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# Strengthening Tradition, Innovating: Peasant contributions to technological innovation for sustainability

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## ABSTRACT

OBJECTIVES:
We face an important challenge in collaborating with communities to use state of the art science and technology that will also permit them to use their own capabilities and knowledge as part of a process to strengthen their communities on many different levels: political, social, productive, cultural and environmental. As social scientists, we join this effort from the paradigm of Ecological Economics (Barkin y Rosas, 2006; Burkett, 2006), a heterodox advance guided by three ethical principles: intergenerational equity, social justice, and sustainability. Its implementation requires methodological innovations that assure consideration of solutions to the aforementioned challenges in an interdisciplinary way, with a pluralistic approach, and with a historical perspective that takes into account cultural, material and environmental heritages. An integral part of this method is the incorporation of the "Precautionary Principle" that privileges productive processes that avoid social and environmental risk in contrast with orthodox systems that try to measure the relation between benefits and costs, selecting those results with the highest return (Reichman y Tickner, 2002; Harramöes, et al., 2002).

The proposal incorporates innovations using well known or state of the art scientific and technological advances that can enhance traditional capabilities in the communities, raising productivity in traditional activities or contributing to introduce new activities consistent with social and productive structures that also help to protect or rehabilitate their ecosystems. The point of departure for this proposal is the combination of different forms of knowledge that permit the users to better protect their societies from the homogenizing and most destructive effects of globalization; in the practice of the European Union, this current is known as "Post-Normal Science" (Ravetz, 1996; Funtowicz y Ravetz, 2000).

METHODS:
The implementation of this proposal implies a series of modifications in economic analysis of great import. One of the most significant is the rejection of the common practice to "discount"

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the future, that is, to value future benefits as if the sacrifices from present investment will always produce welfare improvements; in contrast, in our view, the use of resources and the decline in environmental quality will (inevitably) lead to a fall in living standards for future generations. Rather than discounting future flows, some even consider a premium for environmental protection or reductions in non-renewable resource use or even in renewable resources to a rate consistent with their replenishment. Other basic elements in the methodology that affect the methodology include: the consideration of social conflict as an integral feature of social behavior and the need to construct institutions for conflict resolution; the consideration of the contradictions of energy use as a permanent characteristic of the open system of which the economy is a part (II Law of Thermodynamics and entropy); the inability of society to replace natural resources consumed in production (now or in the past) with produced capital, thus rejecting the thesis of weak sustainability used my most economists in favor of the stronger version; the recognition of the need for social and political participation in decision-making about strategic routes, a process that denies the unquestioned right to property holders to decide on the use of natural resources and real property irrespective of their socio-economic and natural impacts; and, finally, an inability to value natural resources and processes.

RESULTS:
The approach suggested by the methodology outlined above is designed to promote strategies that lead to the “Sustainable Management of Regional Resources.” Its basic principles are: Autonomy, Self-sufficiency, Productive diversification, and Sustainable resource management. These strategies are drawn from an ongoing interchange with the participating communities, leading us to implement projects that respect their structure of social and political organization, and their relations with their ecosystems.

The means by which we apply this approach depend on available knowledge for the use of the local resource base and the priorities set by our collaborators. All the projects have various facets: economic – producing goods that enjoy privileged access to protected or solidarity markets; environmental – conserving or rehabilitating ecosystems; and social – with elements that privilege gender equality and strengthen traditional authorities.

Among the projects in which we have advanced are: 1) The production of ‘low-fat’ pork on the basis of a modified diet that uses waste avocados that were formerly discarded in local ravines. Local informants led us to discover that avocados reduce ‘bad’ and raise ‘good’ cholesterol, allowing us to transfer this insight into a process to benefit women responsible for backyard production. 2) The production of enriched ‘Omega-3’ eggs to improve their nutritional and health impacts in consumers on the basis of enriching the diets of hens with an herb rich in this fatty acid, requiring the construction of a sewage treatment plant to supply water for the feed. 3) The water treatment plants themselves led to the discovery that disposable diapers have polymers that can be used to regulate water supply to fruit trees, improving their survivability. 4) The discovery of the value of the mulberry tree in temperate forests and their historical importance led us to propose a project to ‘rescue’ a millenarian tradition of production of silk thread in indigenous communities. 5) The environmental, cultural and economic value of perennial cotton offers important prospects for diversifying and strengthening communities in the western mountain range of Mexico where its production can be spread.

All of these projects reflect our efforts to elaborate on the development of a new theoretical framework to promote the Sustainable Management strategy described above. The paper will combine the analytical elements with the practical results to propose a new approach for advancing in the application of science and technology to promote social welfare.

## I. Introduction

This contribution explores and describes the epistemological contributions of peasant communities as part of their efforts to develop their alternative strategies for technological innovation that emerge in response to those imposed by the orthodox approach to economic rationality. This exploration emerges on two different, but complementary, analytical levels. First, it draws from fifteen years of experience in numerous rural communities committed to initiating processes to construct a *New Communitarian Rurality* (***NCR***). On the basis of this experience, we have developed an analytical model that identifies a series of strategies that successfully challenge orthodox approaches to the social appropriation of nature. Among these strategies, the concepts of communality, autonomy, self-sufficiency, political-cultural structures, support networks, and productive and market diversification, among others, contribute to the *orientation* of the processes of technological innovation towards the emergence of a new rationality and a different process for appropriating surplus. Similarly, the work identifies not only the importance of local knowledge systems to contribute conceptual capacities that complement those that play a role in the development of western science, but also, and more significantly, its contribution from the perspective of an ethical stance alternative to that of economic rationality.

A second level highlights the contribution of these peasant *praxes* as the underpinning of the epistemological developments that given substance to the methodological criteria of two emerging fields related to "technological innovation for promoting sustainability": *ecological economics* (***EE***) and the *new culture of water* (***NCA***). On the basis of this analytical symbiosis a common epistemological line articulates the ethical principles of peasant *praxis*: the fundamental need to develop alternative mechanisms for allocating and distributing resources as well as the use of differing languages for valuing nature (Burkett, 2006; Barkin 2008; Martínez Alier, 2007).

Finally, on the basis of the symbiosis among the processes of the ***NCR*** and the methodological contributions from ***EE*** and the ***NCA***, we can identify the importance of the technological innovation processes for advancing towards sustainability: the articulation of social responsibility (intergenerational equity, social justice) and environmental responsibility (sustainable regional resource management). In this sense, the analysis highlights the emergence of *community associations* (communality) as alternative/complementary mechanisms to those operated by the *market* and by the *State* for resource allocation and the development of technological capacities, including the orientation of technological innovation. The unfolding of this type of reorientation of the innovation processes is only possible if they are embedded in mechanisms for non-capitalist accumulation, that is, based on collective decision-making (Barkin y Rosas, 2006). This approach presupposes the possibility for developing technological innovation on the basis of other rationalities, those that make possible the forging of other worlds.

**II. Peasant experiences and innovation: Alternative orientations of economic rationality**

On the basis of neoclassical economics, science and technology have developed as important instruments for raising economic growth, independently of whether it promotes or inhibits the advance of social and/or environmental well-being; that is, against sustainability. In this way, the objectives of the policies adopted to promote technological innovation generally are accompanied by the idea of "assuring national economic growth." In this conventional way of thinking about technological development, it is taken for granted that research is oriented towards increasing productivity to improve competitivity, thereby contributing to surplus (profit), as the basic elements needed for economic progress. This behavior is in accord with the new rules and institutions imposed by the globalization process (Dutrénit, *et al.,* 2007)

To strengthen the process, the economic system places the market at the center of the process, "a more efficient" mechanism for distribution and for the allocation of the resources generated by the innovation process. Of course, this is the explanation for the nature of the market-oriented structural reforms implemented in Mexico during the past three decades and intensified with the adoption of the package of policies known as the "Washington consensus (Katz, 2007). As a result of this logic, policies promoting innovation followed this same direction, and were justified with the discourse of taking advantage of "opportunities offered by economic globalization"; "competitivity", "profitability", and "modernization" became the watchwords of capital.

The framework is composed of the following elements: 1) needed investment in technological innovation → b) higher productivity → c) rising profits → d) use of markets as a mechanism for distributing and allocating resources → e) need for greater technological innovation to respond efficiently to the demands of the "globalized" marketplace. This hegemonic vision of the direction for technological innovation is called the "orthodox discourse" in this article.

The relationship between innovation and sustainability in the orthodox discourse is justified in order to develop natural resource management strategies that inherently and structurally concentrate economic benefits in the hands of a few at the cost of transferring the costs to society (social exclusion) and nature (raising the rates of entropy and ecological resilience). This is even occurring in the innovative processes defined in the 'global north' by the "catechism of ecoefficiency" and the "dematerialization of consumption", as is pointed out by Martínez-Alier (2004).

The point of departure for this analysis of the accumulation model is the evidence that it generates effects (socio-environmental costs) that cannot possibly be considered to be universal values of sustainability. An even worse fate is facing the rural communities in Latin America where structural obstacles that accentuate these costs, heightening inequality, threatening cultural and biological diversity in many regions. It is clear that scientific developments are generating conflicts between research results and consumers' needs; thus, it is essential to include ethical questions raised by an outsider. The separation of questions about the ethics of science and technology activity is directly related to environmental problems (global warming, air pollution, and land and water contamination, etc.).

In contrast to the direction of innovation activity guided by the principles of neoclassical economics, this article focuses on describing and exploring the epistemological contributions generated by those communities immersed in the processes of ***NCR***. Specifically, their contributions do not only include the conceptual developments known as "local knowledge systems”, but also consist of the incorporation of innovation processes guided by the principles of *social justice, intergenerational equity*, and *sustainable regional resources management*.

As a product of this focus from the perspective of peasant communities, technological innovation is being reoriented towards the community (rather than the individual); to development (rather than growth); and to efficiency in natural resource use (rather than the efficiency of capital).

## III. Empirical points of reference and strategies of the new rural communality: Forging sustainability.

### 3.1. Some peasant experiences.

Technological innovation has an important place in the productive projects on which we have worked with many communities. In what follows, we highlight some of the practical experiences in peasant communities, on the basis of which we have developed an analytical model that facilitates the understanding of the communitarian strategies. We have labeled those communal strategies that challenge models of economic rationality the new communitarian rurality (Barkin, 2004; Barón 2004; Santiago 2004; Fuente y Ramos 2008). Some examples:

- The attempt to construct a peasant biosphere reserve in the Chimalapas. The local indigenous community (*Zoque*) attempted to manage the area, channeling resources for community sustenance. It undertook a program for the professional training of cadre as biologists to collaborate with foreign collaborators interested in studying and protecting the region’s biological diversity and as forest and water management experts and as fire fighters to protect their ecosystems. They undertook a selective program of planting tree nurseries for valuable and/or rare species declared to be in danger on extinction while also implementing an ecotourism program. These community achievements were not easily implemented, but were managed for more than a decade with support from domestic environmental groups and financial assistance from the English government; these efforts were unceremoniously terminated when the Mexican government forbade the UK from continuing its technical assistance and scholarship program and a local environmental group disbanded (Barkin, 2004).
- Local experiences on the Isthmus of Tehuantepec. The deepening process of social polarization has prompted many communities to build alliances among themselves too strengthen their ability to take advantage of the potential for local projects based on natural resource and river basin management programs, supported by a cooperatively owed (and managed) cement manufacturing plant in the region. The program includes an ambitious program to rehabilitate local river beds and forests as well as land and water management projects, with which they have begun to generate new employment and productive opportunities for export agriculture and handicraft activities (Barkin, 2004).
- The revaluating of traditional productive systems for hog raising has had important effects in strengthening *Purhépecha* communities in the west-central state of Michoacán. On the basis of local vernacular knowledge and a controlled experiment involving a medical research center, a nutritional research laboratory, and in-depth social science study, a pilot program involving a special diet for the pigs, involving non-commercial avocado, was implemented to produce “low-fat pork” with significantly lower levels of low-density cholesterol than regular supplies in the region. By designing a production system in the back yards of local families, the scheme strengthened communities by assuring local participation and raising household incomes for the

participating families. The high quality of the meat allows it to be sold at a substantial premium over prevailing local prices (Barkin, 2001).

This productive experience was implemented on the basis of exhaustive collaborative research, involving a number of disciplines and direct collaboration with the communities. As a first step, a traditional activity in the communities was identified: the raising of backyard animals; the field work also was useful in making it clear that many people in the community were already aware that grazing pigs in the avocado groves inhibited the production of solid layers of fat in the animals, but they had not realized that this might be transformed into an opportunity, given the growing consciousness of the health advantages of a lower fat content in meat; our laboratory work documented the lower LDL cholesterol levels and the higher quality of the fats, in terms of benefits to human nutrition. Our multidisciplinary team determined the feasibility of developing a diet to produce high-quality product with greater added value, designed to contribute to broader community efforts to strengthen and diversify local economies and improve women's position, since this activity is in their sphere of responsibility.

- A proposal to promote the production of enriched eggs (replacing Omega-9 with Omega 3 –a fatty acid that contributes to human health– in the yoke) in periurban areas was developed as an activity to address environmental problems, generate higher incomes and strengthen communities, promoting better social and material conditions. This project was designed on the model of the "low fat pork" project described above, in spite of the fact that the large industrial poultry firms are presently marketing this product. The challenge in this case was to reduce production costs while assuring (or raising) prevailing quality standards, insisting on the goal of strengthening local economies and the role of women in production and governance. The projects are similar in identifying productive activities in which women have ample experience, and are proving adept at incorporating the results of modern technological developments to develop high value added products.

  In this regard, the technological innovations had to be accessible. To ensure this, the organizing team incorporated colleagues from various research institutes; these included the National Institute of Medical Science and Nutrition Salvador Zubirán; the Teaching, Research and Extension Poultry Center and the Chemical Research Institute of the National University; the National Agricultural University (Chapingo); and Universities in the nearby states of Tlaxcala and Puebla; we also have signed an agreement with a major international media consulting firm to design the educational and marketing strategy to inform the public about the benefits of these products. The enlarged team accepts the underlying premise that the objective of this work is the implementation of the ethical principle of technology transfer to raise social welfare (human development); among other implications, is the joint commitment to create social enterprises controlled by the participating communities.

These projects, and others that to which this methodology is being extended, are evidence of the application of "post-normal" science, whose premise is the need to take people into account in the design and implementation of proposed solutions. This commitment also assumes the responsibility to incorporate their paradigms and specific knowledge systems in the design process and to ensure their participation in the search for solutions. The technological synergies among paradigms and knowledge systems have been crucial in the success of these projects, but a crucial difference in comparison with NGOs and multilateral organizations has been the ethical component: the building of a model of sustainability on the basis of social and environmental responsibility. That is, the implementation of a process to ensure the success of a model of New Communitarian Rurality.

### 3.2. New Communitarian Rurality: A response to neoclassical economic rationality

In the face of persistent attacks from the global economy, with its logic of the rational actor, peasant responses have been varied and complex. Analytical frameworks have also been reorganized to attempt to take into account these changes in strategies among peasant groups (Barkin 2000, 2001; Teubal 2000). Since the objective of this essay is to identify peasant responses and their innovation processes as reactions to national and global international economic restructuring, this section describes four transformations that occur simultaneously in the rural society (Figure 1).

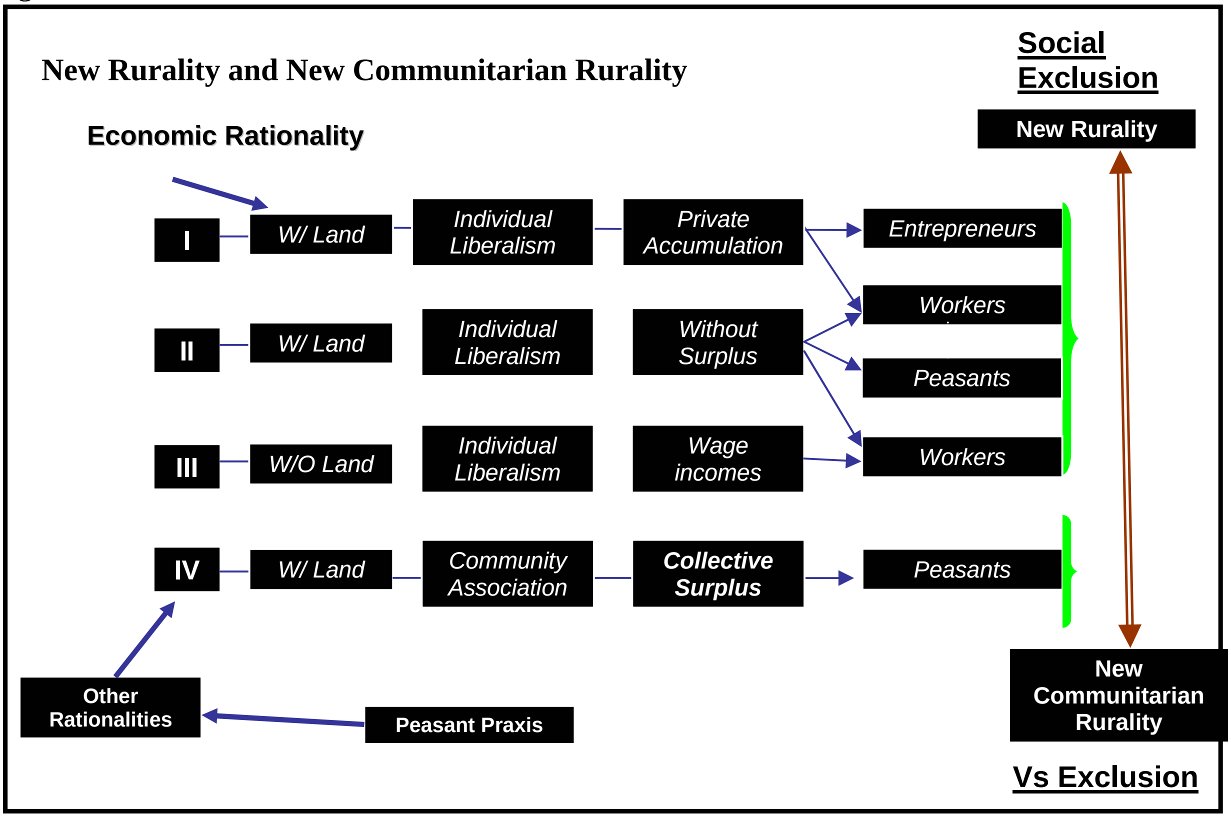
I. Peasants with access to land and have the means to engage in technological innovation, promote private accumulation;
II. Peasants with access to land, but without strategies to promote innovative technological strategies that promote private accumulation, are relegated to subsistence production and must resort to outside sources of wage-labor to complement their incomes;
III. Landless peasants or those who have lost their land rights who only have their wage labor as a source of income are without innovation strategies;
IV. Peasants with access to land and with social organizations based on communal associations that promote technological innovation combined with strategies that generate economic surplus and concentrate them in the hands of the community leaders.

Farmers who are in the first (**I**) group and can adapt to the demands of the dominant economic model constitute the “ideal type” for rural development of a neoliberal pattern. This model faces structural limits to create a pattern of inclusive development; it generates inherently proletarianization (as is the case of types **II** and **III**). As a result of the need to generate the highest possible profits in a highly competitive market, many situations led to specialized monocultural production with intensive use of chemical inputs and direct ecosystem exploitation as a prerequisite for its continuity. Therefore, we see an increase in the scope and intensity of distributive environmental conflicts.

The type **I** processes, and most especially those of type **II** and **III**, are identified in this article as inherent tendencies in the “New Rurality” project emerging from international economic integration (globalization). In contrast to these responses, there is another type of peasant responses that unfurled as alternative routes to that of economic rationality; these have been assembled in the scheme as type **IV**, as part of the process of the “new communitarian rurality.” This approach constitutes a reference group from which we try to define the role of **EE**, since these processes of the social appropriation of nature propose to achieve an equilibrium between social and environmental responsibility.

As becomes evident, this is a problem of the “articulation” between the “peasant mode of production” and the “capitalist”, between economic and peasant rationalities. In the next section, several different strategies are examined that allow for a valuing of this type of interaction as processes that challenge the logic of capitalist accumulation and promote new mechanisms for technological innovation to promote rural sustainability.

Figure 1. Transformation processes and responses by rural actors in the context of economic globalization.




Source: Fuente (2007)

### 3.3. New communitarian rurality strategies for promoting technological innovation

Barkin and Toledo offer analytical guidelines for understanding the aforementioned interaction between peasant rationality and the processes of incorporating local knowledge systems in the developing an alternative process of technological innovation consistent with sustainable resource management. Barkin (1998) distinguishes four principles for forging sustainability: 1) autonomy; 2) self-sufficiency; 3) productive diversification; and 4) integrated regional natural resources management. Similarly, he recognizes especially the leading roles of peasant practices, which are becoming increasingly important in Meso-America, to challenge the exclusionary character of economic globalization (Barkin y Barón 2005).

On the basis of his detailed studies of eighteen peasant experiences, Toledo (2000:77) highlights five aspects that are essential parts of a strategy for the social appropriation of nature: 1) the defense of traditional cultural values; 2) the maintenance and/or reproduction of the communal structure base on equity among members and a consensus developed through the community assembly; 3) high technological and administrative efficiency; 4) collective control of economic processes and exchanged based on a degree of 'productive equilibrium'; and 5) conservative use of natural resources.

By taking these authors as a reference and the experiences mentioned in the previous parts of this paper, an analytical model is offered which formulates a strategy for rural communities in the process of alternate forms for the social appropriation of nature that challenges economic rationality. The central categories of this model are based on the articulation of the ideas of *communality*, *autonomy*, and the *integrated management of natural resources*.

*Communality* represents a type of “social contract” of communitarian association, a heritage from the Mesoamerican cultures of a past era (Díaz 2001, Martínez 2002); it represents an ethical perspective that differs from economic rationality for resource allocation, in the processes for the social appropriation of nature, and, necessarily, for technological innovation. In this sense, community is not the joint representation of the individual over collective interests as occurs in the orthodox idea of the “social contract.” It is not understood as “a contract where each one protects his own individual interests; on the contrary, if the political association doesn’t protect him, he feels fully justified to oppose it because I accepted the contract in terms of my personal interests, and if I feel it is not fulfilling the arrangement, I can refuse to continue” (Villoro, 2003: 48-9).

It is possible to interpret the experiences of peasant practice mentioned above as a social contract “since I am defending the common welfare through a consensual arrangement; although it may go against my individual interest, I will continue to be loyal to the majority… democracy is, in this second type of contract, a type of political association that is, at the same time, an ethical agreement, because it is the way an ethical public group functions” (Villoro, 2003: 48-9).[4] The model of new communitarian rurality, outlined above, is an institutional process incorporating local knowledge systems to understand peasant responses in the face of *exclusion* generated by neoliberal economic expansion. The result is a growing institutional capacity to maintain (produce and reproduce) an alternative system of social relations of production to that of proletarian discipline, so generalized in the rest of society.

<u>These strategies to forge sustainability bring together the following common processes:</u>

3.3.1. Communality may be understood as a communitarian ethos, a participatory process that is central for resource allocation. The results depend on four separate processes:

- **Cultural cohesion**, nurtured by spiritual and religious practices as well as the ritualization of the past in the present, the codification of cosmovisions, and ties to the land;
- **Participatory or consensual democracy**, deepened by the daily exercise and defense of the general (or citizen) assembly, backed up by asserting its traditional importance and various supervisory and regulatory groups. It offers an important counterweight to the elected figures from institutions of formal or representative democracy that shape local or municipal governments and define its authority. It emerges as a way of reducing the tendency to concentrate political power and breaking its links to economic forces. This mechanism is furthered by processes of selecting people for these positions on the basis of prestige, acquired through community participation. The absence of political parties in this dynamic is another element that further participatory democracy;
- The organization of **community work**, expressed as the group of activities realized and ranked by community members. Among these are: the decision making assembly;

[4] For a longer discussion on “Multicultural Autonomies in Latin America” see the material produced by the project directed by Leo Gabriel and Gilberto López y Rivas (2005 y 2008) and their site: http://www.latautonomy.org/

coordination positions; voluntary labor for community infrastructure; and the *fiestas* for community events and pleasure (Martínez 2002);

- **Territory as a refuge**. The physical space is not only necessary as a place in which to solidify social cohesion based on the "commons", also defined in cultural and historical terms (as is defined in terms of the communal property status of land tenure) but also as a living space, a place for life and for local forms of progress; it becomes the venue for applying local knowledge and for inventing new methods, for experimenting with the possible utility of new technologies, for new uses of natural resources and new ways to protect the ecosystems, as a place to exercise and strengthen political autonomy.

3.3.2. **Autonomy** is a process for the production and reproduction of the communitarian ethos as distinguished from the market forces and others operational forms of the neoliberal State. Autonomy emerges from the local community, but can only be effective as it takes shape through regional alliances. Its operation depends on the interaction of four mutually related processes:

- A political-cultural nexus from which a political network is shaped to tie communities together and then to relate them to governmental institutions, especially at the state and federal levels. It is in this space that political relations –be they subordinate, resistance, or of autonomy– manifest themselves. In this sphere connections are made between political culture and civil society; they are reflected in structural relations as opposed to cultural or intercultural-multicultural relations (Otero 2006);
- The formation of **support networks** involves the interaction of the several levels of civil society with educational institutions and those promoting technological development. In this vein, some work by ecological economists is based on the premise that these activities must be integrated with that local community organizations and producer groups. This is based on the examples offered in Section 2, above.
- **Food sovereignty** is the result of production and supply strategies as well as the intensity of production. It is a complex and polemical process, as warned in Barkin (1998), closely tied to the moves towards international economic integration that promotes a move towards monoculture, based on an intensive use of inputs – energy and virtual as well as real water;
- The **development of community productive forces** were technological development occurs in an environment in which there are differing degrees of technological appropriation and a effort to promote productive diversification. The purpose of integrating technological innovations would be to promote productivity improvements and generate greater 'commercial value' by extending the productive chain to create greater value added, as in substituting timber extraction for furniture production systems;
- **Surplus production.** A broad range of activities which can be included in a model of "multifunctional" production would also promote the diversification of the economic base in the spheres of marketing and exchange (Giarraca 2000). The degree of integration or lack thereof with processes of capitalist integration and accumulation determines the ability to attract finance. For example, migrant remittances might or not contribute to productive diversification or community activities, depending on the measure of communitarian ethos achieved; that is, to be a part of the process of capitalist accumulation or to contribute to the generation of non-proletarian surplus (Barkin y Rosas 2005, Rosas 2006). With regard to the

search for alternatives to the problems related to market fluctuations, the participants have created significant strategies for fair trade based on solidarity markets (Cadena 2005).

3.3.3. The **sustainable management of regional resources** is one of the central themes for the academic debate because of the complexity of integrating spatial and temporal valuations: ecological values on the one hand, and socio-economic ones on the other. The approach using the social metabolism – one that has become quite common in Europe – has contributed to this analysis. There are several proposed methodologies to formulate indicators and attributes than can be valued and evaluated, such as that known *MESMIS* (Masera *et al.* 2000; Oyama y Castillo 2006). These methodologies allow the researcher to identify and differentiate diverse community strategies by "extended peers" (as proposed from the perspective of "post-normal science" in Funtowicz y Ravetz 2000) and compare them to those offered through basic research (Toledo 2006). Among these we find:

- **Land zoning**: communitarian, micro-regional, municipal and regional.
- **Restoration**: Habitats, communities, biological populations, genetic pools.
- **Conservation**: Landscapes, habitats, communities, biological populations, genes.
- **Exploitation**: Extraction, fisheries, forestry, livestock, agricultural

## IV. Principle methodologies for the study of technological innovation in rural societies committed to sustainability.

The conventional work on science and technology development within the framework of the orthodox literature presupposes an approach to the valuation of nature on the basis of the monetary prices derived from prevailing market prices; as a result, it has become acceptable to quantify and price environmental services. Furthermore, on the basis of the allocation and distributive languages of this paradigm, practitioners have no difficulty in measuring the benefits and costs derived from market operations for evaluating alternative strategies; these measures are based on the unquestioning acceptance of the postulates of neoclassical economic theory. This position identifies the market as the most efficient allocation mechanism, one that can regulate itself, so that it minimizes social interventions. The model is highly regarded by the dominant science, not only because it offers causal explanations not only about natural resource management and judgments about alternatives, but also about scientific and technological development for this sector. This evaluation has shaped the analysis of this section, which starts from the premise that this model has contributed to heightening inequality and threatening social justice struggles, accelerating environmental degradation and placing cultural and biological diversity in greater danger than ever.

As an alternative, this section suggests the need to construct a proposal based on different premises and epistemological principles. If offers a different valuation system, based on other methodological criteria, in a search for social processes of appropriation of nature consistent with the principles of sustainability rather than the demands of capital. In this vein, a synergy is suggested between the fields of EE and the NCA, leading to a different methodology.

### 4.1. Contributions from Ecological Economics: Towards a new understanding of sustainability

#### 4.1.1. The quality of information.

There is a broad acknowledgement of the limits of the orthodox approaches to science (normal, in the Kuhnian sense, or positivistic) and technology for the way in which they manage uncertainty, and therefore, decision making with regard to problems related to environmental risk occasioned by the social appropriation of nature. Since the priority for orthodox analysis is the increase in productivity, the quality of information is disregarded but is a serious obstacle for objective evaluations in other paradigms. This limitation emerges clearly from several concepts and methodological criteria derived from EE, among which the following stand out:

- *Post-normal science*. This new approach to integrating knowledge systems recognizes the need to incorporate a community of "extended peers" (people outside the formal academic and research circles) in the evaluation of "the scientific inputs for decision making" (Funtowicz y Ravetz, 1994). This is crucial in the Latin American context, given the abundance of local knowledge systems evident in those communities that are creating their own strategies challenging the dominant logic that purports to evaluate and constrain environment destruction but not to reverse it (Barkin, 1998).
- *The Precautionary Principle*. This principle asserts that is in insufficient to define the viability or validity of a project on the basis of short–term economic criteria, tied to environmental policies based on command and control and market based instruments. This Principle calls for an integration of the culture of environmentalism with means to protect civil society from the risks that pose a threat to human and ecosystem health, be it from disregard or just plain ignorance. It introduces the need for the valuation of the impacts of development projects where the possibilities of damage are uncertain: they should not be permitted or, in the best of cases, allow only those where risks are clearly identified and are indispensable for satisfying an essential need, and are ratified by a democratic process (Harremoës, *et al.* 2002; Riechmann y Tickner, 2000).
- *Multicriteria analysis*. As a methodological proposal, this contribution obliges the questioning of benefit-cost analysis that reduces decision making to a single monetary denominator and an economic calculus based on pricing criteria. The alternative challenges monetary valuation techniques for goods and services as insufficient, and highlights their incommensurability with other valuation methods based on indicators of human and ecosystem health and related to the very survivability of particular social groups or entire species (Munda, 2004).

#### 4.1.2. Biophysical aspects and environmental units.

The biophysical criteria for analysis make evident the complexity of the ecological-economic system. While the (economic) orthodoxy sees nature as an input into the productive process, one that produces rents, EE perceives the biophysical dimension as a complex system, one that must be fully incorporated into the analytical scheme, since human activity is constantly appropriating it for its own benefit.

When viewed in the light of the *precautionary principle,* these aspects make it clear that the *thermodynamics* and *homeostatic* processes place strong limits on the model of economic growth generated by the dominant market paradigm. These considerations also suggest methodological tools that can be used to reconsider the appropriateness of various tools commonly used to make judgments about policy proposals, technological innovations or project designs: two of the most common, the *discount rate* and the *optimal rate of contamination*, can be strongly questioned from this perspective. Similarly, it becomes evident that time scales themselves differ strongly among paradigms, since the market rationality strongly discounts the future and the EE approach is directly concerned with constraining present day actions to ensure the viability of systems for future generations; thus, considerations about the "appropriate" rate of extraction of natural resources (mining) are radically different when evaluated with market criteria or from the perspective of biogeochemical factors in geological time.

- *Second Law of Thermodynamics* (*entropy*). In its simplest for, this Law addresses the problem of the degradation (becoming less useful, less ordered) as energy is transformed. Nicholas Georgescu-Roegen (1976, 1994) formally incorporated this problem in economic thought, updating previous formulations from XIX century thinkers, and thereby revolutionizing thinking about the possibilities of unlimited economic growth by pointing out that the process inherently contributed to the degradation in the quality of natural systems. This formulation, transforming the inherited model of a closed economic system into a part of a much larger open system from the point of view of an essential element –energy– has become a fundamental premise of all considerations about the environmental impacts of social activity.
- *Social metabolism* is another significant concept for thinking about sustainability and natural resource management among Latin American scholars (Toledo, 2008; Martínez A., 2007). This idea bring into the analysis a series of criteria to evaluate the economic system from the point of view of energy and material flows and their cycles, further reinforcing the notion that the production itself is an *open system*. The recent introduction of the concept of *virtual water* into economic analysis is a reflection of its importance (Allen, 2003).
- The i*n-substitutability of natural capital for socially produced capital* highlights a fundamental contradiction in the two paradigms. This paradigmatic axiom is fundamental, since it leads to the realization that many natural processes (including entropy itself) are irreversible. The idea that resource exhaustion need not be an insoluble obstacle to economic progress leads to the presumption in prevailing thought that scientific advance and technological innovation have proved capable of finding substitutes among materials or replacing natural resources with man-made artifacts; it then makes the assumption that this can continue into the future, an idea labeled technological optimism and rejected by the EE. From this distinction, a conceptual difference between *strong and weak sustainability* underlies some of the debates between the paradigms; the i*n-substitutability* referred to in this paragraph, then, suggests strong limits on the use of economic instruments in guiding the behavior of actors, given the significance of the risk factors highlighted by the precautionary principle and the lack of effectiveness of the command and control measures implemented in present-day environmental policy measures. [5] Thus, for example, in the frame of reference of *weak sustainability*, when confronting the problems of contamination a favorite formula is to use the "polluter pays" principle, an

[5] The Mexican case illustrates this problem well. The Law for Ecological Balance and Environmental Protection (LEEGPA) refers to the use of economic incentives to "promote changes in the behavior of people who engage in … activities so that their interests are compatible with collective interests for environmental protection and sustainable development… Or for persons "who make incorrect use of natural resources or modify ecosystems, they must assume the appropriate costs." An academic exercise to construct such economic instruments can be found in Ávila *et al*. (2003).

approach rejected in most cases by EE, since in many instances this behavior occasions irreversible damage, once the *thermodynamics* and *homeostatic* properties of the ecosystems are considered; of course, this is also the case with impacts on human health, to people who cannot be adequately compensated (rehabilitated, restored) by mere monetary payments. In these cases, the economic measures are not only insufficient, but they also generate greater inequality, social injustice and environmental degradation. An implication of this measure in environmental policy is the attempt substitute command and control measures (that have not worked well) for economic measures (that also do not work) (see Figure 2).

- *The unit of environmental management.* In the case of water problems, EE asserts that the appropriate unit for analysis is tied directly to the concept of the water basin or watershed, that also encompasses problems of forest and mine management. Because of this, it would also be ensure that any diagnostic be realized at an integrated basin level, to include all of the local actions involving resource management reflect consistency with regard to technical, logistic, political, and economic criteria. Thus, the directives and negotiations that take place within the Basin Councils, dependent on the National Water Commission (CNA) might prove to be a good point for departure; it would be difficult, however, to ensure the meaningful participation of the water users and water producers as well as the recognition of taking into account the interests of all types of consumers, including the environment itself.

#### 4.1.3. The limitations of water supplies: Users of and beneficiaries from the social appropriation of water: Distributive ecological conflicts.

The inclusion of *distributive ecological conflicts* in the discussion is another dimension of the problem of responding to the difficulties of responding to the contradictions generated by the orthodox prescriptions for natural resource management. Questions arise, for example: 1) How can we construct a model for natural resource management and design technological innovation policies that contribute to sustainability which also assures equity among users and social classes, given the broad historical and structural differences that characterize these people and the obstacles that have arisen that make implementation of solutions difficult. 2) What is the relationship between these differences and the preferred market solutions for the distribution of costs and benefits among those involved in trying to design solutions to improve the relation between society and nature?

At the center of the critique by EE of the orthodoxy of the economics profession is the matter of the origin and justification of the present forms for distributing income, power, property, and, in general, the ability to appropriate natural resources and their products. Similarly, there is the matter of the social and environmental costs involved with these forms of economic concentration and the resulting innovation strategies. From this perspective, it is clear the direct relation between economic and political power in the several levels of social organization involved in the social appropriations of nature and the processes of the accumulation of resources and capabilities for technological innovation.

### 4.2. Contributions from the perspective of the NCA: Water users and valuation languages

The NCA proposes a socio-economic-political-environmental relation oriented towards a new scale of languages of valuation of water. It is based on the assumption of the need for the democratization of water management, and especially distribution, for social participation in its administration, and environmental responsibility as its guiding principles. From this perspective, priority is accorded the resolution of distributive ecological conflicts as a central task and obligation of political activity, reflecting the criteria of intergenerational equity, social justice and environmental responsibility. This is the essence of the European Framework Directive for a NCA (2005) that establishes priories for the following uses of water: 1) Water as a human right; 2) Water for ecosystems; 3) Water for social and communitarian uses; and 4) Water for economic development and social well-being. It also establishes penalties and controls for the illegitimate uses of water (see Figure 2).

Figure 2. Contributions of the New Culture of Water for Water Valuation

**Water Users and Languages of Valuation**

Human Rights ← ethical: equity, justice (free)
Ecosystem needs ← ethical: environmental (free)
For social uses ← ethical: equity, justice (free)
Econ. Develop. /Soc. Welfare ← economic instruments–cross subsidies

Illegal Functions ← Command and control instruments – public interest
Precautionary Principle

Source: GEEM (2007)

As we have developed these categories, the first three encompass social and environmental matters, clearly related to questions of intergenerational equity, social justice and environmental responsibility. Water as a human right refers to the establishment of a “lifeline” (South Africa) or “floor of dignity” (Chile) for basic consumption, that guarantees individual and collective wellbeing and should be granted free of charge; similarly, the volumes required to sustain subsistence agriculture would also fall into this category. At present, on the basis of the market paradigm, Mexican authorities consider that the lack of payment for water is one of the principal problems in water management. We believe, on the basis of the analysis offered here, that the solution for disarray in the water sector can not be achieved by penalizing the consumption of the minimum volumes that constitute the human right to water; rather, we propose a tariff structure based on an interdisciplinary vision that would make the social commitment written into the nation’s constitution.[6]

The *environmental use of water* seeks to guarantee the sound state of the ecosystems, taking account both their rehabilitation and their conservation. In this case, the ecosystem itself becomes a priority consumer. This also implies that the use of water by all the other consumers must not exceed the recharge rate of the aquifers. The third use, that of *social solidarity*, obliges the government to develop a new policy that guarantees water service for all public and urban services, including parks, hospitals, schools, community centers, etc. These include all public

[6] Civil society has displayed an interest in active participation in this approach. Evidence of this is the formation in 2006 (as part of the activities of the alternative World Water Forum) of the Coalition of Mexican Organizations for the Right to Water (COMDA) which is promoting the campaign “Water to the Constitution”. A legislative initiative was presented to Congress in 2006 to declare the access to water a constitutionally guaranteed right (see Cámara de Diputados 2006. http://gaceta.diputados.gob.mx/Gaceta/60/2006/dic/20061207-I.html#Ini20061207Lavara) .

service installations needed to ensure the availability of important collective needs and not provided for profit that contribute to social cohesion.

Water for economic development and social wellbeing is the largest category of all. It is here where we would classify those residential consumers what require more than the “lifeline” amounts mentioned in the first priority use; administered by the local water authority, this consumption would be charged through a rising block tariff structure. This category also includes farmers as well as industrial and service sector users, who use the largest volumes of available water, as part of their production processes to generate profit. On the basis of this division of functions, this water-for-profit segment would also be charged with the obligation to pay for the total cost of operating water and sewerage services, and also guaranteeing the appropriate measures for assuring the health of the nation’s ecosystems, through a tariff structure of cross subsidies at ensure respect for the principles of equity, justice, and sustainability.

Finally, it is essential to sanction and reduce the antisocial or frankly illegal uses of the aquifers and discharges of contaminated water. In addition to excessive withdrawals by people with concessions, there are many unauthorized wells in operation, as well as systematic problems of theft of water from the urban distribution network, among other problems. Another serious problem involves widespread violations of existing regulations for discharges; in spite of official campaigns to stem this practice, the problem continues to grow, by both private users and public authorities. In the face of this problem, the NCA proposes in reversing this trend at all costs with intensified supervision and, most especially, active public participation, to identify sources and the imposition of strong penalties (social, legal, and monetary). It is not enough for the firms to internalize the costs of the problems they are causing in society or to nature; instead, a new relationship must be developed with nature to permit the development of a sustainable water management system, one that takes into account the needs of future generations.

**By way of a conclusion: An analytical model for understanding peasant contributions to forging sustainability**

Peasant practices transformed into the New Communitarian Rurality are promoting a reorientation of innovation processes. This is a significant epistemological contribution, not simply a substitution of paradigms, since it goes far beyond the narrow discussion of the framework for formal science, so firmly entrenched in economic reasoning. Although there is a broad recognition of the role of local knowledge in developing technological innovation, it is not as widely documented with regard to how this reorientation affects technological innovation (Escobar, 1998; Wilmsen, *et al.*, 2008). The peasant contribution can be found embedded in their commitment to the valuation of the three ethic principles: *intergenerational equity*, *social justice*, and the *sustainable management of regional resources*.

Thus, their contribution –and the central objective of this paper– consists in providing alternative directionality to economic rationality for shaping innovation as part of the process for the social appropriation of nature and the ability to generate sufficient incomes so as to increase living standards. This implies the development of mechanisms for the redistribution of costs and benefits, the broadening of languages for valuing nature (many of them expressed in incommensurable non-monetary terms) as well as the incorporation and accumulation of capabilities at the community level. At this community level, technological innovation involves a reorientation that takes the following forms:

> Towards the community rather than the individual;
> To promote wellbeing rather then economic growth as a priority; and
> To favor efficiency in natural resource use rather than that of capital.

Societies work and orient their products of their innovation activity to improve their own living and working conditions: constructing and rehabilitating the social and physical infrastructure (water drainage, education, health, people's markets); food self-sufficiency, rebuild green zones and protected areas, promote 'popular' markets and local development, and social tourism. Looked at in this way, innovation is not promoted as lineal process in which a series of well-defined processes are systematized by the scientific community, but rather as a multifactoral process in which a broad range of knowledge systems –including local ones– are integrated into peasant practice. They produce various paths that permit leapfrogging stages of development and incorporating unanticipated contributions from other communities in this process.

From this perspective, peasant practice offers a contribution that replaces orthodox economic rationality as a generator of in-sustainability for another approach (an environmental one) that places into play power relations and its transformation through the communitarian associations. This can be understood in the way Enrique Leff suggests:

> …the transition towards environmental rationality would not be possible as a simple change in paradigm within the same scientific order. These theoretical and practical transformations can only occur through strategies involving transfers of power through knowledge, placing into play the role of the subject in theoretical development searching for knowledge (Leff, 2006: 35).

To understand the epistemological contribution of these practices to technological innovation implies appropriating community space in which specific social practices are not exempt from struggle, in which different actors take unequal positions with regard to the quantity and quality of scientific and technological *capital* that each one commands. The challenges offered by local social practices to the dominant rationality are those that are outside the spaces that 'science' has legitimated (recognized as paradigmatic or as 'normal science'): those represented by diverse peasant praxes. This is a common claim reiterated by Southern writers[7] and by diverse working groups (*v.g.,* Borrini-Feyerabend, 2004) that reiterate the importance of organized resistance and of communitarian organization, as evidenced by the experience of "Deep" Mexico in the face of the dynamic of international economic integration (Batalla, 2005).

In this article, we incorporate the idea of a *dialogue of knowledge systems* instead a disciplinary (inter, multi, or trans) articulation among them, to highlight the dynamic process involved in the construction of an environmental rationality. It is not simply a process that involves the formal production of theory, but also the social transformation that emerges from social praxis. Thus, the *dialogue of knowledge systems* differs from the orthodox posture of multidisciplinarity claimed by many NGOs and multilateral organizations; [8] that overtly confront the concentration of power

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[7] Including authors like David Barkin, Enrique Dussel, Enrique Leff, Víctor Manuel Toledo, Luis Villoro, and Hugo Zemelman, among others

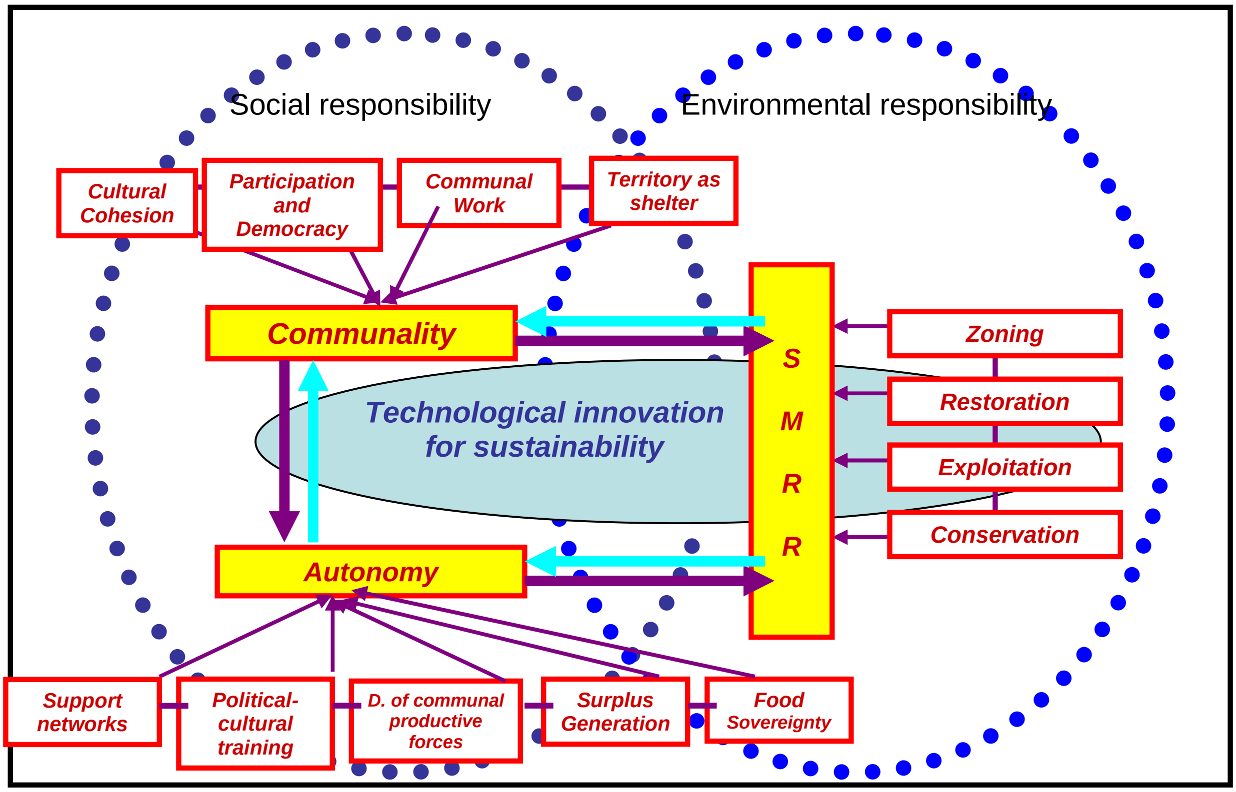
[8] An approach shared y other supporters of local development of technology, evident in many NGO declarations (e.g., CARE, Practical Action, o KIT) or official government development organizations (DFID, DANIDA o CIDA), many of which are documented in journals like *Development in Practice*.

by discussing the possibility of "negotiating" and "democratizing knowledge." The dialogue of knowledge systems, then, in the innovation process involves

> the recognition that different knowledges – indigenous, traditional, local– contribute their experiences and join with scientific and expert knowledge; *but also imply a dissent and break with a homogeneous path towards sustainability; it is the openness towards diversity that challenges the hegemony of a unitary logic and goes beyond the strategy of inclusion and participation of alternative visions and several rationalities…* (Leff, 2004:326, emphasis added).

In general, from these epistemological sources (EE, NCR, NCA) it is clear that many peasant productive activities are better designed to be sustainable because of the closer ties of their resource base; they also frequently require less total energy and more egalitarian in results than activities organized by capitalist organizations, where results are measured simply by monetary profits. The question at hand is whether these initiatives can offer economically viable alternatives capable of challenging neoclassical economic rationality in the medium and long terms. Environmental sustainability must be combined with an ability to generate economic surplus, an ability that must emerge from social practice and from complex learning processes involving interaction with the capitalist system and its contradictions and use it for improving social and environmental well-being, something that is possible within organizations that are cognizant of the importance of collective decision-making in avoiding the pitfalls of unquestioned integration into the dynamics of the market. The improvement in the "terms of trade" (including the use of fair trade), productive diversification, technological innovation with an ethical component, are at one and the same time cause and consequence of the realization of the need to forge a new environmental sustainability by the communities immersed in the new communitarian rurality.

**Figure 3: Building sustainability: Social and environmental responsibility**




**Source: Formulation based on Barkin (1998) and Martinez (2002) and peasant practice in the Sierra Juarez of Oaxaca.**

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