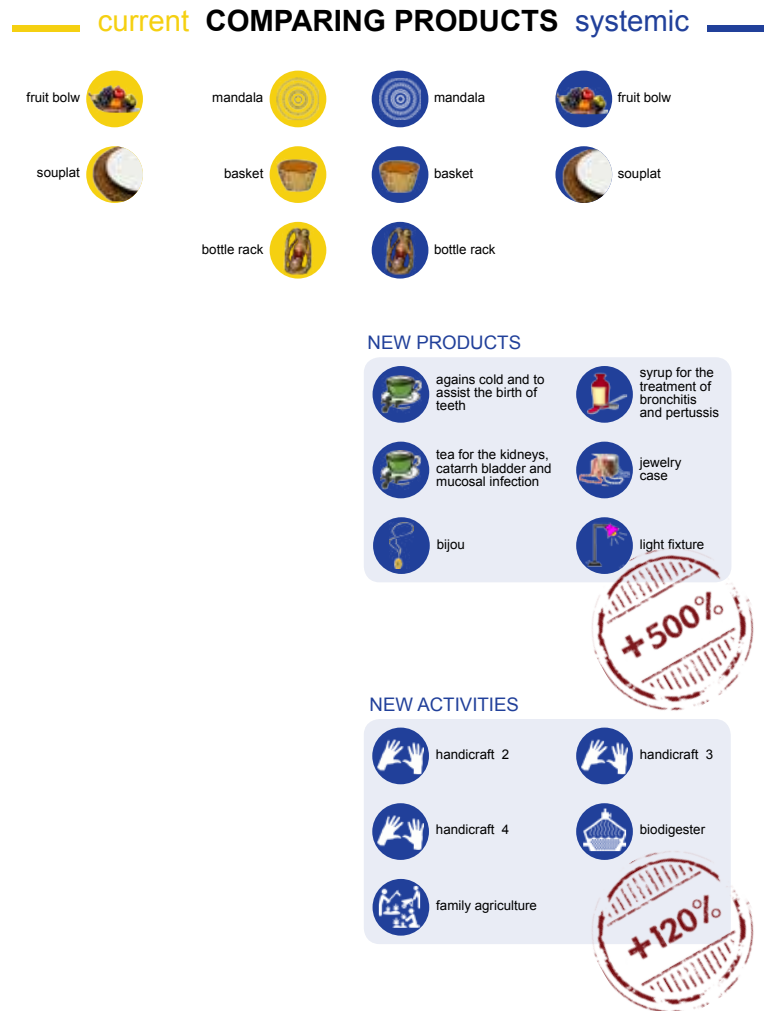


FIGURE 78 – Confrontation between the current and systemic approach of the Capim *barba-de-bode* (beard of goat grass)

In the current approach (linear) there are five products and an activity. With the systemic approach the territory can offer more six products through five more activities carried out by the community, with local resources.

## “Taquara” in the territory of Serro

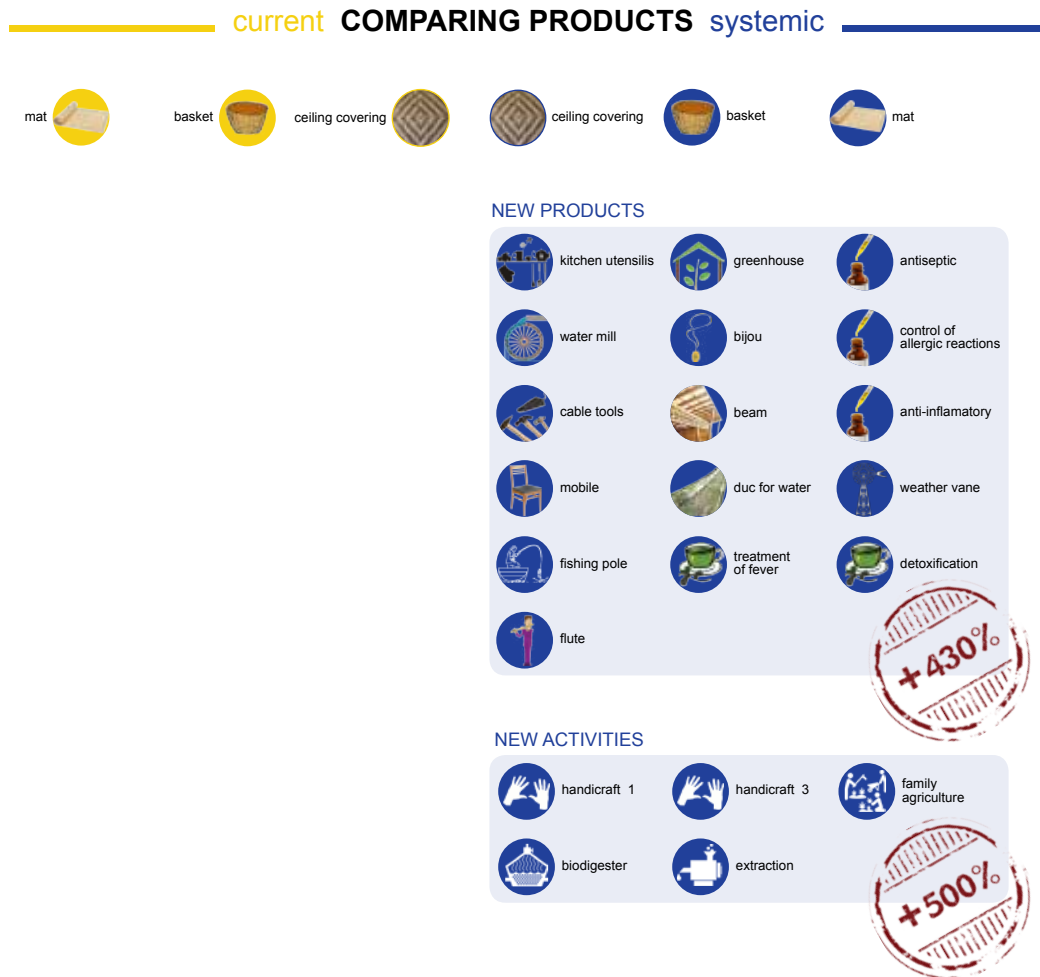


FIGURE 79 – Confrontation between the current and systemic approach of the *Taquara* (bamboo)

In the current approach (linear) there are three products and an activity. With the systemic approach the territory can offer more over 16 products, through over five activities, carried out by the community, with local resources.

## Corn Husk in the territory of Serro



FIGURE 80 – Confrontation between the current and systemic approach of the Corn Straw

In the current approach (linear) there is a product and an activity. With the systemic approach the territory can offer more 13 products, through four activities performed by the community, with local resources.



DREAM IT.  
MAKE IT.  
SHARE IT.

# 6 conclusions



The Brazilian diversity, particularly that present in the *Estrada Real* (Royal Road), has an added value in the characterization and definition of their territories. The mining culture (from the state of *Minas Gerais* / Brazil), born in the tracings of the *Estrada Real* (Royal Road), is plural and dynamic, embracing a social universe composed of particular aspects that go from local knowledge to territorial space, included in the way of speaking and dressing, artifacts, values and intangible goods. Such culture is a heritage that has been built from the past, and is characterized as a cultural complex permeated of the multiple ethnic and social aspects.

It may be said that each region of the *Estrada Real* (Royal Road) complex has intrinsic peculiarities that emphasize its quality, and display an essential strategic potential for differentiation and enhancement of the identity of their territories. These are key elements to infer that the complex of the *Estrada Real* (Royal Road) is fertile ground for the application of Systemic Design.

Thus, this research appropriates the diversity of the *Estrada Real* (Royal Road) territory to demonstrate that, through understanding the inherent relationships of local flow and their connections, it is possible to identify the sociocultural quality that comprises, assess their implications and, especially, investigating possibilities of socioeconomic development and rescue of local cultures, in a lasting perspective.

From the design and analysis of Holistic Relief, an area was delimited for the application of the Systemic Design called “*Serro* Territory”. In this, handicraftsmen were found who learned their crafts with family members across generations, producing products with a set of characteristics that relate to your community and local resources, that is, impregnated with cultural elements.

After investigated and analyzed all inputs and outputs of the activities (productive systems) of *Serro* Territory, flows of matter and energy in their production systems were designed.

As can be seen, the application of this methodology (Systemic Design) enables emersion of several new activities and products on the basis of local needs and opportunities, directly and closely related to the local material culture and immaterial culture.

Thus, it may be inferred that it is possible to generate a new economic and development model in the Territory of *Serro* in the long term, by creating connections between their productive systems, by recognizing their cultural values (tangible and intangible), under the framework of Systemic Design.

As envisioned results, are noted:

- In the economic sphere:
  - expansion of activities;

- increasing jobs;
- the elevation of income generation in the community.
  
- In the environmental sphere:
  - sustainable management of natural resources.
  
- In the cultural field:
  - the appreciation of culture;
  - the enhancement of local know-how.
  
- In the social sector:
  - the improvement of quality of life;
  - keeps the inhabitants in their territory.
  
- In the field of the University of State of Minas Gerais (UEMG) we can glimpse in the short / medium term:
  - the distinct cultural approach to the problems under the design;
  - the inclusion of Systemic Design as a discipline in Product Design Course;
  - the application of this methodology in research projects in Brazil;
  - the spread of the Systemic Design methodology in Brazil;
  - and in the medium / long term, the creation of a research center dedicated to Systemic Design.

However, in the Brazilian context, actions of design with systemic vision applied in projects of territorial enhancement are still recent activities. They are still huge challenges and also opportunities, both inherent to culture, development of identity and human relationship, which leads to a wide range of design possibilities of intervention.

Through the methodology of Systemic Design in the projectual context recreates up a new theoretical scenario for the process, emerging cultural, environmental and territorial specifics disposed between the actors and the environment, establishing a real connection between man, territory and cultural property, evidenced in the products. New challenges and paradigms arise in this context, strengthening the developments of local culture by stimulating and facilitating new relationships in social, environmental and economic levels.

The investigative character and methodological unfolding of this research denotes a comprehensive opportunity, with a humanistic and proactive manner with issues that were once seen in a linear focus. The systemic view of the process, that gained through preliminary analysis of the territory, creates an opportunity to assess the problems and needs of their localities to meet the actors and subjects, arranging them in a connected and participative order, valuing and exalting the pride of the own territory.

This research is only an embryo of a series of studies that can be deepened and expanded, so as to punctuate more specifically sectors and activities that would serve as pilot projects to be initiated.

## 6.1 Recommendations for future studies

Although the careful during the designing of the matter and energy flows of artisanal production systems, as close to reality of Serro Territory, we understand that these are theoretical, *i.e.*, have yet to be put into practice. So we envision the creation of a Community Center that is, simultaneously, a site of:

- work for craftsmen, offering the opportunity to exchange experiences and knowledge;
- training for young apprentices, ensuring the perpetuation of know-how;
- training for the artisans themselves, where they can learn new skills or improve current ones;
- development of new products and / or services;
- sustainability;
- experience tourism, in which artisans offer to tourists the opportunity to experience all the local handicrafts production chain, thus valuing the activity and the territory;
- center of purchases, in which all the artisans can acquire more adequate inputs and at lower cost due to the volume of purchases;
- inventory of products and supplies;
- commercialization of products.

To this end, we believe it is first necessary to involve interested community who wants to belong to the proposed system, precisely those people who will act upon such an approach, creating a cohesive relationship network. From this network formation, united in such work cooperative system, it would be important to develop partnerships with:

- universities, in order to generate a group of interdisciplinary research;
- local politicians, in order to verify the possibility of donation of land for the construction of the Centre, as well as search for tax incentives;
- fostering agencies for research and scientific and technological innovation, aimed at financing the project;
- *Estrada Real* (Royal Road) Institute as support.

We emphasize that, as this study has a defined and delimited theme, numerous possibilities are opened up for continuity and deepening of the same, as well as to develop new projects with the systemic approach in other territories and / or other productive sectors.

In this sense, an issue that much attracted our attention during the study within the Serro Territory, was the enormous potential that

this place has for the use of their native plants in the development of herbal and phytocosmetic products, since the Serro is the second largest biome in South America – the *Cerrado*. Some of these plants are known and used by the population in curing many ills, which in turn are passed from family to family, from faith healer to faith healer, between *quilombos*<sup>137</sup>, and among indigenous communities. In other words, this is, certainly, a field of immense possibilities.

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137 *Quilombos* are hiding places where slaves (Africans and African descendants) who escaped from farms took refuge during the time of slavery. Currently there are still some of them.







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