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INTEGRATING ECONOMIC GROWTH, EQUITY, AND ENVIRONMENTAL ASSETS COMPONENTS OF SUSTAINABLE DEVELOPMENT IN TROPICAL AGRICULTURE: A CONCEPTUAL FRAMEWORK

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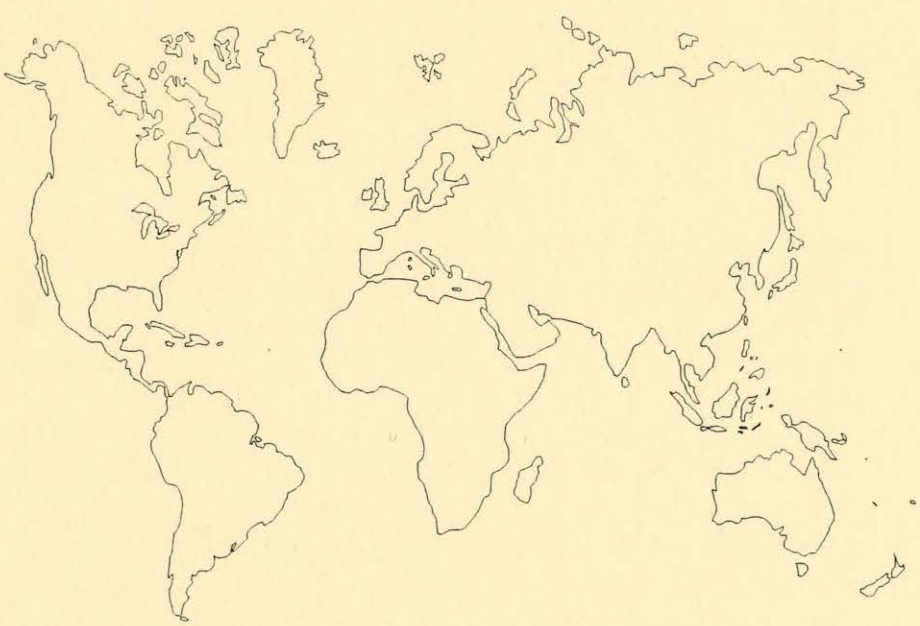

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ABSTRACT

Clarity of, and understanding of the key issues relating to the reconciliation of economic growth, equity, and environmental sustainability dimensions of tropical agriculture development are necessary for the mounting of effective development strategies for the twenty first century. It is argued that conceptual definitions and elaborations are key components of productive dialogue on the issues, and have attempted to facilitate this dialogue by developing a reconciliation framework embedded in certain key concepts. The reconciliation framework consisted of the following processes: (1) development and refinement of key concepts, (2) articulation of the nature of, and functional roles of key concepts within the reconciliation framework and (3) development of the essential arguments in a structured form of analysis.

The conclusion reached is that fruitful discussions on the reconciliation issues must at *a minimum*, recognize that outcomes might vary, depending on: (1) the *type* of tropical agriculture systems, as defined by *interactions* between the characteristics of agro-ecological assets and the characteristics of socio-technical environments, and (2) the *time period* scenario used for the analysis, with respect to the *location* of the tropical agriculture systems *below or at the limits* of their agro-ecological sustainability capacity. Tropical agriculture systems that have *not* reached their agro-ecological sustainability limits, faces growth, equity, and environmental reconciliation issues that must be addressed within the context of *complementarity* between resource use and improved standard-of-living, given certain constraints. Tropical agriculture systems that have *reached* their agro-ecological sustainability limits, faces growth, equity, and environmental reconciliation issues that must be addressed within the context of *trade-offs* between improved standard-of-living and resource use, given certain constraints.

Key words: Reconciliation, Economic Growth, Equity, Poverty, Standard-of-Living, Sustainable Agricultural Development, Tropical Agriculture, Types of Systems, Complementary Relationships, Trade-off Relationships

INTEGRATING ECONOMIC GROWTH, EQUITY, AND ENVIRONMENTAL ASSETS COMPONENTS OF SUSTAINABLE DEVELOPMENT IN TROPICAL AGRICULTURE: A CONCEPTUAL FRAMEWORK[1]

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INTRODUCTION

Issues relating to sustainable agricultural development and natural resource conservation are increasingly occupying the center stage in discussions of development strategies at the national, regional, and global levels. The 1992 Earth Summit in Rio de Janeiro, and the April 25-May 6, 1994 United Nations Global Conference on the Sustainable Development of Small Island Developing States (SIDS) in Barbados, were endorsements of a new and critical approach to the world's problems with resources. This new approach added *conservation* and *sustainability* criteria to the classical *growth* and *development* criteria widely used for measuring human welfare gains.

The significance of the new approach to valuing human welfare gains lies in the fact that the approach argues for a fundamental shift in the paradigm dealing with both the *ordering* and the *systemic nesting behavior* of the classical growth and development welfare criteria, versus the new conservation and sustainability criteria. Specifically, the traditional growth and

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development criteria are essentially economic accounting indicators (national accounts) used for measuring human welfare gains. The economic growth, development, and welfare perspectives were thought to be a way of bringing about some degree of equity among people. These national accounts consistently indicate positive correlation between income and the growth and development indicators of welfare. In contrast, environmental indicators such as conservation and sustainability, sometimes worsen with economic growth. The new approach essentially does the following: (1) reorders the criteria for valuing welfare gains by assigning equivalency if not primacy, to environmental criteria and (2) nests the traditional economic accounting entities *within* the environmental sphere, rather than the converse under the old approach. This fundamental shift in paradigms is articulated in the statement, "the ecosystem contains the economy to which it supplies a throughput of matter-energy taken from *in natura* uses according to some rule of sustainable yield rather than according to individual willingness to pay" (Daly, 1992, p. 187).

The new approach to valuing welfare gains is clearly multi-dimensional with respect to functional relationships, cause and effect, action and reaction, whichever terminology you may prefer. From my perspective, however, it is clear that one significant relationship emerging from the new approach is the explicitly stated relationship between what has been referred to as *visioning a desirable future* and *visioning a sustainable agricultural system* (Francis, 1993). Visioning a desirable future is the necessary (but by no means sufficient) process (condition) whereby we create a concept of an "environment in which we and our descendants would like to be" (Francis, 1993, p. 207). Given the accomplishment of this first process (condition), one can then proceed in some logical step-wise fashion to visioning a sustainable agricultural system.

Such a second-stage conceptual process will involve wrestling with the dilemma of reconciling the traditional economic growth and development indicators of welfare with the environmental sustainability indicators. The resolution of this conceptual dilemma is fundamental to resolution of the operational issue of sustainable tropical agriculture, where the need is now more urgent than even to find economically viable *cum* environmentally sustainable agricultural strategies.

It is now well recognized that sustainable agriculture and development are no longer options but rather they must be goals of all developing countries (Lal and Ragland, 1993a). Furthermore, it is increasingly being recognized that sustainable agriculture cannot be achieved through the exclusive use of technological manipulation. Rather, "It involves finding a balance between production and preservation, natural and artificial, on-site and off-site, the present and the future, and fitting these competing needs into a system which allow technicians to inform decision makers of the needs and the likely costs" (Ragland, 1993, p. 28). The dilemmas (or challenges) associated with the integration (reconciliation) of the multiple-dimensional aspects of the agricultural sustainability issues are indeed formidable for modern agriculture of temperate zone regions, as well as subsistence/near-subsistence agriculture that dominate the tropics. However, it is important to recognize at the outset, that while many of the reconciliation challenges might cut across agro-ecological zones, some of the basic issues of agricultural sustainability are different in each region. These basic issues have been differentiated by Lal and Ragland (1993a) according to the following five characteristics: (1) degree of land resource constraints, (2) per capita caloric intake and food availability anomalies, (3) off-farm employment alternatives, (4) land degradation levels from an historical perspective and (5) availability, demand for, and utilization of off-farm inputs.

This paper attempts to contribute to the dialogue by exploring a conceptual framework for integrating or reconciling the economic growth, distribution (equity), and environmental assets components of the sustainable agriculture challenges confronting the tropics, which are exacerbated by the characteristics of these regions. It is my firm belief that an appropriate conceptual framework is the first necessary step for the development of effective policy intervention strategies. To the extent that a new conceptual framework might help to bring clarity to the dialogue among the real world actors, and to the perspectives that they bring to the conversation, it could lay the foundation for informed policies and strategies in the years ahead.

CONCEPTS AND DEFINITIONS: SETTING THE BASIS FOR DIALOGUE

Concepts and definitions are essential to any conversation or dialogue relating to sustainable agricultural development issues. The term *concept* (or conceptual framework) is used to mean the basic *general notions* underlying things or a class of things. The term *definition* is used to mean a statement expressing the *essential nature* of something or class of some things. Concepts and definitions become essential requirements for advancing the dialogue and policy agenda on sustainable agricultural development issues because they: (1) create a vision (notion) of some desirable outcome and (2) express aspects of the essential nature of the process for achieving the desired outcome. Given the focus of this paper, some of the key concepts and definitions are: (1) economic growth, economic development and agricultural development, (2) equity, (3) environmental assets and (4) sustainable agricultural development. If one is to critically explore the nature of, and the scope for integration (reconciliation) of these dimensions, it is essential that working definitions be presented at the outset, and *prior* to any elaboration attempt within the integration exercise.

Specific concepts mean a number of things to different people and different disciplines. These differences are often large and polar, particularly with respect to the issues of sustainable development (Cernea, 1993; Munasinghe, 1993; Rees, 1993; Serageldin, 1993; Steer and Lutz, 1993). As such, a brief review of the essential elements of the concepts used in the discussion are presented. Arguments are developed around specific elements of the concepts as defined here. It is recognized that major disagreements can arise from the conceptual definitions, the logic of the arguments, or both. It is my belief, however, that substantial advancement can still occur in the sustainable agricultural development agenda, despite such disagreements, if the points of the disagreement can be clearly identified. I am of the opinion that clarification of concepts will expedite this process.

Economic Growth, Economic Development, and Agricultural Development

The concepts of economic growth, economic development and agricultural development are highly inter-related. The conventional definition of *economic growth* is one of a change over time in the level of real GDP per capita, real partial productivity of labor per capita, or real consumption per capita. *Economic Development* is conventionally defined as a change leading to improvement or progress in some normatively defined criteria of welfare gains and the distribution of such gains. A more tightly defined concept would be, "a *vector* of desirable social objectives; that is, it is a list of attributes which society seeks to achieve or maximize" (Pearce, Barbier and Markandya, 1990, p.2). The elements of this vector would include: (1) the economic growth component, as defined above, (2) improved health and nutritional status,

(3) educational achievement, (4) more equitable income distribution (poverty reduction), and (5) access to productive resources. Economists argue that given the high correlation between these elements, or the relative weights applied to them, that a change in real income per capita is probably the best single *proxy* indication of economic development (Pearce, Barbier and Markandya, 1990).

Economists conventionally view *agricultural development* as a subset of economic development. It is seen as the modernization process applied to agriculture, such that continuous growth is attained in the productivity, production, income and its distribution, at the farm level, subsector level, or sector level, without public protection to this activity being a necessary condition for its growth. In short, the economist views agricultural development as a change in the vector of desirable objectives which society seeks to achieve or maximize for its agricultural sector or subsectors.

Equity

Equity is defined in this paper in terms of disparities or inequalities in the *standard-of-living* (SOL) of people, as indicated by their command over financial resources. In other words, our concept of equity is synonymous with the *reciprocal of poverty*.[2] Our poverty (equity) concept is explicitly defined as "the limited command over resources of individuals, often aggregated together for many purposes, including sharing of resources, into households or into

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[2]It is recognized that poverty is a *subtopic* of the issue of inequality. However, I contend that: (1) the concept as an indicator of income inequality, is highly correlated with other aspects of inequalities and (2) it is more appropriate than the other two conventional economic concepts of income inequality, i.e. *functional income shares* and *size distribution of income shares* (See, Lampman, 1971).

other groups." (Behrman, 1990, p. 28). The degree of individual's or group's command over financial resources is viewed primarily as a function of factors including: (1) ownership or access to assets, (2) prices for the use or sale of these assets, (3) levels of net transfers (money or in-kind) received by individuals or groups, and (4) prices that individuals or groups must pay for goods and services (Behrman, 1990).

The Food and Agriculture Organization (1988) argues that the socio-psychological concept of *marginality* is congruent to the concept of poverty. This argument is based on the notion that marginality like poverty, conveys a sense of being cut off from the mainstream of modern life. As such, the Food and Agriculture Organization (1988, p. 7) definition of poverty is, "the incapacity to become inserted in the socioeconomic environment in a way that continually allows for the satisfaction of basic necessities of life". This definition is consistent with the notion that this paper is trying to convey. In essence, poverty reduction (equity improvement) is viewed as "leveling up the bottom of the income distribution rather than restraining the power and influence of the very rich" (Lampman, 1971, p. 16). The operational dimensions of the poverty concept will not be the focal point of this paper, since these dimensions are covered elsewhere (Davis, 1992; Davis, 1994; Food and Agriculture Organization, 1988; World Bank, 1990). However, in the interest of clarity and advancing the conversation, a brief review of some of the operational dimensions of the concept is presented.

The Food and Agriculture Organization (1988) use the related concepts of destitution and absolute poverty to convey the marginalization effects of poverty. *Destitution* is defined as that income level below which a nutritionally adequate diet and essential non-food items cannot be purchased. *Absolute poverty* is that income level below which a set of basic necessities cannot be afforded. The World Bank's (1990) *absolute poverty* status indicator appears to define the Food and Agriculture Organization (1988) condition called *destitution*. Absolute poverty status is a condition of those persons with $U.S.275 or less per year (1985 prices). It was estimated that in 1985 about 663 million persons worldwide fell into this category. The Bank's *poverty* status indicator seems to define the Food and Agriculture Organization's *absolute poverty* status. This category is defined as a condition of those persons with $U.S.375 or less but more than $U.S.275 (1985 prices). The number of persons estimated to be in this category worldwide in 1985 was about 380 million. The Bank also uses an indicator called *relative poverty* status, which is defined as a condition of those persons earning less than one-third of the national average income of a country. It should be noted that the existing statistical definition of poverty status in the United States was developed in the 1960s and is similarly based on the intuitive concept of poverty as lack of income. The standard varies by family size and are adjusted annually for inflation, as measured by the Consumer Price Index (Sawhill, 1988).

Poverty status have dynamic and time-dependent components which are important for development policy formulation and implementation. The various statistical definitions of poverty status can be placed within a time-dependent dimension such as: (1) *chronic poverty* status-inclusive of persons experiencing poverty for most, if not all of their lives and (2) *transient* poverty status-inclusive of persons experiencing poverty during specific periods. *Cyclical poverty* status and *seasonal poverty* status are subcategories of the transient poverty status category. The cyclical category would include persons experiencing poverty status during stages of the life cycle of household development (elderly or children). The seasonal category would include persons experiencing poverty during certain months of the year or during natural disasters (Food and Agriculture Organization, 1988).

Environmental Assets and Sustainable Agricultural Development

Environmental assets have been defined in a number of ways. Following Pearce, Barbier and Markandya (1990, p. 1), they are, "the stock of all environmental and natural resource assets, from oil in the ground to the quality of soil and groundwater, from the stock of fish in the oceans to the capacity of the globe to recycle and absorb carbon". Alternatively, they can be considered in terms of the Pearce and Turner (1990, p. 29) definition, "all *in situ* resources - energy sources, fisheries, land, the capacity of the environment to assimilate waste products, and so on". Given the focal points of this paper, my concern is primarily with the agro-ecological systems in which agricultural production activities are carried out in the tropics.

Sustainable agricultural development has been defined in a number of ways. From my perspective, it is one dimension of the general concept of *sustainable development*. The endorsement of the concepts of conservation and sustainability by the 1992 Earth Summit and the 1994 SIDS conference referred to earlier, trace their roots in large measure, to the so-called Brundtland Report (World Commission on Environment and Development, 1987). The report (p. 43) defines sustainable development as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Following the Brundtland Report, the Food and Agriculture Organization (1991, p. 3) defines sustainable development as, "the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations."

Consistent with the reordering and nesting behavior of environmental assets, vis-a-vis the economic criteria of human welfare, as these concepts relate to the issue of sustainable development, I define sustainable agricultural development as a process in which the agricultural system or subsystem, "is on a trajectory of receiving increases in desirable social objectives, without consuming such large proportions of the energy of the ecosystem, whereby the ecosystem is unable to regenerate itself continuously" (Davis, 1992, p. 8).

The definition of sustainable agricultural systems as used here is consistent with those of the Brundtland Report (World Commission on Environment and Development, 1987) and the Food and Agriculture Organization (1991). My definition can be summarized in terms of the consensus definition from a 1993 workshop on sustainable agricultural development held at the University of Florida. The workshop definition states that a sustainable agricultural system is one which over the long run, enhances environmental quality and the resource base on which agriculture depends, provides for basic human food and fiber need, is economically viable, and enhances the quality of life of farmers and society as a whole (Office of International Studies and Programs, 1994). In addition, my concept of sustainable agricultural development explicitly recognizes the fundamental relationship between population changes, environmental assimilation capacity, and technology. This particular relationship is elegantly stated by Kesseba (1993, p. 212). He argues that, "In the context of population expansion, therefore, an agricultural system is sustainable only in the context of its current carrying capacity which is transient - in the short run it is defined by a given technology. In the medium to long run, without successive changes in productivity through appropriate technological change, the system would be rendered unsustainable."

SETTING THE FOUNDATION FOR A RECONCILIATION FRAMEWORK: CONCEPT REFINEMENTS AND ELABORATIONS

In order to develop a reconciliation (integration) framework, I elect to proceed as follows: (1) refine certain key concepts and definitions presented earlier, (2) elaborate on the nature of, and functional roles of these concepts as seen from my perspective, (3) introduce additional complementary concepts, (4) set these concepts and relationships within the context of my frame of reference, and (5) articulate the essential arguments in a structured form of analysis. As I proceed from (1) through (5), I are moving conceptually in a step-wise fashion through what I referred to earlier as *visioning a desirable future* to *visioning a sustainable agricultural system*.

Agro-ecological Assets: Characteristics, Functional Role, and Sustainability Requirements

Characteristics and Functional Role

The particular environmental assets that are of concern in this paper can be viewed as the *in situ* resources that are utilized at any point in time in the production and consumption of agriculture and agriculture-related activities in tropical areas of the world. These agriculture-related assets can be conveniently classified into two types: (1) *natural capital stock* and (2) *man-made capital stock*. These two types can be further differentiated into *renewable resources* and *non-renewable* (exhaustible) resources. I also view the agriculture-related resources as *within certain limits*, having the capability for providing some substitutability between renewable and non-renewable resources and between natural capital stock and man-made capital stock. Given the characteristics of these agro-ecological resources, I now explicitly define these assets in terms of their *associated resource flows, service flows, and commodity flows* at any point in time, particularly as these flow values might be related to growth, equity (distribution), and sustainable development. These flows will be referred to as *agro-ecological assets* throughout the paper, and they will be represented by the acronym (AEA_t).

Agro-ecological asset flows (AEA_t) are viewed as playing at least three functional roles in the agriculture and related systems in tropical areas. First, they provide resources (inputs) into the production and consumption processes. Second, they assimilate wastes associated with the production and consumption processes. Third, they provide direct utility via their aesthetic properties. Following Pearce and Turner (1990, p. 41), it is argued that these three functional roles can be considered as *economic* functions because, "They all have a positive economic value: if we bought and sold these functions in the market-place they would all have positive prices." In passing, it is important to note that Pearce and Turner (1990) argue forcefully that the dangers arising from the mistreatment of agro-ecological assets (and other environmental assets) arise from the fact that the positive values for their economic functions are not generally recognized.

Sustainability Requirements

In order to meet the conservation and sustainability requirements of the development process as defined earlier, the flows from the agro-ecological assets (AEA_t) must satisfy the two basic laws of thermodynamics (the Law of Conservation of Energy and the Law of Entropy)[3], as they play the above three functional roles. Briefly stated, these requirements are met when: (1) the rate of AEA_t use is *less* than the regenerative rate of AEA_t, and (2) the rate of waste

[3]These laws are more generally referred as the First and Second Laws of Thermodynamics.

flows from production and consumption activities associated with AEA_t use, are *below or at least* equal to the capacity of AEA_t to assimilate such waste (Pearce and Turner, 1990).[4] Given these requirements, I now define agro-ecological sustainability as a *non-decline* in the value of the flows from AEA_t. This non-decline has been referred to as *constancy* (Pearce and Turner, 1990; Davis, 1992 and 1994) in the value of resource flows. This non-decline or constant value is made possible by the fact that the value of the flows is the product of the quantity of the flows and the price of the flows ($QAEA_t$ x $PAEA_t$). Given this relationship, it is possible to have a constant (non-decline) in the value of the flow by *reducing* the quantity of the flows, but *increasing* the price of the flows.[5] In addition to meeting these sustainability requirements, my definition of sustainable agricultural development would require that production and consumption activities associated with the use of agro-ecological assets (AEA_t), be economically viable, and thus enhance the quality of life (improved equity or poverty reduction) of farmers and the agricultural sector.

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[4]It is recognized that a good proportion of the consumption of agricultural productions produced in the tropics occur *outside* of the tropics. As such, AEA_t would not have to assimilate the waste flows from such consumption.

[5]This price-quantity relationship of the resource flow sustainability issues is a major development challenge facing poor tropical areas. While constancy (stability) can be attained by increasing the price of the flows to offset decreasing quantity of the flows, it is difficult to increase resource flow prices in these areas. Price is determined by the *willingness* and the *means* to pay, which are highly income-dependent. Poor people might be both *unable* and *unwilling* to pay the higher price.

Equity Revisited

In earlier discussions of the concept of equity I indicated that I would be defining this concept in terms of inequalities in the standard-of-living (SOL), which was in turn defined in terms of poverty income status. In other words, the *higher* the incidence of poverty (the proportion of a population falling below the designated poverty income threshold), the higher the degree of inequity. I now make more explicit this relationship. If the incidence of poverty income at any point in time is designated (PI_t), then the degree of equity or SOL_t can be designated as the *inverse* of PI_t $(or\ \frac{1}{PI_t})$. Stated differently, SOL (equity) and PI_t move in opposite directions.

Factoring in Non-homogeneity into Tropical Agricultural Systems

Tropical agricultural systems, in addition to having certain characteristics that differentiate them from temperate zone agricultural systems (Lal and Ragland, 1993a), are also highly differentiated *across* tropical and *within* tropical zones (Davis, 1992, 1993, 1994; Kesseba, 1993; Lal and Ragland, 1993a, 1993b; Pearce, Barbier and Markandya, 1990). These across, and within tropical zone differences can be traced to a number of factors. Some of the important ones are differences in: (1) the quality of agro-ecological assets (AEA_t), (2) policy environments, (3) technological packages, (4) institutional factors and (5) level of population pressures.

For discussion purposes, I aggregate these five factors at any point in time, under the terminology *socio-technical environments*, and designate them by the acronym (STE_t). Following procedures suggested in Davis (1993) and Office of International Studies and Programs (1994), a matrix is developed as shown in Figure 1, with the quality of the agro-ecological assets (AEA_t) as the horizontal axis (columns) and the quality of the socio-technical environments (STE_t) facing farmers, as the vertical axis (rows). The intersections of the columns and rows in Figure 1 suggest four archetypical agriculture systems in which the sustainable development issues must be addressed. The four systems are: (1) favorable agro-ecological assets and favorable socio-technical environment, (2) fragile agro-ecological assets and favorable socio-technical environment, (3) favorable agro-ecological assets and unfavorable socio-technical environment, and (4) fragile agro-ecological assets and unfavorable socio-technical environment. These four archetypical agriculture systems or types will define one of the boundary of the reconciliation analysis developed in the paper. The second boundary will be the time dimensions, as they relate to sustainablity conditions. The time dimensions (two periods) boundary will be elaborated on in the next section of the paper.

THE GROWTH, EQUITY, ENVIRONMENTAL ASSETS NEXUS IN SUSTAINABLE AGRICULTURE

Confronting the Economic Growth Issue

The issue relating to the growth, equity, environmental assets nexus in sustainable agriculture development is a major topic of debate. The dilemma confronting the developing countries within the context of this debate is vividly captured by Panayotou (1992, p. 355). He argues that, "Developing countries that are struggling to escape poverty and meet the growing aspirations of their still-expanding populations find the concern for sustainability an added burden on what is already a Herculean task." In analyzing the economic growth, equity, and environmental assets sustainability issues, Panayotou argues that sustainable development as a

		Agro-ecological Assets (AEA_t)	
		Favorable	**Fragile**
Socio-technical Environments Facing Farmers (STE_t)	**Favorable**	I. Favorable AEA_t and Favorable STE_t good rainfall and soils favorable topography favorable or non-negative policies appropriate technology facilitating institutions absence of severe population pressures	II. Fragile AEA_t and Favorable STE_t poor rainfalls and soils often sloping topography favorable or non-negative policies appropriate technology facilitating institutions absence of severe population pressures
	Unfavorable	III. Favorable AEA_t and Unfavorable STE_t good rainfall and soils favorable topography negative policies lack of appropriate technology institutional impediments presence of severe population pressures	IV. Fragile AEA_t and Unfavorable STE_t poor rainfall and soils often sloping topography negative policies lack of appropriate technology institutional impediments presence of severe population pressures

FIGURE 1. Archetypical Tropical Agriculture Systems, Defined in Terms of Quality of Agro-ecological Asset Flows (AEA_t) and Socio-technical Environments Confronting Farmers (STE_t)

concept, implies benefits to both current and future generations. Two key questions regarding the meaning of sustainability served to inform Panayotou's conclusion. One question is whether sustainability means Spartan living by the current generation of the poor so that the next generation of the poor will have a better standard of living, and if that is the case, where is inter-generational justice. Another question is whether sustainability means that future generations should enjoy the same level of poverty as the current generation, and if that is the case, why sustain poverty.

The intuitive answers to the above questions led Panayotou (1992, p. 356) to conclude that the sustainability issue was not just a simple matter of "temporal trade-offs and inter-generational transfers." I am in agreement with his conclusion. The time dimension must be a key component of the analytical boundary of the economic growth, equity, and environmental sustainability debate, and it must extend to foreseeable generations. I am also in agreement with the argument that equity improvement or standard-of-living (SOL) improvement, is fundamentally linked to sustained economic growth, and that neither (improved SOL nor growth) is congenitally linked to declining quality of agro-ecological assets (AEA_t) (Panayotou, 1992; Vyas, 1991). I have expanded on and applied these arguments to the case of the Caribbean elsewhere (Davis, 1992, 1994), and those arguments would apply equally to the situation being addressed in this paper. The position taken in these earlier papers is that sustained economic growth is a key conduit (or path) to equity improvement, and that the latter is critical to sustainable agricultural development. Of equal importance is my argument that it is neither economic growth (nor non-growth) *per se* which cause a decline in environment assets but rather, it is the *source* and *patterns* of market and policy failures that accompany such paths.

While I still adhere to the earlier arguments regarding the growth issue, I will, in this paper, explore the reconciliation issue between economic growth, equity, environmental assets and sustainable agriculture from a number of different perspectives. These perspectives might cast additional light on the issues. First, the issues will be examined in terms of alternative economic growth paths to both equity improvement (SOL or poverty reduction) and sustainable agro-ecological assets (SAE_t) for the four archetypical tropical systems developed in Figure 1, over *two time periods*. This is the four system-two period analytical boundary referred to earlier. Second, the issues will be examined in terms of alternative economic growth paths to both equity improvement and sustainable agro-ecological assets, for these four archetypical tropical systems, over two time periods, under the assumption that some *minimum* level of agro-ecological assets (AEA_{tmin}) flows are *necessary* to meet some *subsistence* standard-of-living.

The concept of an economic growth path moving through some minimum level of agro-ecological assets utilization flows *cum* a particular standard-of-living (SOL), is in keeping with an analytical framework suggested by Pearce and Turner (1990). However, I have modified the Pearce and Turner analytical framework to take into account the fact that: (1) the growth paths associated with equity (SOL) improvement and the use of flows from agro-ecological assets (AEA_t) might be significantly different if evaluated at a time period *when AEA_t might not have actually reached* the limits of their sustainability (carrying) capacity, (*although they might be approaching it)* as against another period when AEA_t might have *reached or exceeded their* sustainability capacity, and (2) different archetypical tropical agriculture systems might exhibit significantly different behavior in the growth paths associated with improved SOL and AEA_t flows utilization, depending on which of the two time periods selected for analysis.

The Reconciliation Paradigms

The basic reconciliation (or integration) paradigms can be described as a two period - four systems analytical framework.

The first time-period (TP_1) is some *historical point in time* during which tropical agriculture systems might be utilizing the aggregate resource flows from their agro-ecological assets (AEA_t), at rates which might place these systems *below* (albeit *near* to) the limits of their sustainability capacity. This historical point in time would vary across regions and among systems. The second time-period (TP_2) is *another point in time* (past, present or future), where these same tropical agriculture systems might be utilizing the aggregate resource flows from their agro-ecological assets, at rates in *excess* of the limits of their sustainability capacity. Again, this point in time would vary across regions and among systems.

The four systems associated with the two time-periods are the four archetypical tropical agriculture systems emerging from Figure 1. Figure 2 shows the paradigms depicting how the reconciliation issues might be characterized. The vertical axis shows the standard-of-living (SOL_t) at any point in time, which as discussed earlier, is a reflection of the degree of equity in the society, sector, or subsector and is also the *inverse* of the incidence of poverty $(\frac{1}{PI_t})$. The horizontal axis shows the aggregated flows of the agro-ecological assets being utilized at any point in time (AEA_t). Recall that AEA_t flows can be derived from any combination of natural and man-made capital stocks. Also, that AEA_t flows can be from any combination of renewable and non-renewable resources, and that within certain limits, there is some scope for substitution between resource types. It is also important to recall that AEA_t flows are explicitly

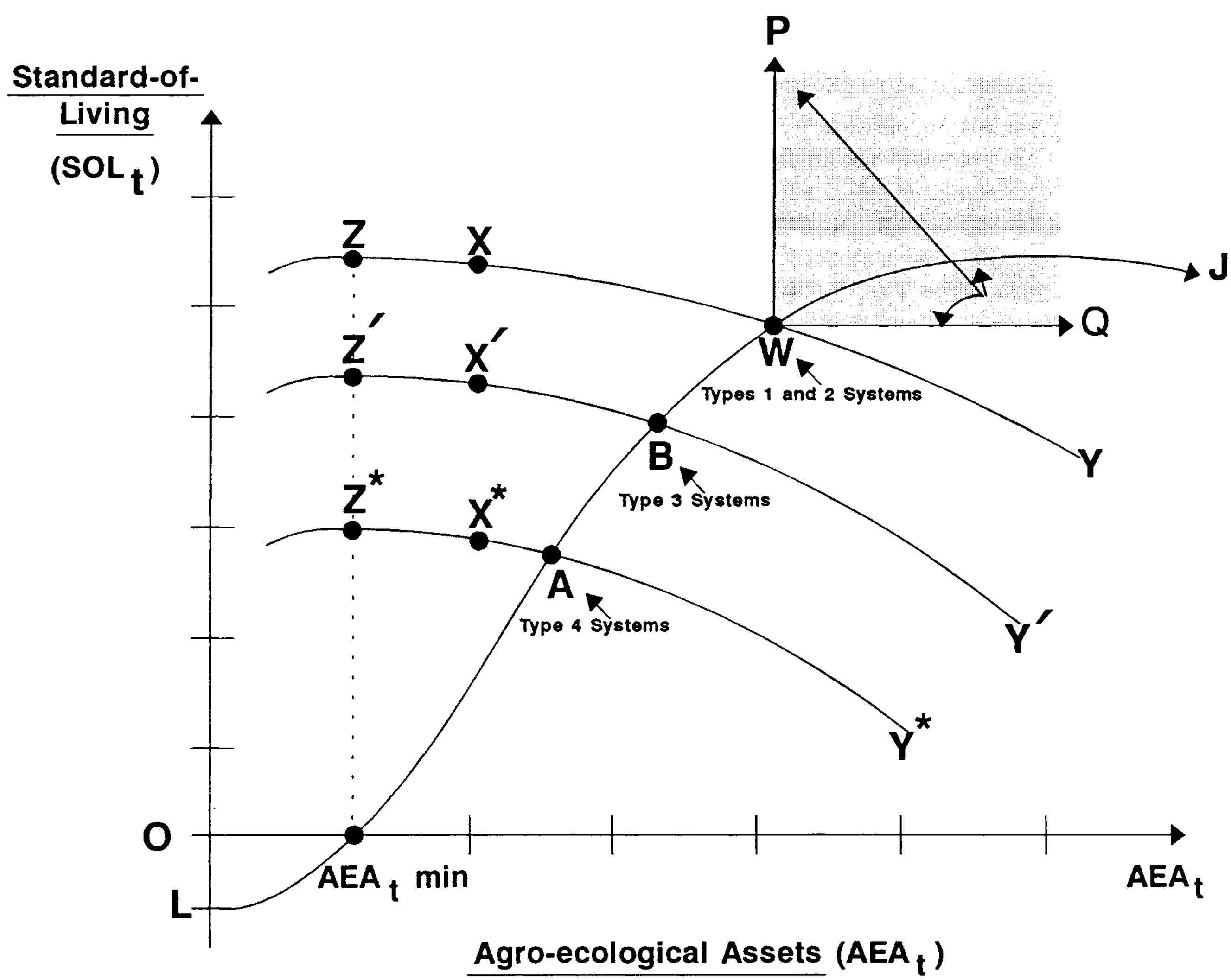

FIGURE 2. Two Period-Four Systems Paradigms of Economic Growth, Standard-of-living, and Sustainable Agro-ecological Assets Relationships

defined in terms of their value in performing the functional roles discussed earlier. These resource flows assume economic value because they have a quantity (Q) component and a price (P) component, and value is the product of the quantity and price components of the resource flows ($QAEA_t$ x $PAEA_t$).[6]

The origin O can be viewed as some *positive* subsistence standard-of-living at any point in time (SOL_t). Given this positive subsistence SOL_t, any decline below this O level, to say point L on the negative scale of the SOL_t axis, would represent a situation below the subsistence standard-of-living. The point AEA_{tmin} corresponds to some minimum level of agro-ecological assets service flow from AEA_t that is *necessary* to meet the subsistence standard-of-living at point O on the SOL_t axis. The use of AEA_t to obtain a service flow causes a depreciation of AEA_t, some of which can be partially compensated for by resource substitution, including man-made capital[7]. Other points in Figure 2 will be discussed in relation to the specific time-period and type of tropical agriculture system being discussed. The two period-four system reconciliation framework will now be developed within the context of the relationships postulated in Figure 2.

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[6]There is no inconsistency associated with expression of AEA_t flows in terms of their price (P) and quantity (Q) components, as these components relate to sustainability requirements. It could be argued that Q could approach 0, and P approach infinity, and hence AEA_t flows would be 0 (i.e. stable). This situation is not possible in the model presented here. By definition SOL_t is some *positive* subsistence level at 0 on the vertical axis of Figure 2, and AEA_{tmin}, is greater than 0 on the horizontal axis. Any utilization of AEA_t flows *below* AEA_{tmin} (left of Z, Z′, Z^*) would decrease SOL_t to *below* a positive subsistence level.

[7]This view is the *opposite* of the view held by some economists who argue that man-made capital and natural capital are *complements* and as such, *cannot* be substituted for each other (See, Costanza and Daly, 1992).

<u>Reconciliation Nexus in Period When AEA_t Might be Approaching, but is Below the Limits of Agro-ecological Sustainability Capacity</u>

A fundamental question of concern here is what might be the salient characteristics of the economic growth, equity, and agro-ecological assets sustainability relationships for the four archetypical tropical agriculture systems (Types 1, 2, 3 and 4), during this reference period scenario. It is argued that the economic growth paths through which equity (SOL_t) improvement and sustainable agro-ecological assets (AEA_t) might be reconciled, should be expected to vary among different types of tropical agriculture systems. The reason for this argument is that intuitively, the *intersection characteristics* of elements in columns of the agro-ecological assets (AEA_t), with elements in the rows of the socio-technical environments (STE_t) as shown in Figure 1, suggest that serious economic discontinuities (or filtering) might be associated with the different socio-technical environments (STE_t). I view the elements of the STE_t as intermediate or meso-economic variables (Behrman, 1990) which by the nature of their interactions with the flows of the AEA_t, and the growth components, can result in major differences in the reconciliation issues between and among the different types of tropical systems. These differences would vary to a greater or a lesser degree between systems within the historical point in time being considered here. Based on these considerations, I propose a number of reconciliation relationships that might be expected for Types 1-4 tropical agricultural systems during this period of analysis.

To begin with, it is suggested that *all four* agriculture systems would have a *common starting point* on their economic growth paths at AEA_{tmin}. This common starting point is based on the earlier argument that for all systems, some minimum level of service flows from agro-ecological assets are necessary to meet some positive subsistence standard-of-living (SOL) at point 0. The illustrative economic growth paths followed by the Types 1 and 2 tropical systems might be viewed as $AEA_{tmin}WJ$. For Type 3 systems it would be $AEA_{tmin}AB$, and for Type 4 systems it would be $AEA_{tmin}A$. It should be noted that the reconciliation growth paths followed by the Type 3 and Type 4 systems are in actuality tracing outs of sub-growth paths at points B and A respectively, on the $AEA_{tmin}WJ$ path of the Type 1 and Type 2 systems. The primary concern is the nature of the alternative growth paths for these variant tropical systems (Types), particularly as these paths define functional relationships between equity (SOL) and agricultural sustainability considerations.

A fundamental and *common* functional relationship exhibited by the growth paths $AEA_{tmin}WJ$ (Types 1 and 2), $AEA_{tmin}AB$ (Type 3), and $AEA_{tmin}A$ (Type 4) is that over the time period being considered here, improved SOL (equity) *requires* increased service flows of agro-ecological assets (AEA_t). In other words, increased SOL can *only* be achieved by *increasing* the use of AEA_t service flows. This positive relationship can be thought of as exhibiting elements of *complementarity, within the context of the time period scenario being discussed.*[8] I suggest that within the context of this basic positive relationship, that the higher SOL (equity) associated with higher service flow levels of AEA_t at point W (Types 1 and 2), compared to those at point B (Type 3), and point A (Type 4), are fundamentally linked to the differences in the *interactions* of the socio-technical environments (STE_t) and the agro-ecological assets (AEA_t) by type (Figure 1).

[8]It cannot be *overemphasized* that this positive relationship will only hold under the given specification of systems with respect to their sustainability characteristics during TP_1.

Movement along growth path $AEA_{tmin}WJ$ to point W, the location of the favorable AEA_t-favorable STE_t of Type 1 systems, and to a lesser degree, the fragile AEA_t-favorable STE_t of Type 2 systems, would permit these systems to increase the standard-of-living (SOL) with increased service flows from agro-ecological assets. This is not an option for the systems at points B (Type 3) and point A (Type 4). Recall that Type 3 systems are those with favorable AEA_t-unfavorable STE_t, and that Type 4 systems are those with fragile AEA_t-unfavorable STE_t. It is suggested that in the case of the Type 1 systems, the greater SOL_t is fundamentally linked to: (1) the more favorable natural capital stock, (2) ability for greater substitution of man-made capital stock for natural capital stock, as a result of more appropriate technology, (3) the more favorable policy and institutional environments, and (4) the absence of population pressures, which might offset other facilitating developmental factors. Despite the fragile nature of the AEA_t associated with Type 2 systems, I none-the-less position these systems at the same point W with the Type 1 systems. Conceptually, I rationalize this position on the argument that the favorable STE_t enjoyed by these systems, permitted them to follow a growth path to higher SOL_t.

It should be noted that no argument is being made that the favorable AEA_t-favorable STE_t of Type 1 systems, or the favorable STE_t but fragile AEA_t of Type 2 systems, permit these systems to maintain a higher SOL_t indefinitely. For one thing, there are limits to the degree of substitution which can occur between natural capital stock and man-made capital stock, even under the most favorable set of institutional, policy, and technological circumstances. Substitutability of resources cannot in the longer run delay arrival at the limits of agro-ecological sustainability, if systems' carrying capacity rates are exceeded. It is within this context that I draw attention to the shaded area PWQ at point W in Figure 2. This shaded area might be illustrative of the reconciliation issues confronting Type 1 and Type 2 systems which might have been enjoying relatively high SOL_t via higher service flows from agro-ecological assets, but are now conscious of their relatively close proximity to their sustainability limits. Within the shaded area PWQ, these systems still have the choice of increasing SOL_t via expansion of AEA_t service flows, based on the fact that: (1) they are still located within the complementarity range of the growth path and (2) they still have not exceeded their sustainability limits within the time period being considered. Within this context (PWQ) the reconciliation choices become: (1) achieving additional improvement in SOL_t, via additional use of service flows from AEA_t or (2) achieving additional improvement in SOL_t, by holding the value of the service flows from AEA_t constant.[9]

Recall the earlier definition of a sustainable system as one having a *non-decline* or *constancy* in the value of resource (service) flows from AEA_t, during the process of achieving developmental objectives. P and Q represents the price and the quantity, respectively, of the resources flows from AEA_t within the shaded area PWQ. At W, (shaded area PWQ) it is possible for Type 1 and Type 2 systems to assign *higher prices* to the flows of AEA_t, while they make conscious decisions to *reduce* the quantity of the flows from AEA_t. By so doing, these systems can hold the value of the AEA_t flows constant, and still achieve higher standard-of-living (SOL). Within the area PWQ, the attainment of higher SOL_t with *declines* (non-constancy) in the aggregate flows of AEA_t is not a feasible choice. This is the case because SOL_t and AEA_t are positively related (complements). The choices here involve policy decisions relating to what

[9]This is also true for systems located at points A and B along the line path to J. However, given the relatively low SOL_t and the unfavorable STE_t confronting these systems, service flows conservation might be assigned a lower priority at these points.

was referred to earlier as *visioning a desirable future* and visioning a *sustainable agricultural system*. The unfavorable socio-technical environments (STE_t) confronting the Types 3 and 4 systems are major factors explaining the disparities in the SOL_t between these systems, compared to the Types 1 and 2 systems. However, in spite of the sharing of common unfavorable socio-technical environments, the Type 3 system by virtue of a more favorable AEA_t is the recipient of higher SOL_t than the Type 4 system.

The diversity of the constraints imposed by the unfavorable socio-technical environments (STE_t) on the scope for enhanced SOL_t, via use of AEA_t flows, is vividly captured by the location of the Types 3 and Type 4 systems at points B and A, respectively. For these two systems, it is clear that in the face of unfavorable population pressures, negative policies, institutional impediments, and inappropriate technology (unfavorable STE_t) the aggregate values of the service flows from AEA_t are well to the left (lower) of point W, which is the location of the service flows for the Types 1 and 2 systems.

Tropical agriculture systems corresponding to Types 3 and 4, must accord high priority to policy changes and strategies designed to remove developmental constraints imposed by the socio-technical environments (STE_t). Removal of such constraints is imperative for effective exploitation of complementary relationships that might exist between improved SOL_t and AEA_t flows under the conditions specified in this period of analysis. I argue further, that policies and strategies relating to the development and utilization of appropriate technologies (including resource management techniques) for Type 3 and Type 4 systems, should be accorded high ranking on the policy agenda at the national and global levels. The availability of such technologies is a prerequisite for natural capital stock (resource) augmentation, which is increasingly being recognized as a necessary condition for continued and increased agro-ecological assets (AEA_t) flows and associated improvement in SOL_t in these two types of systems. This developmental approach takes on a higher degree of urgency in the Type 4 systems (unfavorable (STE_t-fragile AEA_t), where the magnitude of the disfunctional relationships between agro-ecological assets use and human conditions (poverty) have reached alarming proportions in tropical areas (Scherr and Hazell, 1994).

Reconciliation Nexus in Period When AEA_t Might be at the Limits of Agro-ecological Sustainability Capacity

This section deals with the characteristics of the economic growth, equity, and agro-ecological assets relationships of the Types 1-4 agriculture systems during the second reference period scenario. This time period (TP_2) can be the past, present or the future, and it would vary among systems. The relationship between TP_1 and TP_2 lies in the fact that in *both* periods, tropical agriculture systems would share the *common starting point* AEA_{tmin} on their economic growth paths, as shown in Figure 2. Types 1 and 2 systems would have arrived at point W during this period of analysis via the growth path $AEA_{tmin}WJ$. Type 3 systems would have arrived at point B via growth path $AEA_{tmin}AB$, and Type 4 systems at point A via growth path $AEA_{tmin}A$.

Within the context of the scenario conditions specified in period two (TP_2), a *common* functional relationship exhibited by the reconciliation nexus between improved standard-of-living (SOL_t), and increased utilization of agro-ecological assets service flows (AEA_t), is that they are *competitive* (substitutes). This means that at points W, B, and A for Types 1 and 2, Type 3, and Type 4 agriculture systems, respectively, improvement in SOL_t can *only* be achieved by *reducing* the value flows of AEA_t. In other words, the reconciliation issue become essentially a *trade-off* issue. This trade-off issue can be thought of as the forcing of a shift from the respective reconciliation growth paths followed in the time period one (TP_1) analysis, to alternative paths in time period two (TP_2). These alternative reconciliation growth paths are illustrated in Figure 2.

For Types 1 and 2 systems located at point W, the new reconciliation growth path is now defined by the curve ZXWY. For Type 3 systems located at point B, it is Z'X'BY', and for Type 4 systems located at A, it is $Z^*X^*AY^*$. Recall that according to earlier definition of a sustainable agricultural development process, the system *must* experience a *non-decline* (or have constancy) in the resource (service) flows from AEA_t during the process of achieving higher SOL_t. At time two, by definition the resource flows from agro-ecological assets (AEA_t) are being used at rates in *excess* of their sustainability capacity, hence these assets are declining (depreciating). This gives rise to a trade-off reconciliation situation. Now, at point W (Types 1 and 2) by *increasing* the service flows of AEA_t to say point Y (moving AEA_t to the right), this would entail *sacrificing* (reducing) some SOL_t; while *reducing* the service flows to say points X or Z (moving AEA_t to the left), would result in *increased* SOL_t. Comparable effects at point B (Type 3) would result from movements to point Y', and then to points X' or Z'. At point A, the equivalent effects would be associated with movements to point Y^*, and then to point X^* or Z^*.[10]

[10]The limits to which AEA_t service flows can be given up (reduced) in order to receive improved SOL_t is bounded by the points, Z, Z' and Z^* for systems at W, B and A, respectively. Note that these Z points *corresponds* to AEA_{tmin}. Any utilization of service flow levels to the left (below) AEA_{tmin} would generate a negative subsistence SOL_t.

It has been suggested that the trade-off situation depicted in the time period two (TP_2) scenario may not be an issue in the early stages of development (Pearce and Turner, 1990). This argument is based on the assertion that environment and development (increased SOL_t) tend to become substitutes, rather than being positively related (complements), only after economic take-off has been achieved, and a point such at W (Types 1 and 2) has been reached. I suggest that this depiction might not adequately capture the real-world situation confronting tropical agriculture systems. Many tropical agriculture systems *that are still in the early stages of development*, find it difficult to effectively exploit a positive relationship between improved standard-of-living (SOL_t) and agro-ecological assets utilization (AEA_t), because of the negating interactive effects of certain environmental and socio-technical factors. This is indeed the case for the Type 3 and Type 4 agriculture systems, as discussed in the earlier period one analysis. A major implication of this point is that failure to differentiate tropical agriculture systems according to socio-technical characteristics and agro-ecological assets characteristics as done in this paper (Figure 1), can lead to faulty generalizations regarding the nature of the development-environment reconciliation issue. I also suggest that while some tropical agriculture systems might relate to the period two (TP_2) trade-off scenario strictly in terms of some *future probability*, for other systems it might be the *reality of their present situation*. The development policies and strategies would vary by systems, depending on their particular situation within the time continuum.

For tropical agriculture systems confronted with trade-off problems between environmental integrity and development, the basic question has to do with how do they treat their stock of agro-ecological assets (AEA_t) so that they can play their part as a source of improved standard-of-living (SOL_t). Kesseba (1993, p. 215) suggest that a critical step in answering this question is "to identify the key leverage points for assisting poor rural populations to effect a transition to economically viable and ecologically sustainable agriculture." I suggest that these key leverage points are highly *interactive* and should be addressed in an *integrative* manner in the mounting of sustainable agricultural development strategies in these types of systems.

First, emphasis must be given in such strategies to *heightened emphasis on agro-ecological assets (AEA_t) management.* Within the context of this approach, it is imperative that recognition be given to the observation that agro-ecological assets (resources) management is a function of "higher level systems than the commodity" (Food and Agriculture Organization, 1993, p. 7). It is argued that such an approach is necessary for understanding and addressing the interactions between people and the agro-ecological assets. It is the human interactions with agro-ecological assets which cause environmental degradation, resource depletion, and hence unsustainable agricultural systems. As such, both the manifestation of the unsustainability of the agro-ecological assets use and options for its solution are location-specific (Food and Agriculture Organization, 1993).

Second, constraints or impediments to improved standard-of-living (SOL_t) associated with agro-ecological assets (AEA_t) use must be removed. I have identified and categorized these constraints under the label socio-technical environments (STE_t) in Figure 1. These include: (1) policy issues (2) technology issues (3) institutional issues and (4) population pressures. The development and dissemination of technology and resource management practices, suitable for the socioeconomic and agro-ecological conditions of tropical systems facing population pressures are key leverage points in strategy development. Tropical agriculture systems facing trade-off situation between improved standard-of-living and agro-ecological assets sustainability must find ways of increasing the *efficiency* with which agro-ecological assets are used. Technological innovations are key components of such efficiency. Such innovations need *not be solely* low input technologies. Also, such technologies would include more effective substitution of man-made inputs for natural resource inputs (resource augmentation) in environmentally benign ways. Agricultural research and investment are major dimensions of this technological underpinning.

SUMMARY AND CONCLUSIONS

Clarity of, and understanding of the key issues relating to the reconciliation of economic growth, equity, and environmental sustainability dimensions of tropical agriculture development are necessary for the mounting of effective development strategies for the twenty first century. I argued that conceptual definitions and elaborations are key components of productive dialogue on the issues, and attempted to facilitate this dialogue by developing a reconciliation framework embedded in certain key concepts. The reconciliation framework consisted of the following processes: (1) development and refinement of key concepts, (2) articulation of the nature of, and functional roles of key concepts within the reconciliation framework and (3) development of the essential arguments in a structured form of analysis.

I concluded that fruitful discussions on the reconciliation issues must at *a minimum*, recognize that outcomes might vary, depending on: (1) the *type* of tropical agriculture systems, as defined by *interactions* between the characteristics of agro-ecological assets and the characteristics of socio-technical environments, and (2) the *time period* scenario used for the analysis, with respect to the *location* of the tropical agriculture systems *below or at the limits* of their agro-ecological sustainability capacity. Tropical agriculture systems that have *not* reached their agro-ecological sustainability limits, faces growth, equity, and environmental reconciliation issues that must be addressed within the context of a *positive relationship* or *complementarity* between resource use and improved stand-of-living, given certain constraints. Tropical agriculture systems that have *reached* their agro-ecological sustainability limits, faces growth, equity, and environmental reconciliation issues that must be addressed within the context of *trade-offs* between improved standard-of-living and resource use, given certain constraints.

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