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Payment for Environmental Services to Promote Agroecology: The Case of the Complex Context of Rural Brazilian

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Abstract

Modern agriculture has generated complex environmental damages. Sustainable food production models must be encouraged. Agroecology is presented as a more sustainable option, since it brings a holistic view of these complex and interdependent elements: food production and environmental protection. However, this model is challenging to apply, which is intensified by the limitations imposed by environmental command and control instruments. This paper aims to analyze how the economic instrument of Payment for Environmental Services (PES) can be enhanced in order to promote the reproduction of agroecology in Brazil. PES and the main environmental economic theories behind this instrument were briefly analyzed. From the analyses of selected case studies, the core structural and essential issues revolving failures of the current Brazilian PES programs have been identified. The hypothesis states that PES should migrate from the Environmental Neoclassical Economics' logic and be grounded on the principles of Ecological Economics. Based in our analysis, PES should be able to promote agroecology in Brazil reading 3 key drivers: being mainly non-monetary, public and applying a systemic approach. Following this strategy would mean overcoming the market logic, whilst allowing public participation.

Keywords: payment for environmental services, agroecology, public participation, ecological economics, environmental neoclassical economics

1. Introduction

Brazil has a historical large economic dependence of agricultural production based in modern conventional agriculture. Modern conventional agriculture is deeply connected to complex environmental problems. Although it has economic gains, at the same time, it reduces agrobiodiversity, overrides traditional knowledge and produces many externalities that are not calculated into the costs (Santilli, 2009). In Brazil, the green revolution marked the great expansion and intensification of agricultural practices through the implementation of reduced and homogeneous crop cultivars with intensive use of fertilizers, agrochemicals and machinery, especially in developing countries after 1960. It precisely aimed on intensifying the use of resources in order to increase production in the same unit of land, and also to expand to uncultivated areas (Codonho, 2014).

This process was developed based in economic gains and denying the agroecosystem characteristics, thus proving to generate harmful effects to the environment and the society (Altieri, 2012; Machado et al 2008). It has been causing many negative impacts, including the inversion of the ecological, social and sanitary order; pollution; problems regarding the quality and sanitary safety of the crops; and displacement of populations from entire regions. Therefore, restricting this model is essential to reestablish the quality of the environment, the food produced, (Mazoefer, Roudart, 2010) and a living place for innumerable families.

In turn, the agroecology model has better consequences for food production. In the last decade, agroecology has gained space in the academic debate and in the political scene as a productive model that promotes agricultural production mimicking ecological processes (Altieri 1995; Gliessman 1998). Agroecology seems to be a more sustainable model, as it has a holistic view of natural resources and applies ecology knowledge to rethink agricultural ecosystems while considering human and social values.

An agroecology-based model has four major advantages: a) its strategy is based on local agricultural knowledge, technical adaptation, sustainable management of resources, and the application of modern scientific knowledge about resources in agriculture; b) it is capable of restoring land that has been degraded by monocultures; c) small farmers can opt for the sustainable use of their land and maintain the intensification of production in marginal areas; and d) it values the current resources of small farmers, embraces traditional knowledge, and the low cost of work opportunity (Altieri et al 1998, Altieri, 2012).

It is also a complex model that needs to initially create a less unstable system, taking more time to reach a constant and high productive level, and requires more labor and knowledge resources. In this scenario, economic incentives and instruments are essential for promoting this practice. The enabling conditions to promote agroecology systems are still required to be investigated, especially to understand how to adopt it in the political and economic current settings.

The payment for environmental services (PES) has been used as an economic instrument to encourage practices and actions favoring the environment. The question that therefore arises is if PES can be considered as an adequate instrument for promoting agroecology in Brazil. The hypothesis gives a positive response if PES has its theoretical-ideological basis reformulated. In other words, to promote more sustainable practices, such as agroecology, an evolutionary adaptation of PES system is required. This will only be possible through the analyses of its theoretical frameworks together with the continuous learning generated by empirical experiences.

The bulk of this research is to propose an alternative PES model, based on the main critiques faced by this instrument. Thus, the main objective of this paper is to propose a new design of PES allowing the Brazilian programs to promote agroecology. Such new PES model can also be replicated in other contexts, being this a relevant contribution of this research.

Therefore, this work analyzes the phenomenon of agroecology as an alternative for more sustainable agricultural production, and the payment for environmental services as an economic instrument for environmental protection, by investigating which economic theory best underpins this instrument so it accomplishes its objectives. Lastly, this paper exposes the arising problems, both structural and essential, of the current Brazilian PES programs, putting forward a proposal for more adequate regulation of this instrument to foster agroecology.

1.1 Environmental Services Produced by Agroecology

Environmental services are the activities, products, and processes provided by nature to ensure the proper functioning of natural systems and, ultimately, to enable life on earth. Pollination, availability of clean air and water, carbon storage in the soil and maintenance of a rich biodiversity are examples of these services that sustain life and its processes (Nusdeo, 2012).

According to Muradian et al. (2010), ecosystem services are a sub-category of environmental services. From this perspective, ecosystem services are related only to the benefits provided by natural ecosystems, while environmental services also include the benefits associated with different types of ecosystems managed by humans. Thus, environmental services have a broader meaning, which includes the concept of ecological services. Taking this into account, it is possible to conclude that the services of agroecology are environmental services since they consist of human actions that assist nature. For this reason, this paper adopts the expression “environmental services” (ES) rather than “ecological services.”

There are several types of environmental services but some researchers working on this subject advocate that only four types are objects of transfer of resources, which are conservation of biodiversity, protection of water resources, carbon sequestration, and scenic beauty (Wunder, 2005; Nusdeo, 2012). However, this positioning is not fully recognized by the Brazilian legal framework, since it regulates more categories and predicts other services as a part of the payment for environmental services.

The Brazilian Forestry Code has an exemplary list, i.e. non-exhaustive, of environmental services that can be object of compensation via PES. Many of these services listed in the Brazilian legislation are convergent with the agroecology model, such as:

- a) Conservation of biodiversity (Art. 41, I, "c"): which is a key point for this food production model, since it enhances plant species and genetic diversity;
- b) Protection of water resources (Art. 41, I "d"): is another service provided by agroecology through the elimination of agrochemicals and its residues, the conservation of natural predators of pests, and the maintenance of vegetal coverage;
- c) Soil conservation (Art. 41, I, "g"): is also assured since it increases organic materials and biologic activities

during food production; and

- d) Cultural development (Art. 41, I, "f"): is secured under this model as it uses traditional knowledge and practices, including approaches that are not scientifically understood.

Thus, it is evident that agroecology is responsible for providing and fostering relevant environmental services. It helps combat the accelerated loss of biodiversity, contamination of soil and water, deforestation and burning, exodus of rural populations, and disruption of local forms of production, among others (Machado 2008, Santilli, 2009).

Agricultural land and pastures covers almost 25% of the Brazilian territory. Besides providing food, these agroecosystems deliver biotic materials for industrial processes such as fuels and fibers, but also provide important regulating and maintenance services such as pollination and pest control. Furthermore, agricultural landscapes are a valuable source of cultural ecosystem services.

In one attempt to systematize the relations between environmental services, agroecological applications and PES, a list of examples of environmental services provided by agroecosystems (Maes et al 2013) and that are fostered or promoted by agroecological applications is presented in the following table. Such examples are presented according to the types of ES, including provisioning, regulation and maintenance of environmental and cultural services

Table 1. Indicators of environmental services delivered by agroecosystems (including provision, maintenance and cultural services) followed by the respective examples of agroecological applications and possible PES.

	Indicators for services delivered by agro-ecosystems			Examples of agroecological applications	PES
	Division	Group	Class		
Provisioning	Nutrition	Biomass	Cultivated crops	Production of food and fiber	Institutional purchase of locally produced agroecological foods
			Reared animals and their outputs	Animals produced on rotational grazing systems	
			Animals from in-situ aquaculture	Integration of aquaculture with crops production	
		Water	Surface water for drinking	Reduced use of synthetic fertilizers or nutrient sources reduce eutrophication, no use of agrochemicals	Incentives for farmers to reduce the cultivation intensity near groundwater recharging areas, so as use buffer zones near water bodies
			Ground water for drinking		
	Materials	Biomass	Materials from plants and animals for agricultural use	Manure and crop residues for fertilization	Technical advice on how to maximize the efficiency of use
			Genetic materials from all biota	Traditional and locally adapted genotypes of crops and animals	Preference of products made with local varieties
		Water	Surface water for non- drinking purposes	Increase in water retention in agroecosystems	Stimulation of using buffer zones, so as incentives for low impact farming systems on ground water recharging areas
			Ground water for non- drinking purposes	Agroecological soil management to allow the recharge of ground water	
	Energy	Biomass- based energy sources	Plant-based resources	Wood and other plant residues as source of energy	Technical advice on how to maximize the efficiency of use
			Animal-based resources	Biodigestion of crop and animal residues to generate methane and later use the residue as fertilizer	
Regulating/Maintenance Services	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro- organisms, algae, plants, and animals	Biological controls of pests and diseases	Incentives for farmers to reduce the cultivation intensity near groundwater recharging areas, to maintain buffer zones and riparian vegetation, use management practices that foster soil microbiological activity.
			Filtration/sequestration/storage/accumulation by micro- organisms, algae, plants, and animals	Neutralization of toxic substances by micro-organisms, filtering using soil organic matter	
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems	Adequate crop and soil management to retain nutrients in organic matter and avoid loss by percolation or denitrification	
			Dilution by atmosphere, freshwater and marine ecosystems	Use of ecosystem and biological functions to degrade pollutants	
	Mediation of flows	Mass flows	Mediation of smell/noise/visual impacts	Complex landscapes to reduce wind speed, reduce wind erosion	
			Mass stabilization and control of erosion rates	Use of cover crops, intercropping, no tillage, contour cultivation	
		Liquid flows	Buffering and attenuation of mass flows	Agroforestry systems, green barriers	
			Hydrological cycle and water flow maintenance	Mulching, no tillage, agroforestry systems	
	Maintenance of physical, chemical and biological conditions	Lifecycle maintenance, habitat and gene pool protection	Flood protection	Buffer zones, agroforestry, contour cultivation	
			Pollination and seed dispersal	Maintenance of local biodiversity, polycultures, heterogeneous landscapes	
		Pest and disease control	Maintaining nursery populations and habitats	Natural refugees, buffer zones	
			Pest and disease control	Natural enemies' habitat maintenance, polycultures, agrobiodiversity, local and adapted cultivars, adequate crop nutrition	
		Water conditions	Chemical condition of freshwaters	Buffer zones to prevent sediment flow, no tillage to avoid erosion, soil biological activity to degrade noxious chemical compounds	
		Climate	Micro and regional climate regulation	Agroforestry systems and incorporation of trees in the landscape	
Cultural services	Physical and intellectual interactions with biota, ecosystems, and landscapes	Physical and experiential interactions	Experiential use of plants, animals and landscapes in different settings	Agrobiodiversity and farming practices as cultural expression	Establishment and maintenance of local schools, so as training and research centers focused on local bio-physical and cultural values.
			Scientific	Agroecology as a science	
		Intellectual and representative interactions	Educational	Agroecological farms as training centers	
			Heritage, cultural	Traditional knowledge	
			Entertainment	Field days	
			Aesthetic	Heterogeneous landscapes	
	Spiritual, symbolic and other interactions	Spiritual and/or emblematic	Symbolic	Traditional species and crops	
			Sacred and/or religious	Use of medicinal and spiritual plants	

2. Payment for Environmental Services

2.1 *Economy and Environment: Environmental Neoclassical Economics versus Ecological Economics*

Traditional economics has been considered one of the causes of the environmental crisis, especially since it does not see nature as part of the production process. For this reason, new economic theories aiming at the internalization of environmental concerns were developed, such as the Environmental Neoclassical Economics and Ecological Economics (Pope, 2017).

Environmental Neoclassical Economics emerged as an attempt to address environmental problems, at the same time as maintaining the growth-focused model of the production process. It aims at promoting nature monetization to manage the use of renewable and nonrenewable resources. This theory inserts nature into the market as a way to harmonize the dilemma between the overexploitation of natural resources and the need to improve human life by maintaining the production process (Pope, 2017).

This was made initially by combining the theories of Ronald Coase and of Arthur C. Pigou. Coase proposes the idea of market extension, seeking to transform the common property into private property and assigning prices to natural resources. On the other hand, Pigou's theory defends the need for market correction (known as Pigouvian tax), based on extending the economic policy of welfare to the treatment of the environment. According to Pigou, it can be achieved with the intervention of the state as a broker of the negative externalities caused by the economic model. The main concern, however, is to internalize environmental externalities¹ with a view to the rational use of natural resources (Derani, 2008).

It is true that Environmental Neoclassical Economics integrates the environment into its analyses, but only by internalizing it into the mathematics of the market. In other words, it monetarily evaluates nature, giving prices in an attempt to reflect environmental functions and services. From this perspective, the only way to protect any of the commons' properties is to privatize and price them (Derani, 2008).

The idea of paying to conserve nature due to its services rose to dominance when the beliefs in markets were strong and had little public guidance and weakened regulation (Norgaard, 2010). In this sense, Derani (2008) states that the monetization and regulation of nature, both as a scarce factor of production and as private property, optimizes the modes of its economic use and seeks to frame the objective of corporate profit within an environmentally sustainable business policy. It does not, however, succeed in reaching the real heart of the environmental crisis.

Ecological Economics, in turn, criticizes the logic of traditional economics and of Environmental Neoclassical Economics, bringing a different approach. Ecological Economics does not comprehend the economy in fragments and detached from reality, defending that real problems are part of complex systems and therefore do not respect artificial academic boundaries. Ecological Economics understands that the economy is an open subsystem part of and embedded in a bigger system, the biosphere. Therefore, it cannot be analyzed isolated. (Daly, Farley, 2011).

The attribution of monetary value to the environment and environmental services is therefore a typical strategy of Environmental Neoclassical Economics. Ecological Economics also covers this strategy, but goes beyond it, since it is not restricted to a single type of valuation, including physical (or ecological) and social assessments measured with their own and alternative valuation systems. Ecological economics recognizes and accepts the plurality of values, as the economic, social, ecological and cultural (Alier, 2011). Therefore, as a rule, economic instruments used to protect the environment restricted to its commodification and excluding alternative types and discourses of valuation are fundamentally related to Environmental Neoclassical Economics.

¹The concept of externality refers to the consequences of the production process not accounted for by the economic system, and borne or enjoyed by society at large. Thus, externalities can be positive or negative. The natural resources used and the impacts on the environment caused by the production process are examples of negative externalities, the costs of which are borne by society in general and not by the producers who obtain the profits.

2.2 The Economic Instrument of Payment for Environmental Services

As seen earlier, economic science has been guided to address the environmental crisis through the development of new theories that propose to reform traditional economics, making it more sustainable. Law, in turn, commonly uses command and control (CAC) instruments² created to mitigate or, in the best scenario, to reverse environmental degradation. As a result, it forms “a web of legislation, agency rules, permit procedures, standards, judicial decisions, and other enforceable environmental policies, underpinned by a variety of sanctions” (Sinclair, 1997).

Environmental policies oriented by CAC instruments require extensive network-specific information, as well as an efficient integrated management system, so its implementation can achieve the desired results. Therefore, CAC implementation is perceived as costly and inefficient, stifles innovation, causes enforcement difficulties, and focuses on “end-of-pipe” solutions (Sinclair, 1997).

Due to these criticisms, considerable interest in several types of regulatory alternatives has been instigated. A good example relies on economic instruments (EI), through which law and economics find an interconnection. From all available types of economic instruments that can be used for environmental protection, PES, an EI applied through a legal contract (or agreement), stands out due to its great potential for achieving this goal.

The first theoretical formulations on the concept of PES were very criticized for being based in the assumptions of Environmental Neoclassical Economics. The concept brought by Wunder (2005) is an example, since it used market-based elements when defining the characteristics of this legal-economic transaction.

These theoretical formulations led to the creation of PES programs grounded in the Coasean approach. Such programs created markets to trade environmental services to try to overcome the market's failure, which entails the undersupply of these services. Environmental Neoclassical Economics promotes this strategy as a way to “get the price right” for environmental services (Muradian et al, 2010).

In economic terms, PES aims to retribute those who produce environmental services, promoting the internalization of the positive externalities. Externalities, according to Leff (2010), are those situations that happen outside the understanding of the economic processes. The activities that lead to positive externalities are those that bring benefits to the population without it having directly participated in its production. Internalizing positive externalities means recognizing the importance of these services and valuing them as a good result of human actions. In this sense, positive externalities can benefit the whole society and it is fair that those who produce them receive a compensation for that.

However, how the internalization of positive externalities will be made by PES is the key question to understand the effectiveness of this economic instrument to promote sustainable practices, such as agroecology.

Farley and Constanza (2010) defend the inadequacy of relating environmental services to the market logic. The authors also state that other institutions may be required to work to protect nature and “in real life, very few PES schemes achieve the standards proposed by Wunder”, which were voluntary of the transactions, at least one “buyer” and one “seller”, a well-defined environmental service to be provided and the conditionality of the payments.

Following the same line, Muradian (2010) states that most PES schemes do not comply with Wunder's conditions. According to this author, there is a mismatch between theory and practice since the concept of PES based in market elements does not reflect what is happening with real PES experiences. This problem has been causing frustration to stakeholders involved in such PES projects.

Alier (2011) also defends that the strategy of commodification of nature is inappropriate and insufficient for achieving the final objective of environmental protection. For this author, there are two ways in which nature's monetization is extremely problematic: firstly, because it continues to analyze the economy as an independent system, separate from the biosphere, resulting in a limited view of the environmental crisis; secondly, because it

2CAC instruments establish rules, laws, procedures and patterns to economic activities in order to secure the respect of a determinate environmental policy, such as reducing water or air pollution. In Brazil, these are based on administrative determinations and police power, with non-compliance generating administrative or criminal sanctions. Since its strategies focus on repairing the damage, the main characteristic is the punishment. Economic instruments (EI), on the other hand, incentive the voluntary adoption of practices desired by the environmental policy, by using tributes, public prices, and subsidies. The main difference between CAC and EI is that the first mandates a specific action, while the second induces it. Although CAC and EI approaches are different and are often perceived as opposites, both operate best alongside each other.

seeks to privatize nature, pricing it and the benefits that it produces (Alier, 2011). However, the ecosystem is not a regular product. It is the primary fount of every product and, in essence, of everything. Its value cannot be measured by regular metrics and mathematics precisely because it is much more than what the market can express.

Farley and Constanza (2010) adopt this same position. The authors argue that nature is complex and we should focus on sustainability and justice over efficiency. In this sense, they defend Ecological Economics as a more suitable framework to base PES, since it brings a more adaptive and holistic view, avoiding nature commodification.

In response to these criticism, Wunder (2015) adapted his concept, offering clarifications to ease its understanding. For the author, PES has the following elements: 1) voluntary transactions; 2) between service users; (3) and service providers; (4) that are conditional on agreed rules of natural resource management; (5) for generating offsite services.

The main changes presented by Wunder (2015) are the replacement of the elements “buyers” and “sellers” for “providers” and “users”, avoiding market associations. Also, in his new definition, the services and its conditionality cannot be well defined. However, Wunder (2015) still believes that the word “payment” is the best for the instrument.

Going even further, Muradian et al (2010) proposed a new concept to PES, defining it as the “transfer of resources between social actors, which aims to create incentives to align individual and or collective land use decisions with the social interest in management of natural resources”. These authors argue the “payment” (monetary or not) should reflect the interest of the values that each social system represents. The transfer of resources can happen through the market or via other mechanisms, such like incentives or public subsidies defined by regulatory means.

It is important to understand the difference between monetary and non-monetary payment. The first is based on cash transfers, and many authors defend this as the best type of PES since they believe it is more effective in alleviating poverty (Wunder, 2005). However, even though it can help gain social justice (Mamed, 2013), the monetary payment transforms PES in a mere assistentialist tool, reducing its potential as a viable alternative to other socio-environmental policies (Stanton, 2015).

Non-monetary payments represent a broader approach, since it includes incentives such as: training and technical assistance, production inputs, tools, services and infrastructure for the community (Station, 2015).

Considering that more sustainable practices can be, in immediate economic terms, costlier, PES appears as a good instrument to encourage the adoption of such practices. Following Muradian et al (2010) concept, the farmer’s choice of using more sustainable food production models, such as agroecology, would be encouraged with the transfer of resources to them via PES. Doing so, PES would meet its main goal, aligning farmers’ land use decisions with the social interest in managing natural resources in a sustainable way and in receiving proper environmental services.

PES schemes are important because they recognize the relevance of nature and how it affects human welfare, by the point that is essential and not rarely its functions have no substitutes, but are becoming increasingly scarce. There are costs to provide services and protect nature, and the development of sustainable ways of paying is the key (Farley, Constanza, 2010).

In this sense, Muradian et al (2010) believe that in the policy arena, PES has great potential to boost sustainable practices due to its capability to become a win-win mechanism for both environmental protection and assisting vulnerable communities. With the right foundations, this instrument can reach people who preserve the environment, but are otherwise overlooked by the command and control system, including small farmers. PES represents a change within environmental law.

Despite these advantages, it is crucial to keep in mind that PES can present limitations and inadequacies. As seen earlier, in the same way as CAC instruments, EIs are also source of criticism, mainly when they treat nature as commodities. Still, EIs, such as PES, can be a very viable alternative if they overcome the idea of inserting nature into the market. To do so, PES needs to be based on ecological principles and be aligned to the precepts of Ecological Economics.

When restricted to monetary payments, PES shows a very reductionist approach. The utilization of an amplified assessment, with multicriterial methods that also include social and physical elements, takes the instrument to a wider participation of all stakeholders involved in the decision-making process of designing and implementing PES projects. The plurality of values and elements, multicriterial and participative methods are all highly

considered notions by Ecological Economics (Alier, 2011)

3. Methodology

This paper aims to analyze how the economic instrument of Payment for Environmental Services (PES) can be enhanced in order to promote the reproduction of agroecology in Brazil. Using the inductive approach based in literature review and reports of case studies analysis, PES and the main environmental economic theories behind this instrument were investigated.

From the analyses of selected case studies, the core structural and essential issues revolving failures of the current Brazilian PES programs have been identified. To develop this alternative approach of PES to promote agroecology in Brazil, we review Brazilian legislation, reports and literature on PES programs in the country to summarize the main issues raised from these real experiences (Table 2). After analyzing such problems, we will propose a redesign in PES that, aligned with the Ecological Economics general principles, may meet the needs of Brazilian farmers who are practicing agroecology whilst protecting nature and its services. Doing so, we will try to identify the fundamental pillars to move PES from an economic basis to a socioenvironmental basis.

The correlation between environmental law and PES in Brazil is a recent research area representing a research gap. Statistic data is rarely available. In the Table 2, the number of PES programs analyzed as well as the categories that guide the based in literature review and reports of case studies analysis are presented.

Table 2. Categories of analyses of the literature review and reports investigated

Program	Law and Year	Region	Type of payment	Funding	Criteria for determination the amount
Payment for Environmental Services in the State of Paraná Bioclimate and Biocredits	Law n°17.133/2012 Law n°17.134/2012	South – Paraná	Mainly monetary	Public or private	Based on the size of the property, the native vegetation cover area, the biotic quality of the preserved remnant and the phytogeography region where it is inserted.
Payment for Environmental Services in the State of Paraná Project Roads with Araucárias	Law n°17.134/2012	South – Paraná	Monetary	Public and private	\$ 1.5 per seedling planted
Remaining Forests Program - Mina D'Água Project	Law n°13.798/2009 Decree n°55.947/2010	Southeast – São Paulo	Monetary	Public (State, Municipality and Bank).	Takes into account the opportunity cost of the region, protection of the source, the stage of vegetation regeneration, the population affected, the flow of the source and its location. No beneficiary can get more than \$ 12/month or \$ 135/year.
Green Grant Program	Law 17.727/ 2008 Decree 45.113/ 2009	Southeast- Minas Gerais	Monetary	Public	\$ 70 / ha / year of conserved area \$ 70/ha/ano de área conservada
Water Producer Program	Law n°8.995/2008 Law n°9.864/2012	Southeast – Espírito Santo	Monetary	Public and private	The payment is not fixed, varies according to the characteristics of the property, being limited to a maximum. Average of \$ 50 ha / year and an average income of \$ 450 contract / year
Reflorestar Program	Law n°9.864/2012 Decree n° 3.182-R/2012	Southeast – Espírito Santo	Mainly monetary	Public	Each service provided has its payment fixated per hectare. The fixed amount is distributed and paid in annual percentages of 20%, until completing 100% at the end of 5 years.
Family Productive Units Certification Program	Law n°2.025/ 2008	North - Acre	Monetary and non-monetary	Public and private	Monetary: In the Basic Certification the annual value of the bonus is \$ 160. From the Intermediate Certification to the Full Certification, the annual value of the bonus is \$ 200. Non-monetary: Mechanization, seedlings, supplies, animals, technical assistance, priority for credit lines and assistance for community organization.
Forestry Grant Program	Complementary Law n° 53/2007 Law n°3.153/2007 Decree n°26.958/2007	North - Amazonas	Monetary and non-monetary	Public and private	Monetary: \$17,00/month Non-monetary: supplies and equipment, such as boats, radio for communication and power generators.

4. Results

4.1 Brazilian Payment for Environmental Services Programs: Arising Problems

Although PES projects are widespread in the country, Brazil has not defined a federal normative framework for systematizing PES yet. There are two projects of federal laws in the House of Representatives aiming to institute the National Policy of Environmental Services and the Federal Program of PES, projects of law n. 792/2007 and n. 5.487/2009.

Thus, the regulation of PES in Brazil is currently made superficially by the Law n. 12.651/2012, which established the new Forest Code. This legislation seeks the adoption of technologies and activities to harmonize agricultural and forest productivity, while minimizing environmental impacts, following the ecologically sustainable development (Brazil, 2012).

In general terms, the Forest Code authorizes the Executive Power to institute programs to foster greener activities that reduce environmental damages. This is what precedes the PES prevision. The law describes payment or incentives for environmental services as the remuneration of the activities that preserve or improve ecosystems. It gives examples of environmental services that can be subject of the program, followed by suggestions of types of transfer of resources, such as rural credits, rural insurance, special financing, and lower rural taxes.

However, the Forest Code dedicates only one article to PES and the key elements and information are missing, such as: who can be beneficiaries of the PES program; who are allowed to transfer the resources; whether PES is compulsory or voluntary; if private capital can take part; and how monetary transactions work, among others. Thus, it is clear that this legislation does not regulate PES properly, only stating the existence and possibility of its use as an instrument of environmental protection.

Nevertheless, the lack of a federal legal framework did not prevent legal regulations regarding PES projects on the municipal and state levels during the last decades. There is not much research on the number of PES projects implemented, or to be implemented, in Brazil. Based on data from the Ministry of the Environment, the National Water Agency and some institutional websites, Novaes (2014) found 42 programs and policies on PES in Brazil until 2014.

In this same year, the “Law for a Green Planet Institute”, a NGO focused in Environmental Law, published the final report of an extensive research made in several Brazilian states to analyze their ongoing PES programs. Studying the legal regulations and interviewing the project managers and beneficiaries of such programs, this report pointed out their strong and weak characteristics. Its main goal was to help in the development of an adequate Brazilian federal legislation and public policy on PES (Tejeiro et al, 2014).

In spite of the geographic distance and the different approaches between the analyzed programs, the research discovered that most of their main issues are similar (Table 3). The following table informs the name of the program and its main weaknesses.

Table 3. Main problems encountered in each program

Program	Main problems
Payment for Environmental Services in the State of Parana: Bioclimate and Biocredits	High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems, discontinuity and legal uncertainty.
Payment for Environmental Services in the State of Parana: Project Roads with Araucárias	High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems, discontinuity and legal uncertainty.
Remaining Forests Program - Mina D'Água Project	High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, extreme difficulties for the beneficiaries to get the required documents, difficulties for calculating the payments, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems.
Green Grant Program	High transaction costs; extensive work of enlightenment and convincing potential beneficiaries, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems, discontinuity and legal uncertainty.
Water Producer Program	High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, difficulties for calculating the payments, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems, discontinuity and legal uncertainty.
Reflorestar Program	High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, difficulties for calculating the payments, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems, discontinuity and legal uncertainty.
Family Productive Units Certification Program	Uncertainty about the effective provision of ecosystem services, High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, extreme difficulties for the beneficiaries to get the required documents, insufficient human and financial resources, delay or non-compliance with the payment obligation, insufficient monitoring systems, discontinuity and legal uncertainty.
Forestry Grant Program	Uncertainty about the effective provision of ecosystem services; High transaction costs, extensive work of enlightenment and convincing potential beneficiaries, insufficient human and financial resources, the highest dissatisfaction with the value of the monetary benefit received, insufficient monitoring systems.

The report identified some structural problems in the Brazilian PES programs analyzed, which can be summarized as: i) the uncertainty of the provision of the environmental service; ii) the high costs of the transactions, and iii) the legal uncertainty and discontinuity of PES programs (Tejeiro et al, 2014).

4.1.1 Structural Problems

The uncertainty of the provision of the environmental service is linked to the poor understanding on such services, how they function and their complexity. This lack of knowledge allied with the inexperience of using economic instruments for protecting the environment in Brazil entails the loss of focus on the services the PES programs were created to protect in the first place (Tejeiro et al, 2014).

As an example, we have the Forestry Grant Program, since it has as a goal the preservation of native vegetation and containing deforestation. This PES program, however, does not specify which environmental services it seeks to protect, making its implementation more difficult to happen. When a PES program is poorly structured, it is easy to lose the focus on the environmental services that the PES structure was originally designed and created to secure. This issue influences the perception and effectiveness of the goals and objectives as well as the results of the entire PES program (Tejeiro et al, 2014).

Added to it, the conditionality defended by Wunder (2015) and required by most of PES programs in Brazil is shown as a real issue due to this first structural problem. Many providers are not eligible to receive the transfer of resources since they are not able to prove their provision of the environmental services object of the PES contract.

This model of PES faces thus difficult challenges when it needs to incorporate uncertainty into the calculation of provision of ecosystem services (Muradian et al, 2010). There is not enough knowledge about how the ecosystems work and function, because there are too many variables, such as the influence of the weather, different types of human actions, how the soil will interact with environmental services structure, among others (Norgaard, 2010).

On the second structural problem, high transaction costs, it seems they have been caused by the current design and implementation processes of PES programs. Such programs require numerous phases to be established and

the whole process is very bureaucratic. In some cases, due to the several layers of decisions that must be made in the design and implementation of the program, contradictory rules are met, causing real problems mainly to the beneficiaries of PES.

The Certification Program in the state of Acre is an example. In the beginning of the PES programs in this Brazilian state, the documents proving land ownership were not required, however, it was mandatory for receiving the resources later. Besides adding more costs to the whole process, these contradictory rules have caused many problems to the beneficiaries, mainly because there several issues related land tenure in Acre, but also in other Brazilian regions.

Therefore, the beneficiaries of the PES joined this program and, later, had serious difficulties to prove their land use rights, as required for receiving the compensation. The local government is currently trying to settle the main critical points, what is adding more costs to the whole process.

Also, linked with this issue in the state of Acre is the third structural problem identified in the Brazilian PES programs. As seen earlier, there isn't a legislation establishing a federal PES policy. This omission has led to several different PES systems, with some not reflecting the underlying legal basis. As a result, there is a succession of errors, legal uncertainty and the discontinuity of the programs.

Some Brazilian states began to regulate PES within their territories from 2007 and 2008, but many PES programs were designed and implemented even before such legal regulation. For these reasons, several PES programs suffered changes after their implementations, generating instability and losing its credibility. This was exactly what happened in the state of Espírito Santo, where the switch of political direction on environmental policies made the PES project being discredited by all parties involved (Tejeiro et al, 2014).

After reviewing this pioneer report on the ongoing Brazilian PES programs, it is possible to conclude that such structural problems are, in a deeper level, clear consequences of essential problems of this instrument when grounded in the Environmental Neoclassical Economics mentioned earlier in this paper. We can summarize these essential problems as: i) the commodification of nature and environmental services; ii) the privatization of nature and environmental services; and iii) the fragmentary approach of the instrument.

4.1.2 Essential Problems

The first essential problem of PES is already signalized from its name, which must be criticized,³ since it highlights the monetary transaction, giving the impression that there are no other ways to compensate for the provision of environmental services. Although this is a semantic issue, it creates a considerable problem, so it must be taken into account.

PES, when founded in Environmental Neoclassical Economics, commodifies nature as it prices environmental services. For this reason, it transforms the environment into merchandise, inserting it in the capitalist system.

This is problematic for the environment and for the people providing the services. Mainly because of the difficulty of assessing environmental services in monetary terms; and because of the general market rules based on scarcity and supply and demand, the result generally is the payment of low prices. Thus, such issues discourage the provision of environmental services by "providers" and, ultimately, the protection of the environment through sustainable practices. Specifically regarding the environmental services of agriculture, they are not seen as scarce, so the payment is not satisfactory.

For instance, the payment of the Green Grant Program (Bolsa Verde) is R\$ 300.00 (around 80 Euros) every three months for those living in protected areas and extractive settlements established by Incra⁴ in the Amazon for two years. This project seeks to improve social welfare in these communities, whilst controlling deforestation. However, the economic activities of these people are quite restricted by environmental protection, especially by the prohibition and/or limitations regarding the cutting of the native vegetation. This, combined with the lack of basic public services in these areas, means that the payment is insufficient to guarantee some quality of life to the

³ This is a core aspect since, in previous papers and presentations about PES, the authors noticed resistance of Brazilian environmentalists to accept this instrument as a great option to promote environmental protection. For the authors, it is clear that PES is misunderstood also due to its name, since it gives the impression that it can only work within environmental neoclassical economics.

⁴ Incra is initials of the National Institute of Colonization and Agrarian Reform in Portuguese, and it administrates land issues in Brazil; its main priority is to execute the agrarian reform and consummate national land tenure.

communities living in the forest. Thus, their survival is compromised as well as their lifestyles (Packer, 2015).

Mamed (2014) affirms that the established monetary compensation is inadequate considering the amount spent by the providers to use sustainable practices and the activities that cannot be performed because of the obligations under the PES program and the environmental policies applied to these areas.

Directly linked with the commodification of nature is the second essential problem of the PES based in Environmental Neoclassical Economics: the privatization of nature and environmental services. Within this logic, an alliance between the private funding agents of PES and the will to persist polluting is formed. Many of these private agents, when investing in PES programs, have the objective to get in the international compensation system, which will allow them to keep using unsustainable and polluting practices.

According to Packer (2015), by pricing nature and, we can add, using private funds, PES creates new assets for the market. Doing so, PES introduces nature into the market, submitting it to the dominant economic system. However, social issues are peripheral in such logic. People who live differently and outside this system rules are not considered by it.

The current form of PES, founded in Environmental Neoclassical Economics, only shows an untruthful concern with traditional communities, such as agroecological farmers⁵, and the ecosystem. Focused on monetary payment of environmental services, current PES programs are affecting the rights of these communities, limiting the access and management of the land occupied by them (Mamed, 2016). The instrument maintains then the dominant system fed, suppressing any existing cultural diversity.

Furthermore, when inserted in the market's logic, PES needs to scale to cover its costs. For this reason, Packer (2011), after analyzing several case studies with social movements, concluded that this model of PES works more easily with large landowners, paying them for repairing the environmental damages caused by their unsustainable food production practices and model.

Paradoxically, on the other hand, farmers who develop practices related to the conservation and sustainable use of environmental resources are not a priority in this model of PES because they are scattered in different lands and often do not have the title of ownership, which brings insecurity to the market and the "payers" (Packer, 2011).

In his survey, Packer highlights the main risks for traditional groups, including agroecological farmers, when PES is applied based in the market's rules, such as (2011):

- i) Reduction of biodiversity, socio-economic, cultural and religious values at the price placed by the market and by the cost of the production chain;
- ii) External valuation of biodiversity and ecosystems from production chains may mean, immediately, that biodiversity and social techniques built by local communities based on their own valuations, uses and knowledge are subjugated;
- iii) The contract which establishes PES treats large companies and traditional communities in equal socio-economic conditions, placing the most vulnerable part of the agreement in full unequal conditions;
- iv) The obligations placed by PES contract may mean control of livelihoods and over lands and territories;
- v) The selection of some environmental services over others based on the opportunity cost may mean the communities providers will act and inspect the practices and territories related to the services chosen by the PES contract. This can impact their way of life, the management and conservation of the territories and biodiversity that are not object of the payment; and
- vi) Depending on eligibility criteria and demands for scale, small farmers may be left out of the PES market. The one with the largest amount in hectares will eventually concentrate the market, as in all other production chains.

The Brazilian context of farmers is plural and encompasses many classes, such as small, medium, large, peasants, traditional, sustainable, agroecological and agribusiness, among others (Santilli, 2009). The sustainable use of natural resources requires the guarantee of the right to land and territory, democratization of access to land and protection of traditional knowledge, respecting the configurations of common property. Currently, PES remains linked to the world market for environmental goods and services and, therefore, does not conform to these

⁵ Agroecological farmers are considered traditional communities since they use "non-scientific" or traditional knowledge of farming, which is transmitted between family members or generations. They also have an alternative way of life and live in harmony with ecological processes, preserving nature whilst producing food.

sustainability rules (Packer, 2011).

The understanding of the first two essential problems of PES based on Environmental Neoclassical Economics takes us to a third essential problem: the fragmentary approach of this model of PES.

The current legislation regulating PES focuses on environmental and economic aspects, excluding the people involved on it. It tries to cope with environmental issues by disassociating them from the communities and disregarding the plural and complex context where applied. Meaning there are several communities with their own peculiarities and food production techniques. However, the current legislation does not take it into account. This creates conflicts, especially involving traditional communities and agroecological farmers.

Such issues have negative consequences, of which the lack of participation of the communities affected by the PES during its creation and implementation stands out. The participation of all stakeholders is important in the formulation and implementation of PES systems to guarantee credible and accepted rules. With full stakeholders' awareness and participation, PES can be effectively enforced (Farley, Constanza, 2010). Thus, transparency is very much needed in programs in which collective practices interfere to the success of the program (Muradian et al, 2010).

In Brazil, the communities of providers are usually not consulted, meaning that there is no participation in the decision-making regarding the monetary and non-monetary resources (Nusdeo, 2012). As a result, unwanted situations have occurred, such as the sending of agricultural inputs to the community affected by PES programs without their consultation/participation. Such inputs were inappropriate and, therefore, did not generate the expected returns, causing financial losses whilst not helping the community.

Menzel and Teng (2010) suggest that successful natural resource management and the implementation of resilience can only be achieved when social and environmental systems are intertwined. The human dimension must be included from the beginning and emphatically in PES projects, for example through participation. The focus is to include the values and needs of people within the decisions about the natural resources in which they live.

PES often provides only supplemental support to low-income households providing environmental services. In this sense, for a full implementation of environmental and social resilience, it is important to realize how participation, or its lack, increases or weakens livelihood strategies for these people. Participation increases social capital at the community level and, at the same time, improves environmental resilience. In the rural context, PES should be a "co-investment in goods", since the program will have a broader strategy, encompassing environmental management with sustainable livelihoods (Milder, 2010).

According to Nusdeo (2012), it is common in countries like Brazil that while legislation innovates and improves with respect to environmental conservation, it does not successfully achieve the goals. The author argues that this is mainly due to the struggle of social groups submitted to it, as well as the inspection deficit. By analyzing the experience with PES in Brazil, Nusdeo finds that it is beneficial enabling public spaces of decision and associative planning among the community of providers and government.

The exclusion of less representative social groups during the development of PES results in a troubling situation. The small farmers and traditional communities help to maintain the environment because their traditional use of the land promotes the management of natural resources and do not generate significant environmental impacts. With their deliberate exclusion from the policies related to the topic, there is no other conclusion except blatant environmental injustice (Moreira, 2010).

This is a summary of the arising problems identified in the ongoing Brazilian PES programs, here systematized as structural and essential problems. However, even with some constrains, PES still shows great potential to promote sustainable practices, such as agroecology, since the current Brazilian public policies of command and control have not been completely successful in doing so.

In this line, Toledo (2016) explains his experience in the Small Farmers' Movement, arguing that public policies generally do not meet the expectations of social movements. This means that state actions have not been satisfactory for family farmers. The author recalls that when the concept of PES came into vogue, the movements began to see the possibility of reformulating this instrument to embrace their flags, especially "that of a retribution for the peasant way of being and farming, when nonexistence or inefficacy of adequate public policies" reigns.

Reflecting, however, on this matter, Toledo (2016) concluded from his empirical experience that this attempt cannot be achieved through the logic of the market. The author points out that social farmers' movements, after having experienced some PES programs, realized that such payments were inconsistent and insufficient to

recognize the relevance of the traditional farmers' historical role, which goes beyond any financial reward.

It is therefore necessary to draw up PES programs that aim providing material conditions for the maintenance of the lives of rural men and women, especially rural youth. While doing so, PES should encourage environmentally sustainable production processes. Thus, the search should be for non-neoliberal PES models that go beyond the industrial conception of agriculture

In Brazil, most agricultural production involves techniques introduced by the green revolution. The need to minimize the environmental crisis caused by this model and to promote agroecology is clear. This paper considers PES as the most appropriate economic instrument to do it if reformulated and redesigned.

By understanding the current problems of PES in Brazil it is possible to think about possible solutions to improve the performance of this instrument in environmental protection together with social welfare.

5. Discussion

In this section, we discuss what was learned from available experiences and propose a new PES scheme for agroecology.

As seen, PES in Brazil faces two types of problems: first, structural problems meaning the problems regarding its design and implementation; second, essential problems, the problems regarding its alliance with Environmental Neoclassical Economics. To overcome both structural and essential problems, a specific federal legislation regarding PES that sees agroecology as one of the main areas to address should be implemented. This federal scheme must understand all existing PES programs in Brazil and firmly impose some rules as a way to avoid distorted instruments.

Current PES model is a typical instrument of Environmental Neoclassical Economics, theory in which the economy is treated as a closed system, i.e., it does not consider the nature's boundaries nor the social needs. Redesigning PES grounded on Ecological Economics means that the economy should be seen as a subsystem inserted within society and, in a broader way, within the biosphere.

Adopting this new framework, a logical conclusion that emerges is that nature and environmental services cannot be restricted to the borders of the economic system, since their values go beyond this system, being the basis for life. Thus, the inadequacy of inserting environmental services into the market's logic through the commodification and privatizing nature becomes evident.

Still following the Ecological Economics approach, PES must have a more complex and systemic approach, understanding all the existing and possible interconnections between the systems involved in its processes. Therefore, social needs should be considered, which ultimately means the inclusion of public participation in its processes of design and implementation.

In this context, the new Brazilian federal scheme should start from the change of the name of this instrument, representing its new foundation. Instead of "payment", which is clearly based on Environmental Neoclassical Economics, the expressions "compensation", "incentives" and, even better, "transfer of resources" for environmental services are more accurate, since this instrument does not necessarily constitute a monetary return and should not emphasize such an aspect.

Furthermore, considering the Brazilian reality and the alternative valuation discourses used by the social actors affected by the current PES projects in Brazil, the Ecological Economics approach would position this scheme as a non-monetary one, helping to tackle the commodification of nature and, consequently, the low prices offered by such projects.

Barreto and Tura (2016) advocate, based on research with social movements, that agroecological production requires special treatment. They demand that PES benefits should go beyond the mere financial payment, addressing a wide range of possible indirect incentives capable of valorizing and promoting this agricultural model.

Following the same line, the report published about the field research on the Brazilian PES programs informs that non-monetary incentives are more valued by the social actors, parties of the PES contracts. This is due to the diffusion of the expansion and diversification of production on sustainable bases provided by them (Tejeiro et al, 2014).

Examples of non-monetary transfer of resources are the provision of public services, infrastructure, social organization in cooperatives, technical assistance, rural credits, insurance systems for the production, preference on the public procurement, and rural schools that teach traditional knowledge, among others. Many of these types of incentives are already part of the annual budget of the Brazilian government and therefore do not

represent an additional cost to the state.

Going beyond the logic proposed by Environmental Neoclassical Economics and following the Ecological Economics perspective, the ideal model of PES would be public, i.e. between providers and the government, while avoiding the presence of private capital. This is because, being subjected to the market logic, the providers, especially agroecological farmers, may become vulnerable in private negotiations.

The state presence is important to ensure fairness. This is a way to safeguard the protection of ecosystems and the people affected by it. In the words of Farley and Constanza (2010), “reclaim the public good character of environmental services and discarding any attempt to price and market them as a way to foster conservation is not radical, is common sense and necessary”.

And, finally, the Ecological Economics foundation brings the need to overcome the current fragmentary approach of PES, moving towards a systemic and complex perspective. Such framework would transform PES in a bridge between the complex dimensions of sustainability, focusing on social justice and the resilience of nature.

These are therefore the three basic pillars to move PES from an economic basis to a socio-environmental basis and are essential for this instrument be adequate to promote agroecology in Brazil. A Brazilian federal PES public policy which establishes a i) non-monetary; ii) public; and iii) with systemic approach instrument would be able to overcome the current structural and essential problems of the Brazilian PES programs, fostering sustainable practices, such as agroecology.

Having Ecological Economics as its framework and the above mentioned three basic pillars, Brazilian PES contracts would be more flexible, respecting the specificities of each region and stakeholder. Furthermore, the fact that the beneficiary cannot assure with scientific basis the provision of the service, due to the lack of scientific knowledge, should not impair them.

Wunder (2015) defends conditionality as a crucial element of PES. However, Muradian (2010) understands that PES frameworks that are too strict about the relationship between the transfer of resources and the environmental service are inappropriate and hard to achieve. Thus, flexibility is crucial and, in practice, non-monetary incentives tend to work better with less strict conditionality.

A systemic approach would provide the right environment for the engagement of the communities affected by PES programs. Therefore, the active public participation through association structures, together with the use of non-monetary benefits and public instrument, would minimize the costs, bureaucracy and contradictory rules within the program.

For example, the documentation required to join and to be beneficiaries in Brazilian PES programs should be simplified. This would help to mitigate the problem of small farmers in proving the ownership of their lands, which could be done by other ways aside the property title, such as declaration of current and peaceful possession of the property and declaration of the neighborhood. Likewise, the contracts should be simplified, without many technical language, so the stakeholders can understand and discuss them.

Regarding the legal uncertainty and discontinuity of the programs, PES should be well thought before being implemented. Therefore, there should be public hearings, discussions and debates about the program and its contract with all parties involved. Tejeiro et al (2014) state that stakeholders become more satisfied with PES when they have been heard before and during its implementation. There should be space for posterior modifications, but they should not be about the main elements, such as the way of the transfer of resources.

In this sense, the public decision-making process would create legitimate decisions. The conflicts, uncertainty and discontinuity of the programs would decline because an alliance between the social actors involved would be formed, and they can trust each other. In addition, the communities would gain control over the instrument, both on theory and in practical terms.

In the Brazilian reality, farmers practicing sustainable production models can be seen as partners and inspectors of the environmental quality of the program. Thus, it is essential that no breach of trust happens between them and the managers of the PES program through contractual noncompliance or changes in the rules after its implementation. A PES program initially well-designed aligned with the local socioeconomic reality will not require major subsequent changes (Tejeiro et al, 2014).

In addition, for a new, more efficient and fairer model of PES, it is important to understand that Brazil has a diverse range (in spatial and temporal terms) of ecosystems and therefore the condition to cultivate different food crops. This is because the country has a vertical position on the globe, spanning multiple ecoregions and biomes,

meaning that a wide range of crops, especially traditional ones, can be cultivated.

Thus, the rules of PES should strongly encourage the adoption of principles of agroecology, leaving the particularities open for each contract to reflect the local reality. These specificities may include the profile of the beneficiaries, the duration of the contract, the possible forms of monitoring, and the schedule that will be followed. Also, it is necessary that PES schemes integrate other regimes of rural development (Muradian et al, 2010).

6. Conclusions

Agroecology is seen as a more sustainable model of agriculture not only for the environmental protection it generates, but also due to the recognition and appreciation of the fundamental role performed by traditional farmers. Thus, agroecology produces environmental services provided by the Brazilian legislation, such as protecting water resources and traditional knowledge.

On the other hand, the current Brazilian PES programs by reflecting the dominant environmental economic model, Environmental Neoclassical Economics, are not being successful in promoting agroecology or any sustainable agroecosystem. From a literature review and an analysis of reports of PES case studies in Brazil, it can be concluded that current Brazilian PES programs do not reflect the interest of the values of agroecological farmers. It was found that all the problems identified in such studies are linked and can be synthesized in three characteristics of the programs: they 1) are mainly monetary; 2) involve outside private capital, and 3) are applied with a fragmented view of reality, not taking into account socio-environmental issues.

Within the complexity of the rural Brazilian context, it has been proved the need for an evolutionary adaptation of the current PES system in order to reflect the interest of the values of sustainable farmers, such as agroecological farmers, aligning land use decisions with social interest in management of natural resources. Therefore, PES should have its foundations altered, migrating from an economic basis to a socio-environmental basis. Doing so, the potential of PES for protecting the environmental whilst boosting social welfare would increase considerably.

PES must have its theoretical-ideological basis reformulated. Making a transition from Neoclassical Environmental Economics to Ecological Economics as the theoretical foundation of PES is essential for public policies in this matter to promote agroecology in Brazil satisfactorily. As consequence, the current model of payment for environmental services can be reformulated bringing a new model that follows agroecological principles and transcends mere pricing of nature and the market logic. In practical terms, this means that PES should be mainly non-monetary, public and based on a systemic view, prioritizing socio-environmental issues over the economic ones.

Evolution of economic models is a large historical process, which should be based on a necessary large civil society debate, political negotiations and ruptures. Proposing economic model's transitions might be seen as a utopic issue. However, it is part of science responsibility to investigate directions to improve humanity adaptation to current global challenges, as climate change, biodiversity degradation, etc. Researching about the mechanisms to understand how to develop conditions and paths for this required evolution must be encouraged.

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