

# **EMERGY SYNTHESIS 5:** Theory and Applications of the Emergy Methodology

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## Emergy Analysis for Small Farmers

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### ABSTRACT

*Family farming is very important in Brazil because it produces a major part of the food consumed by local population. This production system always suffered destructive pressure from the large scale agriculture. After Second World War, the number of family farmers decreased and the chemical farming systems (oil dependent) increased. Nowadays oil crisis and global warming are boosting the increase of “biofuels” crops that replace food production areas. Petroleum is essential for fertilizers and pesticides production; these two industrial inputs maintain the current agricultural productivity. Crop substitution in course may produce lack of food all over the world. Therefore, food availability is strongly connected with family farming maintenance and also with the reduction of the use of chemical inputs made from fossil fuels in agricultures. The emergy evaluation of these two production systems is necessary to discuss future scenarios and to propose the best public policies. Emergy Analysis allows understanding how the system works as a whole, to identify critical points for environmental sustainability and to evaluate its net energy yield. If the family farmers don't understand what are the researcher objectives and his methods or why he makes so many questions, probably they will not know the meaning of the results, i.e. the applied study may have not significance for them. The challenge is to make possible that family farmers can understand the emergy analysis in order to permit the results to be useful. This work has two main purposes: (a) Discuss the approach of emergy analysis for family farmers; (b) Illustrate an alternative way to make emergy analyses together with small farmers.*

### INTRODUCTION

The Laboratory of Ecological Engineering started in 2004 the study of agrarian reform and rural settlements. One of the studies was the author's master degree dissertation “Emergy analysis of Fazenda Ipanema settlement: land reform and sustainable development” (SOUZA, 2006).

The Fazenda Ipanema emergy indicators showed that this rural settlement has a medium performance but its emergy indices were better than those of a sugarcane monoculture farm (ORTEGA, 2005). Besides that, during the research activities the author noted that was not so easy to talk with family farmers about the research purpose and objectives. Other negative point observed was the use of questionnaires for data collection. The interviews took a lot of time and were not so dynamic.

If the family farmers don't understand what the researcher is doing there or why he ask those questions, probably they will not know the meaning of the results, i.e. the applied study should have significance for them. The challenge is to prepare didactic tools to make possible the understanding of emergy analysis for them to permit that the results can be useful.

The background of this paper is the Brazilian family agriculture. According Brazilian Ministry of Agrarian Development (MDA), family farming produces about 60% of the total food consumed by the Brazilian population. Family farmers are responsible for the production of 58.9% of beans, 41.3% of

rice, 82.2% of cassava, 43.1 of corn, 59% of pig meat, 55.4% of milk cattle and 47.94% of poultry and eggs (MDA:DIEESE, 2008).

Since the beginning, the Brazilian agriculture was organized in monoculture plantations to produce commodities to exportation (sugarcane crops). The food production for local consumption was made by very small farmers (free people, not slaves) in the periphery of the sugarcane plantations (FREYRE, 2004).

In the 20th century, the agriculture became an industrial activity characterized by heavy use of pesticides, chemical fertilizers and agricultural machinery, causing great environmental impact (KAIMOVITZ, 1997). Additionally, after the second war, the industrialization of the agriculture in Brazil expelled a large numbers of small farmers from rural areas, increasing land and income concentration, and decreasing the number of family farmers (MEDEIROS, 2003).

Nowadays, two global crises events affect family farming: global warming and oil crisis. Both crises are boosting the increase of “biofuels” crops, sugarcane and soybean in the Brazilian case. Biofuels crops replace food production areas. Petroleum is an essential raw material for fertilizers and pesticides production. These inputs are responsible for current agricultural productivity. As a result of combined forces it is possible to foresee higher prices and lack of food. Therefore, food availability is strongly connected with family agriculture survival and the substitution of fossil fuels used directly and indirectly in the agriculture.

This doesn't mean that will not have sugarcane crops to produce ethanol. A more sustainable ethanol production consists in micro-distilleries integrated with agrosilvopastoral systems. The micro-distilleries are small scale and produce about 20 liters per hour of ethanol. Along with the liquid fuel, the co-products can be used to increase production and quality of crops, livestock and others (VASCONCELLOS, 2002; ORTEGA et al, 2008).

## **Objectives**

- Discuss the approach of emergy analysis for family farmers;
- Illustrate an alternative way to make emergy analyses with small farmers.

## **Family farm and emergy analysis**

As it was demonstrated before, a new model of agriculture (sustainable or less dependent of fossil fuels) is necessary for the future. Then, production systems sustainability evaluation can provide information of scenarios and best public policies to improve the present situation.

Emergy Analysis (EA) is a scientific tool that measures the nature inputs. It allows understanding how the system works as a whole, identifying critical points for environmental sustainability (ODUM, 1996). The EA includes description of the system, development of systemic diagram, construction of the emergy assessment table, calculation of emergy indicators, interpretation of results.

In order to evaluate the Brazilian family farming system, the researcher must work with many primary data. The most common way to collect primary data is to make questionnaires. According to Coelho (2005), when a questionnaire is used it is possible to adopt an authoritarian position. The researcher concentrates data collection, analysis and interpretation. The researcher acquires a posture of a inquisitor and the farmer becomes only an object of study (and is no more a participative subject).

## **Alternative: participatory approach**

In the participative research conception the activities occur among people who think, decide and act together. The research labor starts considering the farmer's daily activities (that require farming knowledge). This knowledge is translated by the researcher into scientific knowledge and after that, it

is systematized, organized and analyzed always taking into consideration the socialization of results (COELHO, 2005).

Participatory Rapid Diagnosis (PRD) is a set of techniques and tools prepared to be used by rural communities to make their own diagnosis and to manage their own planning and development (VERDEJO, 2006). The PRD identifies problems, opportunities and resources in the community, also helping to discover the common interests and how the farmers structure and articulate themselves (COELHO, 2005).

According Verdejo (2006), PRD may vary within the context. But some characteristics always prevail: (a) it is a data collection and research process which intends to include the perspectives of all community's groups and individuals; (b) it impulses a change in the traditional role of researcher and subject of research; (c) it recognizes the value of community knowledge.

Therefore, the current work proposes a participatory energy analysis. It will be an integration of Energy Analysis and Participatory Rapid Diagnose. This combination may help the farmers to have a better understanding of their own reality and also to understand the basic issues of the energy analysis.

## **Participatory energy analysis**

The integration between EA and PDR will be realized using the participative tools to provide integration, community self-understanding, data collection for energy analysis and to help the researcher discovering the social actors and social interactions that are the systemic elements to understand the community. The EA will be discussed with the small farmers during the research, in the meetings as well as during the calculations and results appraisal.

The basic PRD participatory tools that will be used are two main guides: "80 Herramientas para el Desarrollo Participativo - diagnóstico, planificación, monitoreo, evaluación (80 Tools to the Participatory Development – Diagnosis, planning, monitoring, evaluation)" (GEILFUS, 1997) and "Diagnóstico Rural Participativo – Guia Prático (Participatory Rural Diagnosis – Practice Guide)" (VERDEJO, 2006).

The energy analysis will follow the book "Environmental accounting: energy and environmental decision making" (ODUM, 1996).

## **Some participative tools**

The PRD research method demand simple and not expensive materials: paper, pens, cardboard, glue, among others. It uses farm map, farm system model, semi-structured interview, production data table. These PRD tools also provide ecological, social and economical information for EA method.

## **Semi-structured interviews**

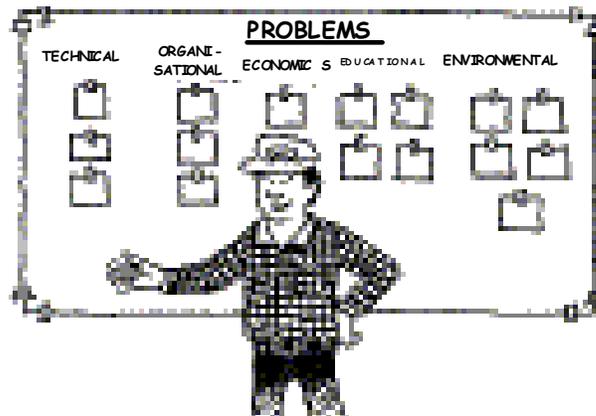
This is an interview guided by 10 to 15 key questions. This tool helps to create an environment of open dialogue and allows the interviewed person, or group, to express freely without the limitations created by a questionnaire. A semi-structured interview can be done with key persons or groups to understand the farming system behavior. For example: old persons can be interviewed to know about the farm past.

## **Brain storm**

This exercise aims to obtain relevant farming system information, in meetings with small groups directly involved. The difference between brainstorm and semi-structured interview is that in this case the issues are more open and the objective to collect perceptions and ideas. This tool (Figure 1) is

## BRAIN STORM

THE IDEAS ARE  
EXPRESSED IN  
CARDS. ALL WHICH  
ARE PLACED IN A  
MURAL



THE CARDS  
ARE  
ARRANGED  
BY THEME

*Figure 1. Example of results of brain storm tool. Source: GEILFUS (1997).*

frequently used in the first meeting to know the main community problems and perspectives. The problems can be arranged by topics and the most important will become visible.

### **Participant observation**

The central objective of the PRD is to understand the community's perception of the surrounding reality. It is crucial to understand why they act in this or otherwise way, before giving opinions and propose "a logical solution". The participatory observation of the daily activities makes it easier the understanding of how the community acts and it makes its choices. These observations can be useful to make some conclusions about the answer of other methods, as emergy analysis.

### **Organizational analysis: Venn diagram**

The activity aims to learn about organizations and groups that act in the community. This tool allows understanding the interactions between the organizations, groups and community (Figure 2). It can help to see the "distance" between the public institutions and the community, or if public services reach the place or not. It is like a diagram of the social relations between external institutions and farmers or farmers organizations.

### **Services and opportunities map**

The objective of this exercise is to establish a graphical representation of the opportunities that the farmers have besides their own farm activities, as temporary jobs, external services offering, markets, public services (Figure 2).

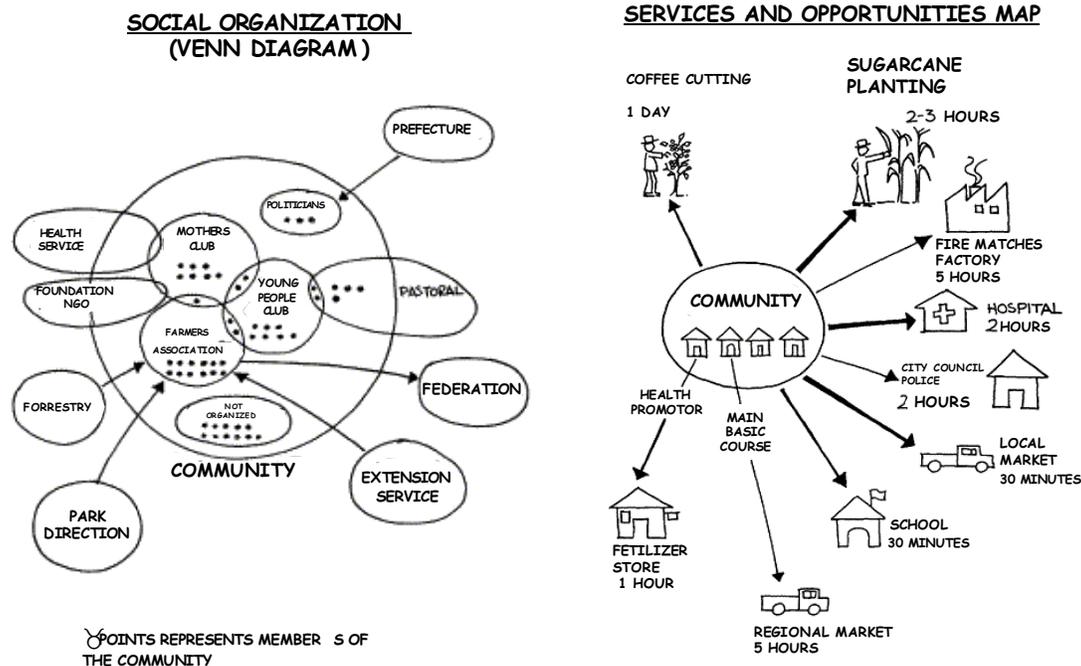


Figure 2. Sample results of the tools: social organization (left) and services and opportunities map (right). Source: GEILFUS (1997).

## Farm map

Plot on a map the vision that farmers have of farm land use, showing the most important information (Figure 3). With this tool, it is possible to identify the main elements of the productive system. In addition, this tool can be used to draw desired scenarios and planning ideas (desirable changes).

## PRD farm system model

After the farm map construction, this tool allows drawing up an operating model of the production unit, with its sub-components and various flows of exchange. This is a "systems approach" analysis accessible to farmers and technicians.

The obtained drawing (Figure 3) can be applied in the emergy analysis converting them to the symbols used by the methodology. This is a tool that has a strong link with EA.

## Expected results

- To build-up the interpretation of the social, economic and environmental reality of the community, as their scientific partners.
- To obtain the basic information needed to plan community changes seeking more sustainability (environmental, economic and social).
- To make possible that the community can understand and discuss what is better for them and how to organize to request actions by the politicians or find others ways to solve their problems using the research results: farm maps, farm connections, farm model, emergy indicators, systemic diagrams (figures 4 and 5), social and economic characterization.

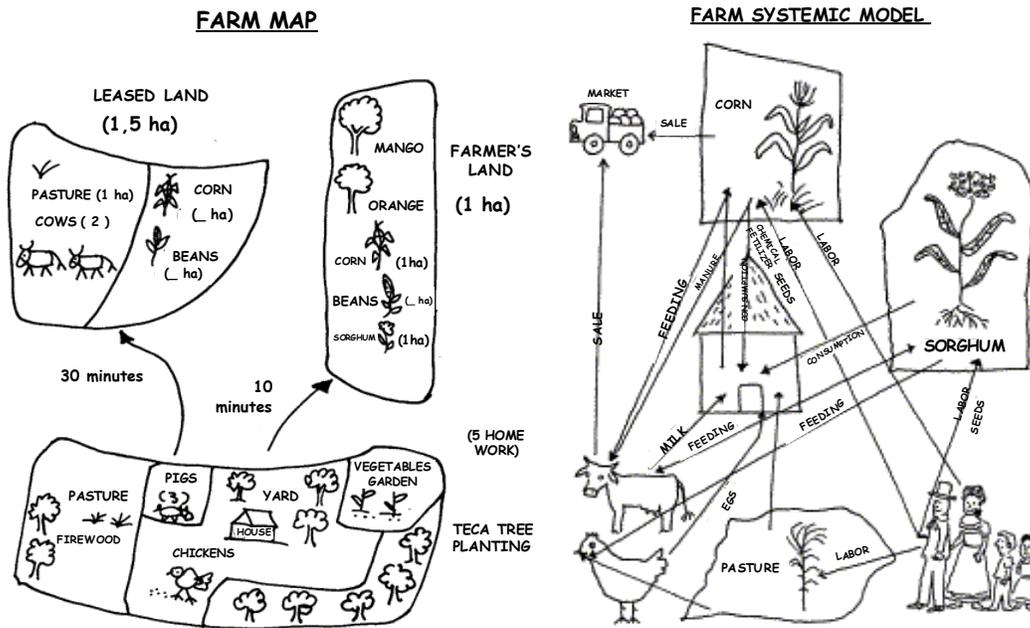


Figure 3. Sample results of the tools: farm map (left) and farm systemic model (right). Source: GEILFUS (1997).

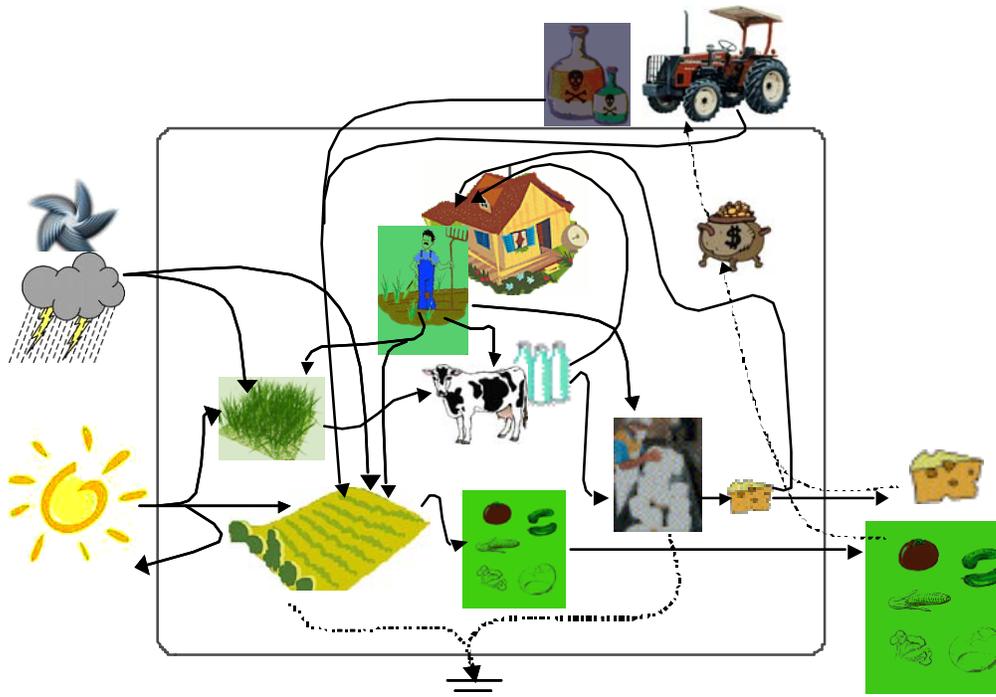
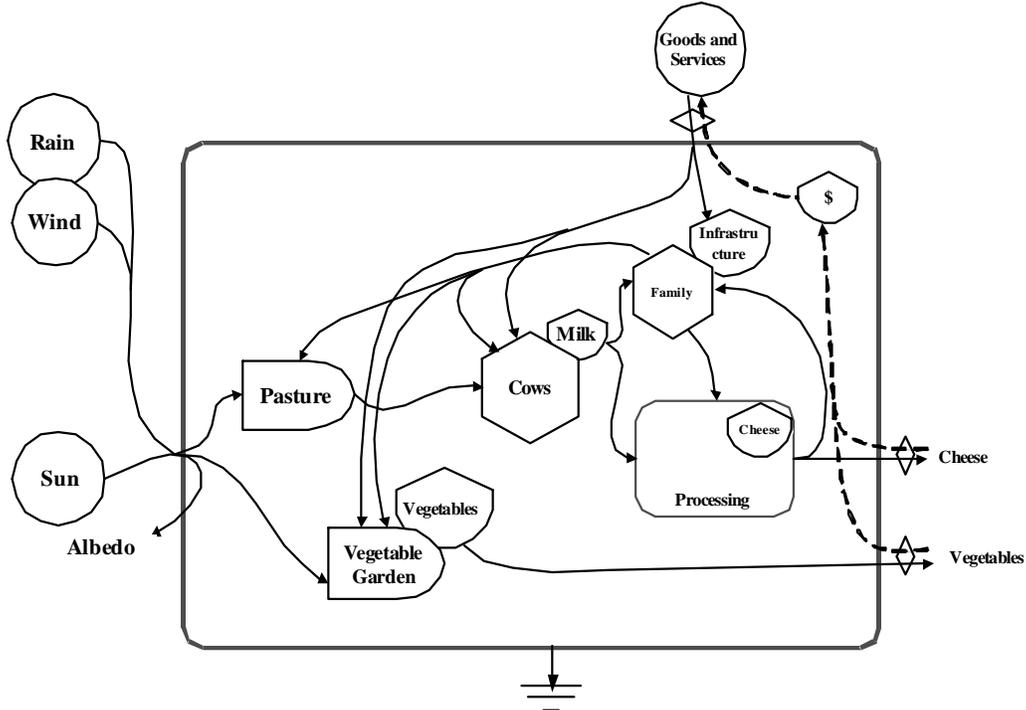


Figure 4. Expected adapted systemic diagram elaborated by small farmers.



*Figure 5. Expected systemic diagram, in the form of emergy analysis, elaborated after de adapted diagram.*

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