

# BIO-ENERGY IN FAMILY FARMING

## A NEW SUSTAINABLE PERSPECTIVE FOR THE RURAL SECTOR IN BRAZIL

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### INTRODUCTION

Small scale family farming represents 85% of the agrarian structure in the State of Paraná in Brazil. According to the National Institute of Settlement and Agrarian Reform/INCRA and the Food and Agriculture Organisation of the United Nations/FAO, about 13.8 million people, or 77% of the population work in the agriculture sector. There are about 4.1 million family establishments, which produce almost 40% of the gross value of agricultural and livestock production, or 60% of the food consumed by the Brazilian population. Around 70% of the beans and 84% of the cassava, important food in Brazil, come from this source, as well as 58% of the swine production, 54% of the dairy cattle, 49% of the maize and 40% of the poultry and eggs. The efficiency and eventual success of any project for sustainable growth in the State of Paraná depends directly on the capacity for mobilizing the people, not only because of its economic importance in current food production, but also for the real possibility of adding a new function to the traditional agrarian sector, that of generating renewable energy.

The agricultural sector is slow to renew itself. Only 23% of small establishments (farming units or small holdings) had access to financial support in the four years prior to this study. The Brazilian Government spotlighted family farming by placing it in the portfolio of a specific ministry, the Ministry of Agrarian Development/MDA. In this ministry is the National Office for Family Farming (Secretaria Nacional

de Agricultura Familiar) that has established and has been improving the National Program for Strengthening Family Farming/ PRONAF (Programa Nacional de Fortalecimento da Agricultura Familiar) starting in 1994/95. At that time an endowment of R\$ 100 million was established as a family farming credit. In 2002, PRONAF offered a credit line of R\$ 2.3 billion and today, after exponential growth, it offers credit of R\$ 16 billion which may allow family farms to overcome the old characteristic pattern of need. After all, according to the MDA, the family farming segment has been increasing its productivity by 3.8% a year.

Over at least four decades in Brazil both family farming and industrial farming steered their operations towards specialization, single cropping and livestock production, all highly dependent on chemical inputs, including for example fertilisers. The prices of the chemical products fluctuate in a roller-coaster way with substantial unpredictability. There are no surplus funds for promoting the sector's modernization or for investments in environmental services.

In both the environmental and energy contexts, Brazil is inefficient in its main business of producing foodstuffs. In the production of the main products the sector generates by-products with no market value. There are huge amounts of solid residues and other wastes not being used. They end up becoming significant environmental liabilities at a very large scale. It would be better to transform these environmental liabilities into opportunities for the production of energy and bio-fertilizers.

## BIOGAS IN SOCIETY

A Case Story from IEA BIOENERGY TASK 37 “Energy from Biogas”



Figure 1: Ajuricaba hydro basin and rural properties

Among all the sources of renewable energy available in the countryside, biomass residue is the most accessible and at a low cost. That means it has the best cost benefit ratio available in rural areas in Brazil. It must be pointed out that 80% of the Brazilian cities have less than 50 thousand inhabitants. Family activities in agriculture are directly reflected in the specialized sectors of local commerce and industries that supply them with machines, raw materials, seeds, tools etc. Furthermore, local services are also stimulated by family farming and are established in direct dependence of harvest seasons or the financial flows of the trade on the products generated.

By adding bioenergy generation to small scale family farming production leads to a positive impact upon the small towns. A new local economy is mobilised which can include the following, and more: design engineering, electrical and mechanical maintenance, assistance for the

Table 1: Costs and investments to implement the Cooperative	
Operational Cost	R\$ 52,072.50 per year
Total Investment Cost - Biodigesters	R\$ 685,096.00
Investment for Each Farm - Biodigester	R\$ 16,714.54
Main Gas Pipeline (~ 22 km)	R\$ 134,860.50
Gas Pipeline on Each Property	R\$ 3,289.28
Generator and Related Equipment	R\$ 150,360.00

NOTE: 1 US\$ = 2.25 R\$; 1€ = 2.97 R\$

biological control of the biodigesters, trade of equipment, raw materials, machinery, engines, generators, piping, control panels, electrical grid connections of low, medium and high tension. This increased activity strengthens the dynamism for all the local energy economy, through which sales is done by means of distributing concessionaries and competitive public bids which generate long-term public contracts at stable prices.

Distributed power generation is one of the keys to make family farms viable as micro-producers of bioenergy. The system of distributed power generation is centred on the possibility of generating energy and supplying it to the distribution grid.

In some countries bioenergy is generated by micro-generators as part of programmes sometimes dubbed “smart grids”, which allows the sharing of the distribution grids with micro-generators as well as with services of data transmission. As a consequence, through effective control and monitoring new services can be made available within the existing power distribution networks.

There is a specific and consolidated new regulation for operations with Distributed Generation: the Resolution 390, signed in December 2009 by the National Electric Energy Agency/ANEEL. This Resolution establishes the legal prerequisites for distributed energy generation with renewable sources.

### THE AGRI-ENERGY COOPERATIVE FOR FAMILY FARMING

Itaipu Binacional, the most important hydroelectric power plant in the world, turned its attention in 2003 to the support of new decentralized ways of generating energy. Among other actions for demonstrating the viability of bioenergy, the hydro company has developed the project “Agri-energy Cooperative for Family Farming” in the Ajuricaba hydro basin, specifically in the Municipality of Marechal Cândido Rondon, state of Paraná. This partnership depends on the support of the Paraná State Rural Technical Assistance Enterprise/Emater-PR and the Paraná State Electricity Company/Copel. This project involves 33 small scale family farms located on the Ajuricaba hydro basin as a planning unit (Fig.1). Individual biodigesters (biogas plants) (Fig.2) are installed in the properties in order to produce bio-fertilizers and biogas. The biogas is transported



**Figure 2:** A anaerobic digesters for biogas production during installation on small farms included in the project

**Figure 3:** Laying of part of the 22-km biogas pipeline

through a 22 kilometer-long gas pipeline (Fig.3) from each biogas plant to a power plant located at a central position, to produce electricity and heat (Fig.4) and/or biomethane vehicle fuel after up-grading (Fig.5).

### FINANCIAL ANALYSIS

The farmers’ herds, dairy cattle and swine, annually generate around 16 thousand tons of residues. Submitted to anaerobic digestion, these residues it will yield around 319 thousand Nm<sup>3</sup> (cubic meters of gas at normal atmospheric pressure) of biogas a year. If used as fuel for combined heat and power (CHP) engines with generators, this biogas will produce about 507 thousand kWh a year which is enough to provide electricity to about 170 households with a monthly consumption of 250 kWh each. With the reference value of the electric sector of about R\$ 0,130 kWh, the project will generate earnings of approximately R\$ 5,960 per year after deduction of costs. The amount of the other product of anaerobic digestion, the digestate that can be used as biofertiliser, will be around 19 thousand m<sup>3</sup> per year. It is estimated that the value of the biofertiliser will provide a revenue of around R\$ 95,325 per year. In terms of Carbon Credits within the CDM (Clean Development Mechanism), it

**Table 2: TABLE 2** The analysis of the economic viability of the project presents the following indicators:

Indicator	Output
Payback Time	7 years
Current Liquid Value	R\$ 244,548.97
Internal Return Rate	18.30%
Cost Benefit Index	30% of the investment
Return of Investment	15.70%
Net Annual Return	2.30%

is estimated that there will be an emission reduction of 2.5 thousand ton equivalent of CO<sub>2</sub> per year with a revenue of R\$ 93,000. The expected total new revenue will be R\$ 225,050 per year.

### PURPOSE OF THE PROJECT

The project aims to provide a concrete reference for agroenergy for small scale family farming and to develop criteria for establishing economic, environmental, social and energetic sustainability. Some important findings that have arisen from the agri/bioenergy Cooperative Project, are summarized below:

- The biodigestion of agri-residues, including animal manure, is the source of energy with the best cost benefit regarding investments and maintenance.
- The legal adoption of the Distributed Generation methodology is a key issue in making all the sources of renewable energies viable, especially bioenergy generated by family farming.
- The paradigm of bioenergy at small scale is essentially collective, co-owned and cooperative. Its territorial limit of planning and management is the small drainage basin of the group of family farms.
- The results of bioenergy programmes cannot be measured only by the energy unit (kW, or kW/hour), but also by economic, environmental and social externalities, which can be translated into “feed-in tariffs”.
- It is necessary to keep the bioenergy processes under total control of the family farmers. That is why the criterion for the participation in an energy project in a small drainage basin must be exclusively that of being located within the area, without taking into



**Figure 4:** The centralised combined heat and power (CHP) plant supplied by biogas through the biogas pipeline

consideration the industrial and commercial connections the producers might have. New structures are needed for handling the paradigm of small scale bioenergy production.

- It will be possible to aggregate value in the farmer's income with carbon credits, commercialization of biofertiliser and of the energy surplus produced from the cooperative project.

In order to make the bioenergy in distributed generation a national reality and allow society to reap the fruit of its benefits, the following steps are necessary:

- Creating a new structure for the management of projects in bioenergy;
- Accessing and incorporating land management and tenure systems;
- Stimulating incentive funds and research/innovation;
- Training project designers, specialists in operations and managers for overseeing the installation, maintenance and monitoring of the generating units;
- Creating technical assistance with an emphasis on bioenergy generated from family farming;
- Establishing a strategy for planting crops without harming the production of foodstuffs, but with sufficient surplus to enrich the residual biomass and increase the production of biogas;
- Defining priorities for the possible applications for family farm generated bioenergy – electricity, heat and biomethane vehicle fuel;
- Stimulating the organization of small scale family farmers to make the generation and use of bioenergy viable;
- Setting standards of Environmental Licensing and Clean Development Mechanisms for bioenergy cooperative operations.



## CONCLUSIONS

The physical works concerning the Agri-energy Cooperative for Family Farming started with the installation at 33 small farm properties of biodigesters insert (see Fig.1). The biodigesters (biogas plants) are connected to the central electric power plant by a 22 km-long-pipeline. The electricity is sold to the Paraná State Electric Company/COPEL. In parallel, a project is being prepared, according to the Clean Development Mechanism/CDM in order to receive carbon credits. Finally, to close the production loop, the biofertiliser originating from the biodigesters is used on the 33 cooperative farms and any surplus can also be sold to provide additional income.

Thus, the access of family farmers to the field of bioenergy, so close to them and yet so often ignored in their activities, is a pre-requisite for them to embark on the Energy Revolution of the 21<sup>st</sup> Century, which was heralded by Ignacy Sachs and which is still to be achieved. Realisation of the energy revolution will depend on the willingness dedicated efforts to remove the mountain of obstacles the authors have tried to list in this text.

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**Figure 5:** The biogas up-grading facility for producing biomethane vehicle fuel