

Sustainable agricultural production systems

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Abstract

Sustainable development is based on ethical principles such as respect for and harmony with nature, political values such as participative democracy and social equity, and moral norms such as environmental rationality. Sustainable development is egalitarian, neutral, and self-managed, able to satisfy the basic needs of people, respecting cultural diversity, and improving the quality of life. The concepts of agriculture and sustainable development refer to the need of minimizing degradation of fertile land, while working to increase production. They include agricultural activities such as soil and water management, crop management, and the conservation of biodiversity, taking into account the provision of food and raw materials. Sustainability of agricultural production systems refers to the capacity of the system to maintain its productivity in spite of economic and natural, external or internal limitations. Sustainability is a function of the natural features of a system and the pressures and interventions it experiences, as well as social, economic, and technical interventions that are carried out in order to fight negative pressures, highlighting the resiliency of the system.

Introduction

The expansion of conventional agricultural productive techniques (monoculture, use of agrochemicals) is producing an intense ecological crisis worldwide, leading science and scientists to confront unprecedented new challenges such as the need to evaluate, in ecological terms, the efficiency of rural production systems (agriculture, livestock, forestry and pisciculture) in the context of sustainability.

During the last few decades, self-management of rural ecosystems has been re-evaluated and awareness is growing of the need to reorient agricultural production systems and develop alternative models of land use. This entails not only the development of a new social and political consciousness, but also the proposal of new conceptual approaches which make it possible to achieve new goals.

Dissemination and consolidation of Agroecological principles are therefore emphasized, as well as a reevaluation of indigenous and rural farming practices. Agroecology emerges as a new field of scientific knowledge, with different theoretical, epistemological, methodological and practical implications, which outline a trans-disciplinary approach to address social, political, ecological and ethical issues for solving rural problems (Toledo, 1995). Agroecology thus intends to not only maximize production of one component, but also optimize the agro-ecosystem in economic, social and ecological terms (Altieri, *et al.* 2000). As an alternative, Agroecology includes an approach to agriculture which is more linked to the natural environment, more sensitive from a social perspective, centered in sustainable production, and integrating ecological phenomena that occur in a cultivated field.

These contributions make it possible to establish a new scientific paradigm in which researchers study traditional cultures (seen not as a backward social sector, but as a part of society that possesses *ecological wisdom*), seeking alternatives to the previous hegemony of agroindustrial production imposed on nature.

Retrospective review of the concept of development

Trade liberalization has been presented for decades as the only path to development and the objective of all civilized nations. Its terminology became the accepted language of economy, and its concepts formed the backbone to structure entire societies. Today, this consensus has been broken in both developed and developing countries. However, the terminology still persists and therefore represents an obstacle to designing new models for sustainable management, and to propose alternatives to the overwhelming, deregulated free-trade system.

Development is a process with goals and objectives, and strategies to achieve them. Development is a multidimensional concept which includes economic, political and social elements, as well as those related to use of resources and impacts on the environment.

During the 1960s, development was considered a synonym of economic growth. The 1966 winner of the Nobel Prize in Economics, Simón Kuznets, defined economic growth as a sustained increase of per capita income and a sustained, long-term process of structural change, characterized by progressive growth of the relative participation of non-primary sectors in a country's production.

In 1972, during the United Nations Conference on the Human Environment held in Stockholm, the development process that has been being implemented received strong criticism, being blamed as the main cause of environmental deterioration.

The vision of the 1970s was zero growth, given the false dichotomy established between development and environment, which was known as the growth paradigm.

Starting in the 1980s, a phase of stagnation and regression in the well-being of humanity started to be noticed, in the form of lower per capita income, lowered living standards, failure to achieve expectations of well-being, and a lack of economic growth that hindered development.

A new term was then invented and started to be used by various authors: "ecodevelopment", which is derived from the concept of ecosystems. This includes natural systems and their socio-cultural context, and acknowledges diversity and plurality of solutions for problems of development.

Table 1 presents a comparison of two visions, under different technological approaches, about what a society should be.

In this context, what is sought is to transform the crisis of the moment into a move towards alternative development. Thus, the concept of sustainable development emerges.

Beyond productivity

Modern science started by denying legitimacy of other forms of dialogue with nature, such as common sense, psychic entities, magic and alchemy. It even denies nature itself when it ignores its complexity, assuming that it is ruled by a small number of simple and unchangeable laws.

Rationalist and Cartesian thought imposes itself above any other type of analysis. This emphasis modern society places on reductionist, rational, analytical and patriarchal thought (masculine values occupy the main social spaces) has resulted in the establishment of a development model that has held societies prisoners of a myth for over four centuries: the myth of uninterrupted and unlimited progress and economic growth. Every year every country must achieve increased rates of production of goods and services. This progress responds to the unbending logic of maximum benefits with minimum costs and use of time. A truly stunning industrialist-productivist machine has been created around this objective. All productive forces have been organized to extract from the Earth everything it can supply; it has been tortured, perforated, and destroyed

so that it yields all its secrets. A systematic assault on the natural wealth of the soil and sub-soil, in the air, water, external atmosphere has been established – nature has been plundered.

In the light of Agroecology and sustainability, this conception is completely out of phase.

Table 1. Comparative characteristics of the vision of technology

Hard technology society	Soft technology society
Ecologically unhealthy	Ecologically healthy
Great energy consumption	Low energy consumption
High contamination rate	Low contamination rate
One-time-only use of materials and energy	Use of recyclable materials and renewable sources of energy
Works for a limited time	Works all the time
Mass production	Artisanal industrial production
High specialization	Low specialization
Family-centered	Community units
Urban emphasis	Rural emphasis
Elitist political consensus	Collective democratic policies
Technical limitations set by wealth	Technical limitations set by nature
Alignment of nature	Integration with nature
Global trade	Exchange / local trade
Destructive to local culture	Trade compatible with local culture
Misuse-prone technology	Protection against misuse
Highly destructive for other species	Dependent on other species
Innovation controlled by private interests: earnings and wars	Innovation regulated by collective needs
Growth-oriented economy	Steady-state economy
Intensive use of capital	Intensive use of labor
Centralized	Decentralized
Alienates and excludes all population	Integrates the entire population
General efficiency increases with large size	General efficiency increases with small size
Operates with modalities which are difficult for the general population to understand	Operates in modalities that are understood by all
Frequent and serious technological accidents	Few irrelevant technological accidents
Singular solutions to technical and social problems	Different solutions to technical and social problems
Agricultural emphasis on monoculturing	Agricultural emphasis on diversity
Quantity is highly valued	Quality criteria highly valued
Work undertaken mainly for income	Work undertaken mainly for satisfaction
Industry specialized in the production of foods	Production of food shared by all
Science and technology are distanced from the culture	Science and technology integrated with culture
Small units totally dependant on other external units	Self-sufficient small units
Science and technology executed by elites of specialists	Science and technology executed by all
Science and technology divorced from other types of knowledge	Science and technology integrated with other forms of knowledge
Strong differentiation between work and recreation	Slight or absent differentiation between work and recreation
High unemployment	Unemployment does not exist
Technical objectives valid only for a small part of Society	Technical objectives valid for all members of Society

On the contrary, in an agroecological vision, the world appears currently as something already full and very fragile. Economies or populations are no more than subsets of wider ecosystems, and production should have the purpose of providing the necessary goods and services (physical and non-physical). Quality of life becomes the basis on which development planning is based.

The vision of the World is part of a culture and changes through time; it depends on many factors, among them social institutions, the media, and opinion-generating businesses.

The concept of “sustainability” was forged in the spheres of Ecology and Biology, to define the tendency of ecosystems towards a dynamic balance, supported by the networks of inter-dependencies and complementarities that rule ecosystems.

Today, sustainability appears as a strategy for establishing sustainable agrosystems, and developing sustainable systems is an unavoidable challenge for agro-ecologists of the 21st century, including human communities with their cultures and resources. This does not only entail changing laws and customs, but basically, undertaking a new style of seeing, relating to, and interpreting the world. *The problem we then confront is that creating a more sustainable future is confronted by something that is very hard to change: the prevailing way of thinking* (World-Watch, 2000).

Characteristics of sustainable development

The expression “desarrollo sostenible” (in Spanish) is derived from the English phrase “sustainable development”. The Anglo-Saxon word “sustainable” does not have the same connotation as the Spanish word “sostenible”, which means “to sustain or support”, or to keep an object stable, to give support or preserve a thing in its being or state. In other words, it has a static connotation. The English word has a similar meaning, but it adds a positive dynamic connotation to the definition: to persist in the effort, introducing a long-term temporal vision.

Sustainability as a concept emerged from the 1987 Brundtland Report hand-in-hand with “sustainable development”, and the proposal to continue maintaining this economic growth model “adjusting” the parameters to allow for its continuity through time. Indeed, it was not a good start. The proposal left intact and without debate the main foundations of the predatory production model that, as it acknowledged, was leading the planet towards disaster. At the same time, it avoided debate on socioeconomic aspects and the consequences of this economic model, such as the growing generation of poverty at a global scale, and the immense expansion of the gap between the rich and the poor.

Without doubt, the generalized acceptance of the purpose of making economic development “sustainable” is ambivalent. On one hand, it shows a greater concern for the health of ecosystems that maintain life on the Earth, introducing this concern into the field of economic management. Meanwhile, the lack of clarity with which this term is used shows that the good intentions that lie behind it will remain empty gestures, and will not contribute to place industrial society on more sustainable foundations.

The extended use of the term “sustainable” in economic-environmental literature is similar to the inflation in the social sciences of fashionable terms whose ambiguous definitions lead to using them more as figures of speech than as useful concepts to understand and solve problems in the real world.

The concept of sustainable development expresses that which is intimate and unavoidable, and the mutual inter-dependency between natural systems and development. Sustainable development refers to a constant process of change, where exploitation of natural resources and the direction of investment and technological scientific progress, along with institutional changes,

make it possible to render the satisfaction of present and future social needs compatible (Bifani, 1994).

In the 1992 World Summit, theologian Leonardo Boff proposed that what we needed was not a sustainable development, but rather sustainable societies. From that time forward, different sectors of society started to appropriate the term “sustainability”.

Sustainable development is based on ethical principles such as respect for and harmony with nature; political values, such as participatory democracy and social equity; and moral norms, such as environmental rationality. Sustainable development is egalitarian, decentralized and self managed; capable of satisfying the basic needs of the population, respecting cultural diversity and improving life quality (Leff, 1998).

The concept of sustainable development is used in different approaches, such as: the ecological approach to sustainable development (IUCN-WWF-UNEP, 1991); the environmental approach (Leff, 1998); the economic approach (OECD Council, 1989); and more sectorial approaches as agricultural and sustainable development, which use the term sustainability as the need to minimize degradation of agricultural lands, thus maximizing production. It implies a consideration of the range of agricultural activities, such as soil and water management, crop management, and conservation of biodiversity, in their mutual interaction; considering, at the same time, the objective of providing food and raw materials. Sustainability of the tropical agricultural production system refers to the capacity to maintain its productivity in spite of larger economic, natural, external or internal alterations, or under conditions of smaller but continued and cumulative alterations. In this definition, sustainability is a function of the natural characteristics of the system and the pressures and interventions it is subject to, as well as social, economic and technical interventions that are made to offset negative pressures – thus emphasizing the system’s *resiliency* (Bifani, 1997).

Sustainable development has become a project implemented by developing countries, aimed at eradicating poverty, satisfying basic needs and improving their population’s quality of life. However, it is forgotten that to achieve this, it is necessary to construct alternative development paradigms in line with specific needs of each country or region, and even of each social sector. To achieve that, it will be necessary to define the concepts that will make it possible to understand processes oriented towards the construction of a sustainable logic in the face of economic globalization, based on principles of social equity, cultural diversity, and ecological sustainability. This implies having new principles to value nature, new strategies for the re-appropriation of productive processes, and new senses that mobilize and reorganize society.

A strategy for sustainable development includes: selective protection measures for strategic economic sectors, combined with a rational trade liberalization process; technical assistance from the government, infrastructure support for national production and promotion of markets; encouraging local and regional markets – everything within a system based on transparent and democratic multilateral rules.

Table 2 contrasts the characteristics of the two types of development.

In sustainable agriculture, agroecosystems are considered as the fundamental units of study, where energy transformation, biological processes and socioeconomic relations are investigated and analyzed as an indivisible whole.

Table 2. Characteristics of sustainable development and modern development.

Sustainable	Modern
1. Sustaining and improving income levels through developing self-controlled resources	1. Sustaining and improving profit levels, market mobilization of resources
2. Fair, flexible and multiple use of resources	2. Rigid and unfair use and distribution of resources
3. Proportional development, based on available local resources	3. Increasingly disproportionate scales due to dependency on external resources
4. Acceptable level of surplus per unit of final product	4. Low surplus levels per unit of final product
5. High degree of diversity	5. High degree of specialization
6. Crucial local innovation capacity	6. Dependent on new external technologies
7. Slow changes: learning and doing	7. Centralized and external project model
8. Relevance of family labor and community networks	8. Formal technological solutions and institutions: salaried labor
9. Has an impact on prices outside the farm, and being active in the creation of markets	9. Prices and market outside the farm are "arranged" and received passively by farmers
10. Low levels of external inputs, low financial costs	10. Manual labor is replaced by external inputs and technologies
11. Sustainability, rationality	11. Unsustainability, irrationality
12. Agriculture connected to the local sphere.	12. Agriculture linked to the external market
13. Need for only a small resource base to generate acceptable income.	13. Need of large resource base to generate acceptable profits

Source: Van der Ploeg, 2000.

Among the necessary bases to achieve a sustainable agriculture are:

- Biological and social systems have agricultural potential.
- This potential has been captured by traditional farmers through a process of trial, error, selection, and cultural learning.
- These biological and social systems have co-evolved in such a way that each depends on feedback from the other.
- The potential of agrarian and social systems may be understood by studying how traditional agricultural cultures have captured that potential.
- The combination of social and ecological knowledge, together with knowledge developed by agricultural sciences, may improve both traditional and modern agro-systems.
- Agricultural development addressed under an agroecological approach emphasizes conservation of cultural options and agricultural strategies for the future, and will as a result have less detrimental effects than the approaches of conventional agricultural science.

Ecoagriculture as an alternative is valid as long as it contributes to:

- creating a balanced environment,
- providing stable yields,
- preserving soil fertility,
- increasing natural pest control by increasing natural control systems,
- producing resources that emerge as a result of the combination of crops, trees and animals in different spatiotemporal combinations, using their complementarities and synergies.

Diversity in agricultural production systems

The essence of modern agriculture is undoubtedly based on “artificialization”, which alters ecosystemic structures and functions.

One of the most important aspects of “artificialization” is productive specialization – i.e., a reduction in the use of natural diversity to concentrate rather on the use of a few varieties and, most frequently, monoculture. Crop specialization and homogenization tend to eliminate species, thus upsetting the structure of soils, and modifying nutrient and energy flow, as well as biogeochemical cycles.

On the other hand, practices of indiscriminate and selective harvesting also have a tendency to reduce an ecosystem’s diversity, which will finally result in the destruction of its functioning and self-organizing mechanisms.

The loss of diversity not only has effects on ecosystem structure and function, but it also increases risks – the more homogeneous a system, the greater its vulnerability to pests, diseases and climate changes, etc.

Diversity reduction has become more marked in the last 100 years. Of the more than 350,000 species of plants known, only 150 have been domesticated by man, and only 8 species provide 85% of the foods consumed by human beings. At the same time, 8 species (wheat, rice, corn, barley, oat, sorghum, millet and rye) provide three-quarters of the total of dietary proteins and energy consumed by man, and three (wheat, corn and rice) provide 50% of human energy.

The economic and political relevance of biodiversity comes not only from the role it has played in the development of the global economy, but also from the relevant role it will have in the coming years, thanks to biotechnological progress and genetic engineering.

One of the most controversial aspects of the debate about biodiversity refers to the economic use of germplasm.

The use of genetic material is a determining factor in the development experienced by agriculture in the last fifty years. The economic relevance of germplasm has been noticed mainly in improvements in yield of the most important crops such as corn, wheat and rice, which have doubled from 1935 to the present.

The extreme selectivity of human beings in the use of resources has lead them to depend on a very few species. Selectivity and concentration on the use of genetic resources lead, directly or indirectly, to their reduction.

The economic interest for vegetable germplasm dates back to ancient times; its trade has been associated with exploration and conquests by Egyptians, Vikings, Englishmen, Dutchmen, Spaniards, Portuguese, etc. The species of the New World quickly spread and became a basic component of the diet in European and African countries, as shown by their levels of consumption of corn, potatoes and yucca.

However, this important trade of germplasm has not had a financial counterpart, as is usually the case in trade.

Through history, free trade of germplasm has had certain important implications and dimensions for agricultural and economic global development.

For instance, the greatest agricultural production of a species does not take place in the center of origin, or even in the centers where it is domesticated, but in totally different areas. For instance, the largest agricultural producer in the world, the United States of America, depends 100% on germplasm from other regions for its agricultural production of food, and 84.7% on such germplasm for its production of raw materials (Kloppenburger, 1988). Forty percent (40%)

of the USA's agricultural food production depends on varieties that come from Latin America, and 36% from the Western and Central Asia. These two regions provide more than 65% of the germplasm of the 20 most important food crops at present.

The regions of origin have adopted foreign species that have become dominant in their respective regions. For instance, more than half of the Latin American area dedicated to industrial crops is dominated by a species imported from Asia: sugar cane. Mediterranean countries and California in the United States dominate world production of tomatoes, whose center of origin of diversity is Peru and of domestication is Mexico, from where it was taken to Spain, and from there, to Italy.

Free and open trade of germplasm, associated with control of technology, creates truly dynamic comparative advantages, stronger and more important than the static advantages associated with a supposedly fixed and immobile provision of resources. It not only creates comparative advantages for the center receiving germplasm through the intensive use it makes of this resource, but also creates a new product for which the monopoly that may be granted or not by intellectual property laws gives it comparative advantages in international markets.

The dominant production center creates comparative advantages relative to the original factor, and in addition, based on these advantages, it also obtains monopolistic control over its substitute.

Thus, comparative advantages are neither fixed nor inherent in the provision of natural resources or in pre-determined geographic conditions, but can rather be created through development and application of technology (Bifani, 1997).

Technological changes in conventional agriculture strengthen development of a strong process of unequal capitalism, which not only has an impact on the rural sector, but also on the economy itself. Industrial agriculture increased the forms of "artificialization" of nature, producing few benefits.

Latin America becomes a source that produces and provides raw materials to the world without real opportunities to achieve true sustainable development:

- rapid stagnation of community agriculture which produces food for local consumption,
- growth of agriculture for export, which pushes traditional production systems onto more fragile and marginal lands,
- deterioration in exchange since the middle of the last century brought about by following the ECLAC school of thought, which entails an overexploitation of resources and undervaluation of products whose distance is more unfavorable for the whole Region,
- expansion of agro-export systems and their consequent concentration, implying an expansion of use of available lands to sustain scale, which on the one hand increases deforestation and opening of agricultural boundaries, and on the other, displaces small and medium-sized producers, along with farming and indigenous economies, with social and environmental costs that have yet to be considered. The monoculture "agriculturization" process is a clear syndrome of unsustainability or "sustainable underdevelopment",
- artificial lowering of food prices in developed countries for the inhabitants of cities - this hides the pressure on farmers and systems to produce more every year and at a lower cost,
- social, health and nutritional changes with the emergence of new infections and chronic diseases,
- increasing loss of food sovereignty and weakening of local endogenous development systems,

- political and institutional commitment to development policies of international organizations, which have in some cases generated more problems than achieved specific solutions,
- technological-scientific commitment to productivity of agro-export systems, and little development and generation of appropriate knowledge for local production systems,
- strong commitment of mass communication media (press, radio and written press) to models of promotion of industrial agriculture, and
- strong interference of corporations in national decisions over “rural development”.

The development model imposed on the Latin American region since the middle of the 20th century gave absolute priority to urban-industrial processes which degraded the rural environment, a situation that deepened the general crisis of traditional agriculture. In spite of that, agricultural production grew between 1950 and 1975 at an annual rate of 5.5%, as systems of agro-production for export started to again preeminence. It is in these terms that its relevance must be evaluated more thoroughly, considering also additional relevant criteria such as the strategic position of food self-sufficiency, and food as a cultural, not only economic, means of sustenance; the persistence of family, unmonetized economies; the relevance of family economies; the occupation of territory; the absorption capacity of rural labor; the importance of women in the rural sector; the creation of a space for the generation of conditions promoting urban-industrial expansion, and geopolitical integration of the territory.

Regional agroproduction has always been heterogeneous from the social, technological and productive perspectives. “In the last few decades, this differentiation between productive systems has become more marked. At one extreme of the spectrum we find traditional farming systems, with sustainable practices anchored in a consolidated culture, generally based on multiple use of ecosystems and on minimal use of external inputs. These systems are subject to permanent erosion, to the point that in some zones only vestiges of them remain. Rural and urban proletarianization seems to have been the unavoidable destiny of a good part of the children of traditional farmers. On the other hand, there is commercial agroproduction which, from the environmental perspective, implies an “artificialization” of ecosystems, which frequently exceeds the threshold of long term sustainability” (United Nations, 1992).

The industrial agriculture model driven by the Green Revolution has had visible results, and others that are not so visible. Lately, there has been an increase in scientific and critical research efforts which indicate that –industrialized management of natural resources breaks residue re-arrangement and reposition rates, producing increasing entropy. The possibility to re-use only a part of the residues implies that they are transformed into different forms of contamination, and generate growing loss of productive capacity of natural resources– (Guzmán, *et al.*, 2000).

Appropriation of natural goods, and of the wealth and surplus generated by this appropriation, have taken place since the second half of the 20th century, when the most advanced technological and scientific development was combined with privatization, denationalization, deregulation, transferences, subsidies, exemptions, concessions, causing deprivation, marginalization, exclusion, and impoverishment, which facilitated macro-social processes of exploitation of employees and artisans, men and women, boys and girls, and the despoiling of the ecosystem. Globalization was extended in a superficial, misleading manner, associated with processes of domination and appropriation.

Ten ecological principles are proposed for a local sustainable development, which are based on the location of communities, their topological inclusion in the territory of the planet.

Of the proposed principles, six make up a group of *practical principles*, including the following:

- *Diversity*: biological, genetic, scenic, productive. This affirms a feature that is inherent in traditional appropriation of the agroecosystem and enters in conflict with the homogenizing and specializing tendency of neoliberal development prevailing in the world.
- *Self-sufficiency*: food, energetic, technological, economic. This assumes minimal dependence of the rural community on external inputs. It should not be confused with autarchy (which implies total isolation).
- *Integration*: of productive practices, units of the landscape, of natural cycles. Present in traditional ecological and economic rationality; this principle is eroded by prevailing modern practices and dependencies of the communities.
- *Equity*: productive, of resources, participation, decision-making, etc. In the face of external mechanisms that promote social and economic differentiation of communities (leading to different forms of despotism). Equity is a binding assumption of any communitarian democracy.
- *Justice*: aimed at obtaining fair prices for products sold by the community. This principle seeks to confront the various mechanisms of unequal economic exchange, where communities have been historically exploited by external markets. It works to abolish unequal exchange between communities and markets (economic, productive exploitation), which such exchange triggers between rural communities and local agroecosystems (ecological exploitation).
- *Rationality*: the application of multiple uses of an agroecosystem allows for and promotes biological, ecological, genetic diversity, as well as the balance of flows of material and energy in the agroecosystem. This is achieved through an equitable distribution of the areas dedicated to agriculture, livestock farming and forestry production in the community territory, as opposed to monoculture or specialized production.

Other four *philosophical principles* around the idea of balance are:

- *Spatial balance*: aimed at achieving and ensuring landscape stability through balanced management of different ecogeographic units that make up the community territory, and integrating it in productive processes.
- *Productive balance*: traditional wisdom has always sought to achieve a balance in the always difficult encounter between the value of use and value of change; i.e., between a productive rationality exclusively aimed at subsistence of the producers, and one which is obsessed with taking everything produced to the market. It tries to adopt and maintain a strategy by which the value of change (production for the market) is always under the control of the community's interests and family needs, or value of use (production aimed at guaranteeing food, energy, and technological self-sufficiency of the community). The intention is not to fall into autarchy (total elimination of the value of change), nor into the mercantile inferno of the market-based economy (total elimination of the value of use). Nature (exchanges that ensure self-subsistence) operates as an ally which allows safe navigation on the *perverse waters* of the private market and capital.
- *Community balance*: seeks to balance the interests of the whole and the interests of its parts; i.e., between collective or community rights and interests, and those of the families and individuals that make up the community. It seeks to avoid excesses of collectivism and use the advantages and potentials of individuals and family nuclei.
- *Family balance*: since families are productive and social cells of the entire community, it is extremely important to ensure a certain stability among them. This principle seeks harmony among individuals, genders and generations that make up the family nucleus, to guarantee

satisfaction of their essential needs through adequate norms for health, nutrition, hygiene, education, reproduction, information and recreation.

Characteristics of sustainability in the agricultural production systems

Given the concern experienced in Latin American countries due to environmental deterioration and the new model or models of development that should be introduced in each of these countries, different approaches have been proposed to address these problems. In Costa Rica, different sectors (academic, researchers, governmental institutions, NGOs, and private businesses), have taken the first steps in the construction of new paradigms that will govern development of agricultural production in the country.

As a contribution to what is presented in those paradigms, a proposal is submitted here to implement new agricultural production systems, including the need to recover genetic diversity, adopting new species, domesticating them, and applying to them the maximum advances contributed by biotechnology.

There is a possibility to introduce new plant species to add them to few species that have been domesticated and are currently cultivated in the country, not necessarily following the same prevailing pattern which has been established in the last fifty years; producing traditional crops such as coffee, sugar cane, rice, corn, beans, yucca, yams, etc.

It is important to explore cultivation of plants from which secondary metabolites may be extracted that are of interest to the pharmaceutical industry, or can be used to produce bio-fuels, which might be viable alternatives to guarantee sustainability and competitiveness of our countries in this new age of globalization. In particular, the production of medicinal, dye, and spice plants, offers a great economic, ecological and social potential for the country's rural sector.

Likewise, as the settlers of our continent did when they took possession of the American germplasm without any payment whatsoever, today we could explore the establishment and commercial exploitation of the cultivation of plant species which are not native to the tropics, given the market opportunities that are currently available for certain medicinal plant species, both in the United States and Europe, and given the capacity to adapt and produce these crops under tropical conditions.

To guarantee the sustainability of this type of production system, it is first necessary to internalize and socialize the theoretical foundations of what sustainable development and production mean for producers of these alternative crops. Then, in a second step, if the technology necessary for the production is developed, if the production of this crop allows for participation of different productive sectors and an acceptable profit margin which is fairly distributed, and the cultivation is carried out without damaging the environment, we could expect that there would be sustainability in the production of these crops in the medium or long term.

In this respect, four dimensions necessary to achieve sustainability are proposed:

- The *ecological* dimension implies preserving and potentiating diversity and the complexity of ecosystems, their productivity, the natural cycles and biodiversity. The ecological crisis is not an abstract problem that concerns only middle classes of the Northern countries which have satisfied their basic needs and can be worried about the natural environment. The ecological crisis is strongly linked to physical and cultural survival of the peoples and excluded sectors of the whole planet.
- The *social* dimension refers to equitable access to environmental goods, in both intra-generational and inter-generational terms, between genders, and between cultures.

The social dimension of sustainability allows an appreciation of the relevance of the fair distribution of environmental goods in a world where inequality is constantly increasing.

- The *economic* dimension demands redefining economic activity according to material and immaterial needs, understood not only as shortages but also as potentialities. New economic activities must be based on local and diversified productive units, adapted to the characteristics of ecosystems to make use of them in a sustainable manner.
- The *political* dimension refers to direct participation of individuals in decision making, in the definition of their collective future, and in managing environmental goods through decentralized and democratic governmental structures. It proposes the need to give a new meaning to politics and generate new practices based on direct participation and the leadership of individuals in the search for alternatives. These practices should necessarily emerge from horizontal relationships, foreign to centralized and vertically-oriented schemes that concentrate power. Sustainability will only be possible if the power of decision is given back to the people.

Any current sustainable development model implies:

- that the economic cycle respects the ecological cycle;
- rational cultivation and ecological production;
- acknowledging that there are limits to productive growth, private property, social development, and irrational exploitation of the ecosystem.
- harmony society-nature: a new South-North order;
- emphasis on collective interests over private interests;
- elimination of all types of social injustices: violence, misery, wealth;
- application of a tight relationship of land use capacity = land use planning: sustainable use of the agroecosystem;
- ensuring production for local consumption, to eliminate poverty and hunger;
- stimulating new values, attitudes and eco-centric behaviors towards the social and natural environments;
- implementing new territorial and socio-environmental regulations;
- devolving power to communities, so that decision making and solutions become democratic, collective and participatory;
- applying the “Four Rs”: reduce, reject, recycle and reuse.

Only ecologically sustainable development and social production can achieve the political and social objectives of the State, in an integral and universal manner. This leads to challenges that must be addressed by any policy aimed at defending the new role of the State:

- The economic-productive cycles should be circular and integrated with ecological cycles, starting from the finite nature of the resources. It is necessary to selectively decelerate growth and universalize development.
- Efforts in the areas of production and development must be based on technology oriented towards energy efficiency and reduction of emissions, because the quality of a productive system is not determined by the quantity of energy and materials consumed, but rather by efficient recycling.
- Unequal and unfair development exists in the social and ecological spheres, aggravating environmental impacts.

- Renewable energy is the technological option to overcome mercantile development policies associated with non-renewable exosomatic sources.
- There is a need to rescue and reconstruct social relations which will allow satisfaction and will not degrade the environment or cause social exploitation. Traditional values and cultural elements are necessary because they strengthen feelings of solidarity and *spiritual enjoyment*.

Real sustainability has to protect the human population and cultures, as well as ecosystems and the diverse flora and fauna in them which play a critical role in maintaining ecological and social processes; this implies:

- breaking away from forms of dependency;
- use of the agroecosystem which allows materials and energy cycles to be as closed as possible;
- management of beneficial impacts;
- use and function of the agroecosystem, with tolerance to adverse biophysical conditions, which favor both humans and nature;
- biotic mechanisms for regeneration of deteriorated materials;
- evaluation, regeneration and/or creation of local knowledge which improve the standard of living of the population, based in their own local identity;
- creation of short circuits for consumption of goods;
- enabling biological and socio-cultural biodiversity;
- fair distribution of social and agroecosystemic wealth;
- respectful relationships between urban and rural areas.

Summary

Globalization gives large transnational corporations power over agriculture, generating an exodus of farmers and making it impossible to end hunger in the World because production ends up in the hands of only those who can afford it. The market cannot end hunger because it is not made to satisfy needs, and does not balance supply and need, but rather supply and demand.

The history of our peoples and our countries is a history of dependency and underdevelopment, domination and penetration and imposition of foreign capital, which degenerates into a deformed, weak and vulnerable development. The development of extensive production centers therefore occurs thanks to our underdevelopment.

The environmental aspect is NOT a technical, technological or economic problem; it is rather an ethical and moral problem, basically humanist (sociopolitical), in which readjustment of the national economy and sacrifices are not shared equitably, while the needs of the most vulnerable groups are not taken into account, nor subsistence production, nor ethnocultural and social problems.

That which is sociocultural is found in types of social relations, cultural customs, social mentality and vision, ways of managing patrimony, of avoiding or reconstructing artificial damages caused, and respect for biological balances – eco-centrism.

Sustainability implies a new rational relationship between society and nature.

Unsustainable development is not only the consequence of bad planning and execution of a project, of the lack of vision, or poor institutional organization. It is rather due to an irrational abuse of agroecosystems, to a lifestyle of overexploitation and overconsumption, to an unfair and unequal structure of society (in terms of the distribution of social wealth, and an emphasis on private interests to the detriment of collective interests), and the same types of relations between countries (subordination of some countries to others) brought about through the imposition of development models, external debt, wars, arms races, technology, trade, credits, penetration of external capital, acculturation and transculturation.

Ecological and social problems have become linked with the crisis of modern agriculture, which generates food contamination (agrochemicals and transgenic crops). The neoliberal approach has not been able to escape from this reality, nor orthodox socialism, adopting an ideology of development that entailed ecologically unsustainable farming practices. The capitalist system, with its rules of the game (industrialized countries), operates because it extracts materials from the rest of the world (non-industrialized countries), generating toxic residues and making its maintenance unsustainable and illogical. Industrialized countries live above their means, using the natural wealth of other countries (Naredo, 1996).

The (ir)rationality of the industrial world is intrinsically incompatible with patterns and principles of nature (Toledo, 1995); for this reason, we are living in and suffering from a serious ecological global ecological crisis that we must confront, making conservation efforts through the promotion of agroecological technologies that introduce ecological rationality into farming practices. Because at present, *...nature cannot be conceived of without society, and society cannot be conceived of without nature* (Beck, 1998).

The agroindustrial model is exhausted; it is not the solution, as assumed by Governments (of politicians and business persons), but rather the cause of the current socio-environmental problems.

We are in a process in which it is imperative to re-think everything: politics, economy, culture, diplomacy, education, life styles, nature – an alternative modernity has to be built. Human beings are compelled to maintain the balance of the Earth's ecosystem, in an act of solidarity with their environment, because we are part of an immense cosmic and planetary community, where we are all mutually dependent, where we have the same origin and the same destiny, *"so that each one lives from the other, for the other and with the other* (Boff, 1996).

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