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GERIPA A NEW CONCEPT FOR RENEWABLE ENERGY AND FOOD PRODUCTION WITH ENVIRONMENTAL AND SOCIAL CONCERNS

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ABSTRACT

This article introduces a proposal concerning a new social and ecological agro-industry structure. This framework was planned to produce energy and food in a sustainable way, it is called GERIPA Project. It was developed with the purpose of integrating production of alcohol, food and electricity, with a working period of twelve months; eight with sugar cane and four with sorghum. The transport of materials runs on engines with vaporized alcohol. It considers thermodynamics optimization, with social and environmental quality, based on the Kyoto Protocol and the premises of Sustained Development. It occupies 4 310 ha, integrating the whole productive process like a *live organism*. With 40 000 liters of alcohol produced daily, as well as 5.2 MW of electricity, 4 760 tons per year of food. Once under economically stable operation, it can generate up to 5 600 permanent jobs. With these characteristics, the project could provide the basic needs of a city of 17 300 inhabitants, becoming a strategic setting for autonomous regional development.

1. INTRODUCTION

Generally speaking, Brazil adopts the conventional sugar and alcohol production system (CSAPS), which is grounded on a plantation system that includes the use of sizable agricultural areas, devastation of forests and biodiversity losses resulting from single-culture techniques, where fertilizers, pesticides, water and fire are intensively used. Among CSAPS environmental impacts, some stand out due to their magnitude, which include the burning of cane before the harvest, the intensive use of pesticides, the excessive mechanical tillage of soil, the unfair treatment of rural workers (low wages and strenuous work), land concentration and unfair land tenancy revenues, and inept use of distillery effluents [1].

New methods have been presented in the pursuit of overcoming these problems, and such propositions are expressed in the creation of this project of social and ecological agro-industry entity in order to generate renewable energy integrated with food production, and this project is named GERIPA. This is an ingenious and innovative in its operational procedures and use of modern technologies. This project offers a alternative to the alcohol and sugar production in Brazil: a model that is medium-sized and could be implanted as integral systems distributed throughout the country. When one considers the conventional production models based on the large plantations, GERIPA can be viewed as a genuine, innovative transformation. The issues that concern agricultural and technical topics are substantiated and well understood, and it is evident that the actual challenge to implement the GERIPA project rests in structuring a framework of institutional arrangements and regulatory order that would ensure the successful implementation of rural projects.

This procedure satisfactorily meets requirements for financing means such as the Clean Development Mechanism (UNO´s Kyoto Protocol). It is envisaged that GERIPA complexes could be created to provide the basis to decentralize the rural development nodes in suitable areas for sugar cane production. The GERIPA Project (GP) would provide acceptable quality jobs and can provide technical solutions in which to allow

the feasibility for sustainable development. Furthermore, there are additional possibilities for productive activities derived from their outputs, for example: electricity, agricultural and animal farming products. This project offers a feasible solution to face exorbitant petroleum prices and concerns with climate changes. This project can generate rural jobs as well as grant access to affordable and convenient energy resources.

2. OPERATIONAL PROCEDURE

The area occupied by GP has the following distribution: 1 589ha for sugar cane; 1 812ha for sorghum rotated with fruits and other alimentary crops; 188ha for semi-confined cattle; 930ha for forest reserve; 6ha for industrial sectors, facilities, infra-structure, etc; and 35ha for other uses, it comes to a total of 4 540ha. Graph 1 illustrates the division.

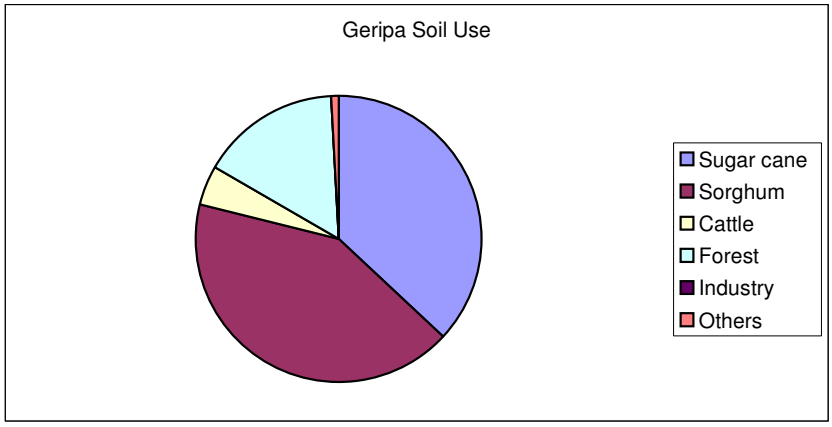

Figure 1. GERIPA soil use

The producing process from the sugar cane and sorghum to final products is illustrated in Figure 1, to show graphically how GERIPA closes loops as a pedagogical tool. The flows have no quantification values because until now the project was basically conceptual and the calculation procedures are in process. Some characteristics of GERIPA are succinctly, indicated:

- **Farming**: The sugar cane is organically fertilized by recycling bio-fertilizer using dropping irrigation. Excellent conditions are created for cultivation without need for rotation crop. The time span of sugar cane doubles to 8 grinds, production increases up to 120 t/ha (8 year average). This project assumes the productivity of 90 t/ha for sugar cane and 50 t/ha for sorghum. The sugar cane and the sorghum are cut at its base. The production of sorghum lasts only four months and, in the remaining eight months on the same area, food crops are produced in convenient soil conditions. The occupied agricultural area is smaller than the traditional one for the same amount produced. It does not promote burning during harvest, as in the traditional sugar cane production, maximizing the use of biomass. It avoids using chemicals and biological control is adopted. It also considers the environmental and social legislation, as well as techniques and technologies of environmental control. All the transport is powered by vaporized alcohol with no petrol consumption. GERIPA destines 20% of the total area for legal reserve, in addition to Permanent Preservation Area according to legislation.
- **Raw Material Preparation:** The whole thatch is sent to the qualification, preparation and cleaning section. Afterwards, the tips are cut and dispatched to the

cattle feeding lot. The cleaning of the thatches is performed by pneumatic equipment, 60% of the straw is used for soil protection and 40% for boiler burning.

- **Juice preparation:** The thatches are chopped and then shredded. Juice extraction is carried out in a high performance diffuser with efficiencies of 98%. The juice treatment is conventional, with cleaning, sterilization, adjustment of concentration and temperature, addition of yeast. It also produced wet bagasse and low pressure steam.
- **Alcohol Production:** The section has four containers, a larger one for continuous operation where fermentation begins and three others that are batch operated, until fermentation is complete. The wine formed is centrifuged for yeast extraction and, afterwards, it feeds the two columns distillery, where hydrated alcohol, vinasse and other sub-products are produced. GERIPA equipment is electrically powered.
- **Bio-digestion:** The solid waste, part of the bottom of the containers, the dejects from cattle raising, diluted and treated, vinasse with pH ranging from 3.5 to 4 and the water from the dehydrator are all mixed, adjusting the concentration. Afterwards there is a temperature adjustment and then they enter the continuous anaerobic bio-digester, where methane rich gas and pH-neutral bio-fertilizer is produced. The ashes from the boiler and other nutrients are added to the bio-fertilizer, producing an ideal fertilizer for the planting of sugar cane and sorghum. Anaerobic treatment of vinasse enables the transformation of a pollutant into a bio-fertilizer.
- **Steam and Electric Energy Generation:** This production uses all the bagasse and biogas to efficiently produce electric energy with 60-80 kgf/cm^2 boilers and various stage turbines. The electric energy enables its own supply for industrial operation, and what is in excess is sold. The bagasse from the outlet of the diffuser grind, with 50% humidity goes to a suspended bed dryer in the boiler, O_2 free, which operates with a positive pressure. The bagasse comes out with 30% of moisture. The gas exit temperature is close to 80˚C, in the best regenerative process of the cycle. The excess of bagasse is packed to be used in the mid-harvest season. The GP concept foresees burning of 100% of the bagasse and 40% of the dry straw (4% of sugar cane) to produce superheated steam (p=62atm and T=450˚C), in a suspension-burning boiler, primordially, to be used for electricity production in a high power and efficiency turbo-generator. The boiler is capable of using natural or bio-digester gas.
- **Yeast treatment:** The yeast from the bottom of the first cube and from the centrifuge is pumped to the termolizer to remove and reuse the residual wine. Afterwards, the yeast is concentrated in a vaporizer and dehydrated with a dryer, and only then stored.
- **Cattle Husbandry:** A total of 2,800 animals are raised in semi-confinement, five months out of confinement with pasture turn. Partial confinement makes it possible to double the number of animals, avoids stress, reduces disease incidences and increases product quality. The GP has a corral area of 4,630m^2 for milking, and cattle food is prepared with sugar cane tips, sorghum seeds and part of the yeast resulting from the broth fermentation, hence seeking a protein adjustment. All wastes pass through an anaerobic bio-digestion process, conditioning them to achieve good feed standards, where the nutritional properties are kept while it is isolated from air. Also, there is a semi-confined cattle rising that uses sugar cane and sorghum tips, and also sorghum seeds, as non-aerobically-silage vegetable feed.

The animal husbandry supplies milk, cheese and other such dairy produce, as well as meat.

Future Possibilities:

- Presently the spent yeast is fed to animals; it could be processed to render human food.
- Potential development of alcohol-chemical industry, aiming to reduce oil dependence.

The superior productivity and quality of sugar cane-sorghum plantation make it an ideal alternative to fossil fuels, especially when considering the excellent physical-chemical and thermodynamic properties of alcohol.

Mechanized and manual picking cases were studied. The manual picking case is hereby presented because it generates greater number of jobs. The GERIPA Project is also founded on methods and practices of leading-edge technology, and praised for its use. The sugar cane-sorghum association elevates the annual work period to 12 months against 8 months of the present sugar plants. The final products are: 2 800 animals (cattle), 2 000 tons of horticulture per year; 2 760 tons of fruits per year; 40 000 liters of fuel alcohol per day, 5.2 MW of surplus electricity and the growth and maintenance of forested area of 930ha. Table 01 shows the main differences between GERIPA and conventional ethanol process.

Table1. Differences between GERIPA and the conventional ethanol process

Procedure	GERIPA	Conventional ethanol process
Rural products	Sugar cane, sorghum, cattle, fruits and other food crops	Sugar cane
Rural procedure	No chemicals for cultivation and no burning for harvesting	Chemicals for cultivation and burning for harvesting
Byproducts used for recycling	Straw, bagasse, sugar cane tops, yeast and cattle feces.	Bagasse
Industrial products	Fuel ethanol, bagasse, electricity, yeast, fruit and other food products.	Sugar and fuel ethanol

3. ENVIRONMENTAL AND SOCIAL ASPECTS

Initially it generates 241 permanent jobs and 5 400 workers will be engaged in the farming of the area devoted to sorghum (1 812ha) during the 8 months between sorghum planting and harvest. The area will produce several vegetables. It is important to emphasize that all GERPA planting is organic, thus eliminating the use of pesticides. The procedure of not using chemicals nor performing any sugar cane burning prior to harvesting eliminates many health problems due to the dioxins and furane emissions, high concentration of O_3 and CO in the air, loss of organic matter and micro-biota from the soil, which leads to increased rates of erosion, loss of vegetal and animals species. In addition, the dense fumes produced in cane-burning can cause road accidents and serious health problems to picking workers. As matter of fact, a Brazilian jurist considers the manual harvest a criminal activity because it causes human and animal mortality. GERIPA's electric cogeneration enables to claim benefits from the Kyoto Protocol Clean Development Mechanism as it substitutes fossil fuel used in conventional thermo electrical installations. CO_2 emission reduction corresponds to 30.000 tons of carbon yearly [3].

Considering negotiation of carbon credits (CK) as US$5,00/CK, GERIPA has an additional revenue of US$ 150.000/year, not accounted in economical calculations due to this market's uncertainty. The investment of this revenue in agro-forests enables to generate 300 jobs every six years, the agro-forest cycle [6]. The agro-forest also generates CKs and, therefore more jobs. Such feasibility is another positive characteristic of GERIPA. The production cost alcohol is US$ 0.11/Liter, against 0.18 [5] of the conventional alcohol distilleries. The cost of GERIPA-alcohol in the market at present is 35% less than diesel and 64% than gasoline for every kilometer driven [3].

Furthermore, GERIPA relies on exemplary civic and social facilities, whose purpose is to provide the entire work force with social, medical and cultural assistance. The residential village consists of houses that come with a living room, a dining room, a kitchen, a bathroom, one, two or three rooms and projected by an architect specialized in using local resources potentiality. The GERIPA unit has two infirmaries, each one with a physician and two nurses, ambulance, driver, safety brigade and other medical center services. It also contains a nursery, pre-school, elementary school and adult alphabetization courses, applying an excellence-level methodology (Celestin Freinet Method). Sports, cultural and social practices with convenient resources such as, covered courts and outside activities will be stimulated.

Also foreseen in the costs of the administrative and operational departments of GERIPA, is the demand of a work group made up of highly qualified technicians. Perhaps the greatest difficulty in implanting the GERIPA project is the current technological-operational level in the sugar and alcohol industry. Time scale is a critical element of sustainability, therefore the social impact caused by the possibility of a plant's closure should be analyzed. This issue is a particularly important for future generations – one of the foundations for sustainable development. The main social impact caused in this case would be unemployment and regional starvation, needing an employee relocation plan, professional education courses and an optional way to feed and supply energy for the rural communities with sustainability.

4. CONCLUSIONS

In the GERIPA concept the substitution of fuel derived from petroleum to alcohol will improve the Brazilian social economical environmental balance and, will also represent a concrete response to the Kyoto protocol, conferring Brazil an all-embracing leadership in the treatment of the Earth. Industrialized animal farming, cultivating agriculture and sugar cane-sorghum integration are the main responsibilities for the success of GERIPA – thus presenting rewarding productivity, environmental quality and social growth, in addition to regional development. By means of cooperatives and companies with shared participation, the implantation by small rural producers or rural settlements, becomes a wealth distributor and enables to incorporate Brazilian territories that are currently economically marginalized. The creative concept of GERIPA project takes advantage of the technical, economical and ecological potentialities of regenerative-recycling procedures within the productive context of alcohol and the excellent eco-social fuel as adequate substitute to fossil fuels. These positive results are due to integration, recycling and adequate organization of the diversified production of alcohol, electric power, fruits, garden vegetables, milk and meat. This project can be seen as a regional rural development tool that embodies social and ecological concerns, which assures conceptual superiority to integrate such a combination in the form of agro-industries, in which all leading-edge technology is explored through optimized processes and efficient

procedures, thus making the production of goods within an excellent context of feasible Sustainable Development.

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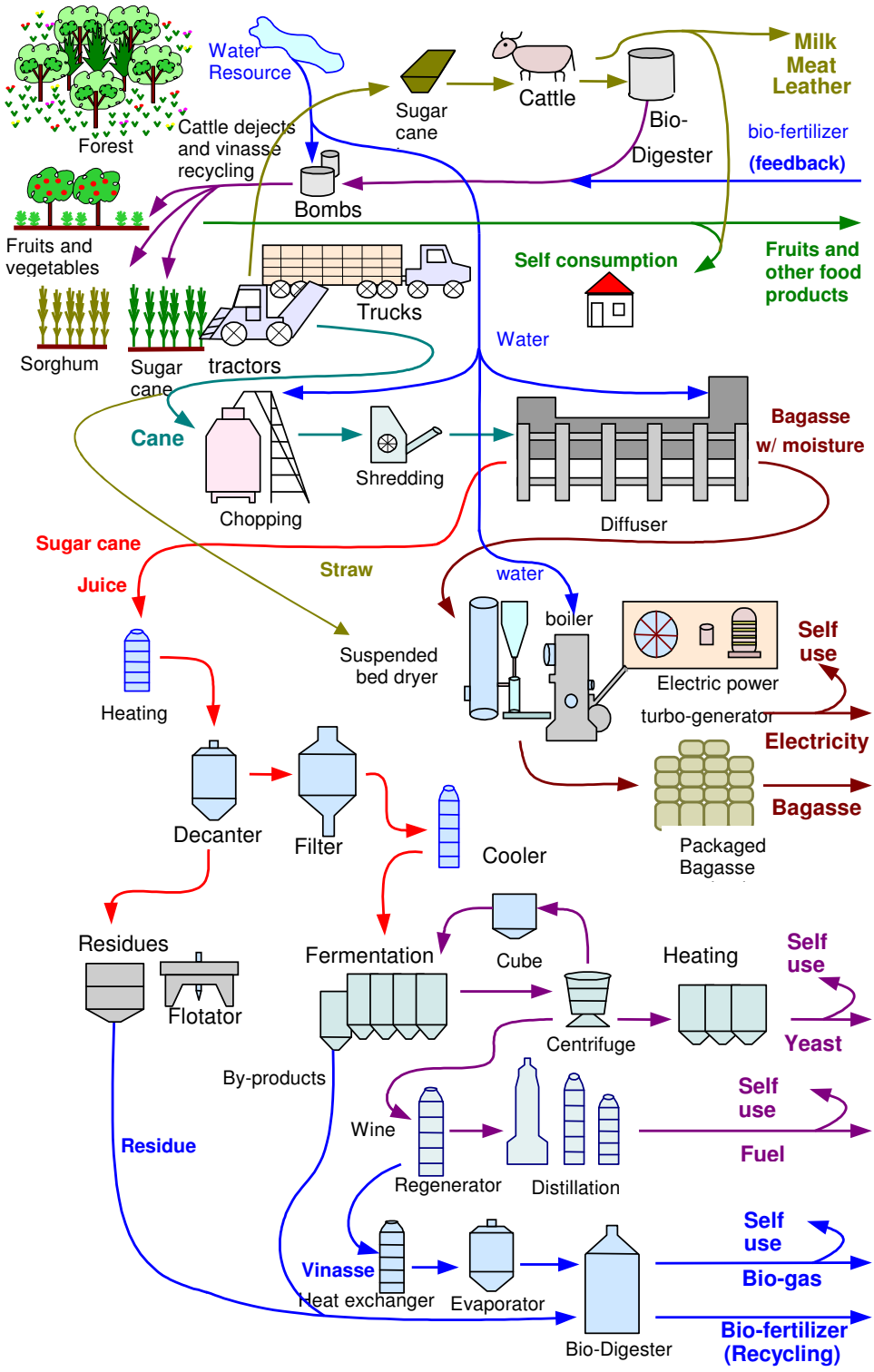

Figure 2. GERIPA illustrative procedure diagram (adapted from [4])