Chapter 4 – Latin America and the Caribbean (LAC)

KNOWLEDGE, SCIENCE, TECHNOLOGY AND AGRICULTURAL INNOVATION SYSTEMS (KSTAI): OPTIONS FOR THE FUTURE

Coordinating lead authors: Inge Armbrecht (Colombia) Flavio Avila (Brazil)

Lead authors: Jorge Blajos (Bolivia), Patrick Lavelle (France), Lucia Pitalluga (Uruguay), Jorge Iran Vasquez (Nicaragua), Dalva M. da Mota (Brazil), Sergio Salles- Fillho (Brazil)

Review Editors: Edelmira Perez (Colombia), David Williams (USA)

Contents

Key Messages

KSTAI systems need greater interaction and in different ways, including exchanging experiences and combining different bodies of knowledge to correct weaknesses and share strengths. One encouraging factor is the great diversity of KSTAI systems in Latin America and the Caribbean that may be grouped into three major knowledge systems that are not mutually exclusive and may complement each other.

Prioritize the development of KSTAI systems (conventional, agro-ecological or traditional) whose practical results contribute to achieving the IAASTD goals of sustainable development.

Promote the generation and dissemination of information on all the trade-offs between different aspects of rural development (e.g., agronomical, economic, social, cultural and ecological) and between the various actors (producers, corporations, society in general).

Focus on seeking more rational and effective solutions to prevent environmental degradation caused by poor management of water, soils and forests, which is a serious problem throughout Latin America and the Caribbean. Payment for environmental services is one possible option.

Promote a systemic vision of agro-forestry and cattle raising activities by combining the agro-ecological approach with the strengths of the other two systems (conventional and traditional/indigenous) for the (short-, medium- and long-term) evaluation of the results of the three approaches in terms of cost benefit.

Develop and strengthen educational programs and programs for the preservation of crops/know-how and agricultural research by and for local and indigenous communities by empowering local communities and combining their know-how with agro-ecological techniques. Promote training and the generation and ownership of new knowledge by producers and local consumers. Facilitate the organizational mechanisms (generated by the KSTAI systems) of small and medium-sized producers.

Develop conventional knowledge in genetics, physiology, agronomy, engineering and bio-remediation, provided that they fulfill the IAASTD goals, by emphasizing those achievements that in the past proved to be positive over time and space.

Create systems for the exchange, socialization and dissemination of knowledge. Synthesizing knowledge and socializing/disseminating it within the three systems identified (conventional, traditional and agro-ecological) requires the use of new institutional tools that are appropriate to each context. The creation of specialized networks in certain sectors or specific crops may be an option for strengthening the interaction between these three systems of knowledge and technology.

Promote participatory research for the generation of knowledge and models of endogenous development that reconcile the objectives of the different groups of farmers (agro-industrial, agro-ecological, family and peasant) and respond to local needs and above all to the need for social equity. The new development models place emphasis on sustainable development, protection of the environment and energy efficient systems. Promote popular participation to ensure that development is socially just, since this type of justice is not necessarily achieved automatically.

Promote exchanges at the regional level between the KSTAI systems of the different countries, by sharing experiences and combining various types of know-how and knowledge systems in order to remedy weaknesses and share strengths. In this way advantage can be taken of existing mechanisms for international cooperation.

Strengthen national bio-security agencies as a means of ensuring compliance with the principle of precaution (through the KSTAI system) when introducing new technologies and before the release of genetically modified organisms for the prevention, detection and reduction of risks to health and to the environment.

Create new organizational and management models (governance models)

Given the weaknesses in the structure, design and management of KSTAI systems in Latin America and the Caribbean, one option being presented is the proposal of new models for the exchange of experiences in the adoption of different organizational and management models by the governments of the region that promote greater efficiency and effectiveness in their respective systems.

Research into social and peasant movements

(Via Campesina, MST) and the promotion of structures that facilitate dialogue between them and other actors in the society and in KSTAI systems. Identify the positive impacts of social movements on IAASTD objectives. Also analyze why and under what conditions agricultural enterprises have made progress towards achieving the goals of IAASTD in Latin America and the Caribbean.

Recognition of the important role of the indigenous/peasant KSTAI in the generation and conservation of native, forest and domestic agro-biodiversity[1] and their intellectual property rights. In order to contribute to the goals of IAASTD, it is necessary to achieve a more equitable distribution of all of the benefits derived from those genetic resources and the traditional knowledge associated with them. The recognition of intellectual property rights is a proposal that has generated a great deal of discussion both for and against. The State needs to adopt policies for the protection of common intellectual property and the KSTAI systems must incorporate crops and forgotten varieties into the productive chain.

Research, promote and strengthen links between local producers and consumers of foodstuffs, at the local regional and international levels (certification).

Modernize the KSTAI system. KSTAI systems must adapt in order to support these changes at the level of academic training (from primary school to a university) and programs of continuing education for all members of society. There is need for greater collaboration between agronomy and ecology and for a more systemic approach to the agricultural sectors. The transition towards more sustainable systems of production requires a democratization of the KSTAI process (prioritization, generation, access, use and evaluation). The basis of democratization is the recognition and development of traditional KSTAI systems and the strengthening of local organizational structures.

The development of KSTAI through the integration of production, agro-ecological and traditional/indigenous know-how must focus on strategies for the protection of the immense biodiversity of Latin America and the Caribbean and strengthen the peoples of the region in their

[1] Understood as planned diversity (of seeds and species cultivated for production and the unplanned diversity of varieties that contribute to other environmental services, such as pollinating insects, vertebrates that disseminate

understanding, access and sustainable use of this patrimony. Biodiversity is the principal source of opportunities for the development of new products and may be the answer to the growing demand for food (quality and quantity) and other products.

Investment strategies, infrastructure and facilities are needed to promote better education and the inclusion of women in the generation of KSTAI and in technology transfers. In Latin America and the Caribbean, emphasis is being placed on migration (internal and international) which creates situations in which women are increasingly involved in agricultural tasks, the care of domestic animals, and other subsistence activities.

4.1. Introduction

The consequences or threats from the situation described in the preceding chapters represent both opportunities and challenges for the Latin American KSTAI system. In Latin America and the Caribbean there are more than 53 million undernourished people and the region is also the one with the greatest inequality in the world (FAO, 2004, page 17). Despite the technological advances of the last few decades, the availability and production per capita of cereal has declined globally over the last 20 years (Pimentel, 2006) and the infant mortality rate continues to be too high at 28 per 1000. It is believed that the so-called developing countries will account for 85 per cent of the global increase in the demand for cereal by 2020 (690,000 tons) (Avila et al, in press). The member countries of FAO have pledged to reduce hunger by half by 2015. The goal is to encourage the countries of the region to pursue public policies that promote the eradication of hunger in Latin America and the Caribbean by 2025 and improve environmental sustainability and social equity. FAO will contribute to the achievement of these goals by providing support in five areas: strengthening of the institutions that guarantee food security and nutrition in each country, South-South cooperation between countries of the region and between these countries and countries in other continents, training in food security, and awareness-raising and communication about the problem of hunger, Latin American networks and the regional political framework, and monitoring and applied research to promote food security.

There are possibilities for stopping and reversing environmental degradation, inequality and poverty based on the capacity for innovation and analysis of societies in Latin America and the Caribbean and with international cooperation. For example, one of the options, namely the organic or agro-ecological production of foods, can significantly increase food production, provide food security for Latin America and the Caribbean, and continue to provide a high level of other environmental soil services (Francis, 2003; Ruiz- Rosado, 2006). This chapter presents possible ways in which the knowledge, science and technology system can contribute effectively to the achievement of the goals of sustainability that have been set (reduction in hunger and poverty, improvement in nutrition and human health, sustainable economic development, improvement in quality of life and equity, and sustainability of the environment) in Latin America and the Caribbean. These options are presented based on an analysis of the implications or impacts expected in each one of these areas based on

---

seeds, organisms (microorganisms and metazoans) that protect plants from pests and adjust the configuration of their genes to the conditions of the ecosystem.

the analysis of the current and historical situation and, where possible, in accordance with the characteristics of the sub-regions: (alphabetically) 1. Amazonia; 2. Andean; 3. Caribbean; 4. Central American; 5. Mexico; 6. Southern Cone; (Annexes 1-6). These options are supported by data and rigorous literature from the joint exercise of the preceding chapters plus independent work.

The aim of this chapter is to identify the principal ways in which KSTAI systems can contribute effectively to the achievement of the goals of sustainability in Latin America and the Caribbean. It is therefore necessary to seek ways to: (1) strengthen the impact of the KSTAI system. This section comprises four parts: diversity of KSTAI systems in Latin America and the Caribbean; sustainable environmental and socioeconomic development; climate change and bio-energy; biodiversity; (2) strengthen capacities for generating, socializing, accessing and adopting KSTAI. The options within each one of these two parts are indicated and highlighted in bold in order to quantitatively distinguish them.

4.2. Options for improving the impact of the KSTAI system

The attributes of a successful KSTAI are: (1) the political and socioeconomic impetus and incentives that lead to the generation, access and use of KSTAI; (2) those in which organizations act like learning organizations; (3) legal networks including intellectual property rights (IPR), multidisciplinary approaches and by multiple actors, organization by level and stages of KSTAI, continuity, response capacity, and democracy.

The methodology used to identify options that would lead to strengthening of the impact of the system of knowledge, science, technology and agricultural innovation was based on a double-entry matrix in which each option proposed was analyzed in the context of each of the sub-regions and goals of IAASTD (Annexes 1-6). In order to provide a context within the complexity of the problem raised, the options for the future were analyzed schematically based on three extreme approaches to or typologies of agricultural production (and the knowledge systems that support them) (Figure 1) in which the various Latin American producers may be situated along a continuum of agriculture, cattle farming or aquaculture, fishing and marine.

4.2.1. Diversity of KSTAI in Latin America and the Caribbean

4.2.1.1. Integration of KSTAI

KSTAI systems need to interact more and in different ways. This could be done through the exchange of experiences and combining of different types of knowledge and know-how to remedy weaknesses and share strengths. One welcome aspect is the great diversity of KSTAI in Latin America and the Caribbean: one type of know-how does not exclude the other.

The management options being pursued in Latin America and the Caribbean combine in different proportions the three types of know-how and technologies (see Chapter 1 and Figure 4.1). The conventional approach taught by universities and advanced technical institutes support agro-industry; agro-ecology generated in universities and some NGO’s serves to create more diverse systems in

terms of the production of environmental goods and services; and the local/traditional know-how taught within families and in local social groups is based on extractive approaches and low input family agriculture. It is clear that in the particular case of each management typology (exploitation) (Figure 4.2), the system utilizes different proportions of each type of KSTAI.

However, it is evident that these systems interact very little with each other, despite such initiatives as the FAO farmers' schools and the numerous initiatives of NGOs and institutions (**http://www.fao.org/ag/agl/agll/farmspi/**;)

A quick analysis shows that while agro-industrial systems achieve the goals of production and economic yields sometimes at the cost of severe depletion of the national capital, agro-ecological systems are much better at preserving the capacity of the systems to produce the various goods and services from the ecosystem, even though their productivity and yield can improve, although this is increasing rapidly as they improve (Figure 4.1).

Insert Figure 4.1

Traditional systems are better at maintaining environmental services for crops because they are based largely on the empirical knowledge of the human populations that have lived sometimes for many generations in the environment. However, these systems no longer appear to be adapted to the current population pressure nor to the need for economic improvement of the populations that practice such agriculture. They often fail in their efforts to prevent poverty and other related ills (lack of equity in terms of gender and social groups; malnutrition), while their effects on the provision of the other environmental services are sometimes quite negative: fertility of soils diminishes as their carbon sequestration propensity declines (climate control) as does their capacity to filter, purify and store water (water services) and to maintain biodiversity in plants, microorganisms and animals, both in the soil and in the air of the ecosystem.

Insert Figure 4.2

The option proposed therefore argues that it is necessary to bring about changes in the respective systems that bring them closer to other systems in order to take advantage of their strengths and to optimize the practices of each of the three groups identified. In an ideal world, the differences between locally observed practices should not depend on their economic resources and possible access to formal education but rather on how producers can adapt to the restrictions imposed by the environment and market conditions.

There is need for partnerships between researchers, extension workers, producers and producer associations for the pursuit of research, which is only one step in a very complex process that requires more than partnerships. The conventional model that separates those who conduct research

from those who disseminate the results and, in particular, from those who use the resulting product showed that many of the alternative technologies generated are not useful, especially to traditional producers (families, indigenous groups) (Salles Filiho and Souza, 2002; Embrapa, 2006).

It is also necessary to encourage a debate on what should be the role of each of the agents of KSTAI and which scientific, technological and innovation policies should be applied in rural areas of Latin America. Parallel initiatives waste efforts, resources and time and does not allow for the development of a common approach to dealing with challenges that have already transcended national frontiers (FAO, 2004). An ongoing training program is recommended in the design and implementation of scientific, technological and innovation policies. This is necessary in order to meet the challenges of social inclusion and the new demands of markets in which protecting the environment and the health of consumers are prerequisites (Embrapa, 2004; FAO 2004).

4.2.1.2. Priority to basic and applied research that support the goals of IAASTD.

KSTAI systems should give priority to research whose practical results demonstrably contribute to the goals of IAASTD, that is to say, demonstrate improvements in living standards for local populations, social equality, gender equality and environmental health, and not merely improvements in productivity per se. Without understanding the underlying ecological and social mechanisms that create inequality, hunger and environmental degradation, it is difficult to attack its causes, which is why basic research is also needed.

It is clearly not possible to achieve IAASTD goals one at a time, since the goals are all interconnected. In Amazonia, for example, the promotion of cattle raising as the only land exploitation system can lead to satisfactory living standards for certain groups, but the disadvantages in terms of gender equality and equality between social groups and the deterioration of environmental functions make it unsustainable (see Annex 1). Only a holistic vision in which the different goals are considered together and the best trade-off sought between them in the socio-economic and biophysical conditions of the land can make this possible.

The following model (Figure 4.3) shows how the different parameters of the socio-economic environment are related to the creation of a landscape, including the biodiversity that is located within this landscape, and the environmental services that are produced (Lavelle, 2006 after Mattison and Noris, 2005). Implicit in this representation is the improvement of human well being through the sustainable production at a high level of environmental goods and services (Mattison and Norris, 2005).

Insert Figure 4.3

The model in Figure 4.3 shows how the socio- economic environment determines a type of composition and organization of the landscape that creates space for a certain biodiversity, which participates in the supply of environmental goods and services and the maintenance of the well being

of communities (Lavelle 2006). It is essential to understand the relationships between these different entities and to identify the levers (propulsors) and the threshold effects in these relationships in order to model the system of interactions and improve the handling of all resources, human, economic and ecological.

It is also necessary to prioritize the research on options for increasing incomes (returns) and promoting conservation of biodiversity with a gender perspective. Initiatives targeted to women improve family incomes and help realize the potential of the know-how accumulated by them and which until recently has not been recognized (Cavalcanti and Da Mota, 2002; IICA, 2004).

4.2.1.3. Development and strengthening of agricultural programs by and for local and indigenous communities

The development and strengthening of educational programs, crop preservation and knowledge retention, and agricultural research by and for local and indigenous communities. Empowerment of local communities by combining their know-how with agro-ecological expertise. Local and indigenous know-how is generated and disseminated within small social groups (family, town, association). Rarely is this know-how broadly formulated and recognized outside the local environment. This situation makes it difficult to use and develop the capacity to observe and understand the functioning of the ecosystems developed by these populations (Veiga and Albaladejo, 2002). Knowledge of the functions of local biodiversity and other natural resources would be very useful in developing agro-ecology which depends to a great extent on intimate knowledge of the natural conditions that are peculiar to each region/culture. This knowledge should also enrich conventional knowledge to help correct any negative environmental impacts of these practices without reducing their productivity and economic value. For this, it is necessary to develop the different types of knowledge through research. Dialogue between different branches of knowledge serves to develop the existing regional biodiversity as well as agricultural research capacity, thereby helping to resolve the problems of rural communities (Embrapa, 2006; IICA, 2004; Veiga, 2002).

However, traditional knowledge has been sometimes used for economic purposes where those who have the knowledge have not benefited from it (Santilli, 2002; Lima and Bensunsan, 2003). One option is to develop mechanisms for regulating access to traditional knowledge. At the same time, training programs and mechanisms for the exchange of knowledge, such as the Farmers Field Schools promoted by FAO, are needed. Schools can help to create a common knowledge base that encompasses the know-how of the different participants, farmers, specialists and scientists. Farmers Field Schools (FFS) have been an impressive success in this regard with 2 to 3 million farmers having graduated in the field of integrated pest management (IPM) over the last 15 years, mainly in Asia and, more recently, in Africa, the Middle East, and Latin America (Pretty, 1995). These initiatives should be pursued in the relevant fields of agricultural science (FAO 2001) with the participation and pedagogical resources normally used in universities and research institutions for the dissemination of agro-ecological and conventional knowledge.

Coordination is needed between the educational system and the KSTAI system in order to promote access to and the production of analytic and critical knowledge. No country has achieved development without a significant investment in human capital and knowledge. The proper management of knowledge, technological development, and increased productivity are now prerequisites for economic development.

Well managed traditional knowledge, science and technology lead to development and social well being. To achieve better coordination between higher education programs and programs in science and technology, both in research and in the transfer of knowledge, requires a reorganization of academic structures and scientific research in all areas and ending the isolation and dispersion that currently exists. It is necessary to strengthen educational and occupational training programs that promote and respect diversity and differences and permit advantage to be taken and use made of the positive elements of the third industrial revolution, while also combating and managing the crushing force of this very revolution as we embark upon the second paradigm of science and agricultural technology (Sanchez, 1994).

4.2.1.4. Promotion of advances in agro-ecology as cutting-edge technology

Promotion of advances in agro-ecology as cutting-edge technology and evaluation (in the short, medium and long term) of its results in terms of cost benefits. Agro-ecology or eco-agriculture has the potential to efficiently reverse the trend towards degradation of the environment and reduction in food security, as it has demonstrated, despite the limited investment and attention that it has received (CIFAA, 2006).

Agro-ecology seeks a balance between on the one hand agriculture for production that attempts to satisfy the goals of poverty reduction through the production of food and other agricultural, forestry and cattle raising goods and, on the other, the maintenance of biodiversity and other environmental services. The basic paradigm is that the more similar the agricultural, forestry and cattle farming ecosystems are to the natural ecosystem the more sustainable are medium- and long-term production and other environmental services, such as the recycling of nutrients, carbon sequestration in soils; filtration, detoxification, regulation and storage of water (Altieri, 1995 Deacaens et al, 2004). One possibility is therefore to introduce agro-ecology into agricultural research and extension programs and in the curricula of farmers' schools. It is also necessary to promote internal changes in the institutions adopting this new paradigm (Sanchez, 1994; Guzman, 2004; Caporal and Costabeber, 2004; Embrapa, 2006). Local and regional agro-ecological experiences with change must be systematized by promoting exchanges between different regions and between the different social actors. The crisis of the productivity model requires new alternatives that are less harmful to the environment and to producers and consumers (FAO, 2003; Guzman, 2004; Caporal and Costabeber, 2004). However, extension activities and the exchange of experiences are not sufficient by themselves. Knowledge and innovation must also be further developed with a view to mainstreaming the agro-ecological approach into production systems (Vandermeer, 1995).

In order to develop ecological production systems compatible with the sustainable management of natural and human resources, the style of development sought must be consistent with these goals. For this reason, basic research should also be complemented by market research and economic studies to both demonstrate and increase the profitability of agro-ecology (Vandermeer, 1995; Swift et al, 1996) and with in-depth analyses based on objective review and questioning of the assumptions about the low productivity of unconventional systems, such as organic productions (Badgley et al, 2006). Agro-ecology should be viewed as a strategic factor for development in Latin American countries, not only as a factor for economic development but also as a key input in social and environmental policy. This requires a series of standard-setting initiatives, institutional reorganization and the allocation of significant economic resources as countries progress towards their broad objective of sustainable development.

Most Latin American countries lack regulatory frameworks for the implementation of an incentive system for agro-ecological production. It would be helpful if such frameworks included a review of the external factors affecting agro-ecological production compared with conventional production. The incentives should be applicable to processes of conversion to ecological production, cost of certification, as well as to investments in farms. This means that, among other things, governments should offer institutional support in the following areas: technical assistance to producers in production, processing and marketing, reduction of the costs of certification, development of demonstration projects, facilitating the supply of inputs and services, managing financing, promoting arrangements for the financing of marketing and production, and helping to provide the necessary equipment for production (Ortiz, 2004; Garrido, 2006).

4.2.1.5. Redirecting new areas of research towards IAASTD goals

KSTAI systems in Latin America and the Caribbean can seek to increase their technical training in the new areas of knowledge using the principle of precaution [applied to bio-technology, precision agriculture, nanotechnology, organic farming]. In order for advances in new technologies to be useful in tropical conditions, they must be adapted and improved for the particular conditions of the agro-ecosystems [Com. Pers. Carlos Araya, National University of Costa Rica, December 2006). The research priorities for these new areas should first consider the environmental and social development goals and not the profit potential. Consequently, a critical evaluation is needed in order to determine whether reputed leading-edge technologies satisfy the goals of the IAAASTD and which sectors benefit. Conventional knowledge has made it possible, through the Green Revolution, to fulfill urgent needs for an increase in the production of foodstuff (Wood et al, 2005). This type of know-how

must continue to be developed with special emphasis on those types of research that take particular account of the need for the development of a multi-functional agriculture that meets the socioeconomic and environmental millennium goals. Synthesis with the agro-ecological approaches mentioned in the above paragraph is an essential phase of this process.

Promotion of sound ethical principles. It is becoming more and more necessary to incorporate into educational programs a philosophical discussion of the ethical principles of justice, equality, reciprocity, autonomy and responsibility, including the topic of the management of resources, both private and public [Hardin, 1998]. Only with a social consensus can desirable behavior be encouraged and undesirable ones that have led to greed and ambition of a few at the cost of poverty and widespread hunger among the populations of Latin America and the Caribbean discouraged. The goal is to encourage and promote the truth in a way that does not ignore or devalue scientific results or know-how for reasons that have to do with the balance of forces or blackmail, since what is at stake is the survival of the planet and of the human race.

4.2.2. Sustainable environmental and socioeconomic development.

4.2.2.1. 4.2.2.1 Emphasis on the search for more effective solutions to prevent environmental degradation

The degradation caused by improper management of water, soils and forests is a serious regional problem throughout Latin America and the Caribbean and requires solutions for the mitigation of such degradation, with payment for the provision of environmental services being a possible option.

In Latin America and the Caribbean, many unsound management practices have had a severe impact on the natural capital and environmental services (Ghuman B.S., 1983; Adis, 1989; Brown, 1993; Cairns, 1994; Polcher J., 1994; Brosset, 1996; Chauvel, 1996; Neill, 1997; Rasmussen, 1998; Fearnside, 1999; Ellingson, 2000; Tian, 2000; Portela, 2001; Mathieu, 2005;). The firm denunciation of these events has led countries like Costa Rica, Mexico and Brazil to develop programs for payment for environmental services (Calle et al., 2002). Studies are needed on the valuation and impact of the environmental services provided by ecosystems and on identifying the type of human community that would sustain them (Mattison and Norris, 2005). Such a strategy would permit a continuation of the lifestyles of the local populations directly associated with the management of native ecosystems by

balancing rural production with environmental conservation (Daily, 1997; Mattos et al., 2001; Bensusan, 2002; MMA, 2006; Zbiden, 2005).

Another priority need is for the research and dissemination of the use of secondary and other degraded or abandoned habitats. Secondary forests, if adequately managed, play an important role as providers of environmental services, protection and maintenance of biodiversity and protection of water sources and wood products for rural construction, manufacture of domestic utensils, medicinal and ornamental plants, fruits, honey, fiber, oils, resins and seeds, among other things, (Promanejo, 2001; Floagri, 2005). Comparative studies are also needed on agricultural alternatives that do not include burning in Amazonia, since slashing and burning has a negative impact on the atmosphere (carbon emissions) and leads to the loss of the nutrients retained by the biomass. Alternative approaches are needed to repair the planting area which are less harmful to the environment and ensure the sustainability of forests, ensuring in particular that the extraction of wood does not negatively impact the conservation of the diversity of plant varieties, or, by extension, of the ecosystem (Sá et al., 2002; Vielhauer et al., in press). An option being proposed for the sub-region of Amazonia is the development of a program of study, dissemination and exchange of experiences on the common management of the Amazon in order to promote public policies that are consistent with the realities of farmers (co-management and self-management). The experience of local groups in close symbiosis with the forest will contribute knowledge and management styles that would ensure conservation for centuries. Moreover, the combination of this experience is indispensable for the development of agro-ecological practices or practices that rely on conventional technologies. More recently, because of exogenous pressures, these types of lifestyle management are being endangered. Such experiences should therefore be pursued as an approach to promoting conservation and social and environmental sustainability, which are the goals of IAASTD (Barros, 1996; Benatti, 2003; Amaral Neto, 2004).

In general, for Latin America and the Caribbean as a whole, what is urgently required is the development of technologies for the control of erosion which should go hand in hand with the creation of greater economic opportunities for small producers, and at the same time should recognize the limitations inherent in low labor productivity and small farm sizes (Dixon et al., 2001).

4.2.2.2. Study and understanding of the dynamics of water and tropical soils and of biological processes as part of the foundation of environmental and economic sustainability.

Many studies have demonstrated the need to promote practices that more closely resemble natural ecological processes for the management of natural resources, control of pests and diseases (Alipizar et al., 1986; Von Maydell., 1991; Kursten, 1993; Jong, 1995; Gallina, 1995; Vohland, 1999; De Clerk, 2000; Lavelle et al., 2004), and the promotion of related biodiversity (Armbrecht et al., 2004). Given that all agro-ecosystems originated from natural ecosystems, ecological, indigenous and traditional knowledge of agricultural systems (cattle farming, fish farming, growing of crops) must be expanded so as to increase the impact of KSTAI systems in Latin America and the Caribbean.

Studies must be undertaken and plans developed to manage the impact of agriculture in water basins both in Latin America and other regions. Expansion of agricultural frontiers is a reality and the use of soils for agriculture results in chemical modifications of underground and surface waters (Markewitz et al., 2006). It is necessary to identify which systems of agricultural management and environmental conservation minimize these impacts (Markewitz et al., 2001; 2006). In order to achieve sustainability research and dissemination programs are needed to stabilize the agricultural frontier, to add value to and ensure the sustainability of the resources and environmental services provided by secondary forests, to restore degraded land and encourage the establishment of companies by community partnerships for the exploitation of forests and non-wood forestry products (Floagri, 2005; Promanejo, 2001).

Moreover, depending on the Latin American environment in question, the management plan can be supplemented by the systematization, development and dissemination of aquaculture technologies that rely on local ingredients (residues, fruits and seeds) (Saint-Paul, 1998; Pereira-Filho, 1995; Mori-Pinedo, 1993) while continuing to value local and indigenous knowledge. Aquaculture in Amazonia is based on local particularities (use of local ingredients for fish feed, subsistence and local know-how). The references for enhancing the efficiency of these activities are disperse and do not include existing production systems. It is necessary to explore fisheries management systems with a view to developing models that ensure a balance between use by the local population and sustainability. Traditionally developed strategies are beginning to experience a crisis because of the over-exploitation of resources. The techniques developed from local and scientific know-how (before the former disappear) need to identify ways of restoring balance (Baltazar, 2005). In Andean regions,

where intensive and extensive cattle farming is practiced in zones that are extremely vulnerable to erosion (hillsides, inter-Andean valleys) Agricultural, forestry and pastoral techniques need to be developed (Calle et al., 2002). These techniques combine the herbaceous, shrub and tree strata to improve production (production of bio-mass stockfeed for cattle) and to expand the services provided by the ecosystem (Murgueitio, 2003). However, although know-how may provide valuable information for environmental and social decision-making, as long as the paradigm is economic growth alone (individual enrichment) without taking externalities into account (environmental and social damage), the expansion of cattle farming should be avoided and emphasis placed on the development of technologies for incorporating agro-biodiversity and forestry biodiversity into the production process (Blann, 2006, De Clerk et al., 2006).

4.2.2.3. Improvement of conventional systems (KSTAI) for reducing and mitigating environmental impacts of more intensive farming, cattle raising and aquatic production systems.

Conventional systems may also be transformed into more sustainable systems with the support of the KSTAI, given the demonstrably positive impacts of environmentally friendly production, conventional production systems must undergo technical changes to make them less harmful to the environment and to the health of consumers (Fachinello, 1999). Many regions of Latin America and the Caribbean have large quantities of aquatic and marine resources (e.g. Caribbean, Amazonia, Andes), and what is now required is research into and the dissemination of models of sport fishing. There are currently few technical references for an activity that can reduce the pressure on resources at the same time as it generates income for the local population which would no longer be obliged to fish for their survival (Pagape, 2007).

For producers working lands on degraded or fragile slopes and who are not prepared to use this land for forest cover, their priority should be to promote more sustainable production styles that can be easily adopted with limited resources and which produce immediate and concrete returns, either in terms of production or in the use of labor (Dixon et al., 2001). Specific initiatives include: (i) the permanent production of commercial valuable crops; (ii) reduced ploughing; (iii) greater density of cultivation; (iv) contour farming; (v) improved varieties; (vi) live hedges; (vii) interspersing of crops; (viii) dispersed forest cover; (ix) mulching; (x) management of invertebrate fauna in a way that is beneficial for the soil (Lavelle et al., 1999; 2006). The benefits of these technologies and the feasibility of their adoption have been amply demonstrated by a series of innovative projects that

have been undertaken throughout the system. However, even though such practices may lead both to an increase in yield and to more sustainable management of natural resources, they will have limited impact on increasing family incomes and unless they are incorporated into diversification and marketing programs, these alternatives must be considered to be only part of the solution (Dixon et al., 2001). For those systems with high population densities in Latin America and the Caribbean, the development and implementation of effective plans at the community level are extremely important for the management of natural resources. These interventions should include technical assistance and incentives for their adoption, in addition to emphasis on obtaining benefits in the short term for resource management activities, such as the management of water basins and forestry, among others (MacNeely and Scheer, 2003). Other promising interventions should focus on technologies for the conservation of humidity in drier areas and for combating drought and desertification (for example, north-east Brazil and the Central Andean region). There is also need for effective water basin management (Mesoamerica and northern Andes). Both of these impacts are expected to become more widespread as a result of global climate changes, which is why risk reduction mechanisms should be strengthened (Dixon et al., 2001).

4.2.2.4. Advances in knowledge through participatory research in all sectors (for example, peasants, indigenous groups, students, scientists, teachers and citizens involved in urban agriculture).

In order achieve this progress, incentives are needed for studies on plurality in rural areas, given the many different types of activities that are carried out there and the impact of traditional forms of resource use and labor organization (Graziano da Silva and Del Grossi, 1998; Graziano da Silva, 1999). Participatory research must be conducted in the different rural sectors on the technical and partnership aspects that affect their activities and consequently their living conditions and the conservation of environmental resources (Embrapa, 2006). The consensus in the literature is that the supply of technology (external and therefore not responsive to local needs) is not the solution for the problem of actors at risk of social exclusion. Thus generating demand for working methods must be the responsibility of the actors themselves. A systemic approach is also needed to the various elements of the chain of production and of activities (Zoby et al., 2003; Embrapa, 2006; Schmitz e Mota, 2006).

Non-farm income, particularly income from agro-industry, can contribute significantly to rural development in areas with small farms. The establishment of agro-industries generally leads to rapid technological change among participating small farmers, helps to generate demand for local production and creates opportunities for non-farm employment. However, the imperfect functioning of traditional markets has limited the expansion of small farms engaged in agro-industry. This is particularly true with regard to rural credit, land markets, crop insurance, information and technology and specialized inputs. Agro-industries have developed numerous strategies to compensate for the effects of defective markets. These include the provision of farm credits, technology and inputs as well as the lease of land to small producers (Dixon et al, 2001).

In order to ensure market access and obtain financing for all production costs, it is necessary to reduce the cost of information and improve market conduits for producers. This framework should include a strategy for expanding technical assistance. The reduction in transaction costs that resulted in the first phase of the establishment of links between industry and farmers is significant and included mechanisms for prompt, simple and easy arbitration to resolve the conflicts that frequently arise in transactions between farmers and ago-industries. It is also important to facilitate access to credit and to eliminate legal and market obstacles that affect small farmers seeking to increase the size of their farms. Priority should also be given to reducing the cost of training – both for farmers and for agro-industry - as well as to supporting farmers organizations (Dixon et al., 2001). Priority should also be given to research and participatory extension services in crop varieties adapted to high altitude zones (shorter crop cycles, drought resistance, etc.). Demonstrated success in promoting indigenous technologies – such as the use of large scale nurseries traversed by deep ditches that reduce the damage caused by frost by preventing the cold air from reaching the growing plants – and continuing research in this area will be highly beneficial (Dixon et al., 2001). An equally important factor is the need to develop technologies that are more compatible with the available time and activities of women, which can be achieved only with the above-mentioned strategies of participatory research and incentives for women whether or not they are heads of households (Cavalcanti and Da Mota, 2002).

Ecologically sound technologies are not merely isolated technologies but integrated systems encompassing technical know how, procedures, methods for the evaluation of goods, services and equipment, as well as organizational and management procedures. This means that, in analyzing the

transfer of technologies, attention must also be paid to those aspects of technological options related to the development of human resources and the increase in local capacities, as well as those aspects related to the particular interests of men and women. These ecologically sound technologies should be compatible with the social, economic, cultural and environmental priorities as determined at the national level.

The accessibility of scientific and technological information and access to ecologically sound technology and their transfer are indispensable requirements for sustainable development. The supply of appropriate information on the ecological aspects of current technologies has two interrelated components: the updating of information on current technologies and on the latest technologies and on the risks that they pose to the environment and the increase in access to ecologically sound technologies (Dixon et al, 2001).

It is essential to have a critical mass of research and development capacity for the effective dissemination and utilization of ecologicially sound technologies and their generation at the national level. Educational and training programs should reflect the need for specific research activities geared towards achieving these objectives and should be aimed at producing specialists in ecologically sound technologies who adopt an inter-disciplinary perspective. The achievement of this critical mass requires increasing the capacity of artisanal farmers, technical personnel, mid-level administrators, scientists, engineers and educators and promoting the corresponding systems of social and administrative support. The transfer of ecologicially sound technologies also requires that they be adapted and incorporated in innovative ways into the local and national culture (Dixon et al., 2001).

One option for achieving the goals of IAASTD is to create a space for the participation of producers in research into bio-diversity and innovation services. The true capacity to conduct research into natural resource management is to be found in small groups of researchers distributed over a range of programs and projects in INIAs, NGOs, universities, private research centers and private enterprises (Dixon et al ., 2001). Given this situation, it is necessary to strengthen and develop horizontal networks of researchers and development professionals in order to increase the exchange of information and achieve a critical mass.

It is particularly important to involve farmers in research into the management of natural resources in view of their limited scientific knowledge in many areas, the great richness of indigenous knowledge of the local environment, the difficulty of ensuring the mass dissemination of alternative methods for the management of natural resources and the need to adapt technological innovations to local conditions (Via Campesina, 2003). Certain types of research into the management of natural resources use sophisticated methodologies that require a great deal of laboratory work and a culture of basic sciences. Other types of research into the management of natural resources require intimate knowledge of the reality of farmers and close contact with them. It is important to maintain a balance between these two types of research and, when possible, to seek opportunities to combine them.

4.2.2.5. Greater control of the release of GMOs.

Respect for the principle of precaution (through KSTAI systems) when introducing new technologies and before the release of genetically modified organisms into the environment in order to prevent risks to health, the contamination of products at their places of origin, and other impacts on the environment.

4.2.2.6. Investment in KSTAI systems for the development of technological innovations to overcome health barriers.

This point refers in particular to the introduction of methods for the traceability and safety (nanotechnology) of foods and methods for the control and detection of health problems, among others. In order for investment in these KSTAI to be efficient, it is proposed to conduct research into the know-how of producer groups and the objective conditions under which they use technologies. Many traditional processing techniques are insanitary. Meanwhile, health barriers represent obstacles that cannot be overcome because large amounts of capital are not available. Alternative approaches must therefore be sought that balance health issues and know-how (Embrapa, 2006).

4.2.2.7. Integrated pest management

Promotion of integrated pest management practices (IPM) and technologies that reduce or eliminate agricultural pests. The development of this type of research is today common in many of the KSTAI systems in Latin America and the Caribbean, but needs further strengthening since it can lead to substantial reductions in the use of agricultural toxins in fields (Rodriquez and Niemeyer, 2005). In order to encourage this trend, it is proposed to establish strict rules for the use of agricultural toxins,

in particular for the protection of field workers and women (Nivia, 2003). It is also necessary to combine conventional research with traditional research in order to identify bio-controllers and develop strategies for the agro-ecological management of production systems (Buck, et al., 2006) and the improvement of conventional systems.

4.2.2.8. Promotion of research and educational training in methods of distribution of productive land between social groups and their impact on sustainable use and poverty.

More families living sustainably in the countryside leads to greater diversity of decisions and consequently to greater diversity of landscape, biodiversity and crops as well as facilitating food security and the exploitation of biodiversity (Monroe et al., 2002; Dietsch et al., 2004). Comparative research programs are also needed to identify the most sustainable distribution and land-use alternatives. The diversity of modes of access to land are associated with forms of use of this land as a direct consequence of the social reproduction of groups and the conservation of biodiversity (Leite et al., 2004; Almeida, 2006). This type of research could lead to policies that are more conducive to achieving the goals of IAASTD.

For frontier systems, intervention priorities include the development of a comprehensive database of natural resources and their characteristics within the system as well as the relationship between this information and planning tools and appropriate resource management policies. This could be strengthened through research partnerships in the development of crop varieties that are adapted to the conditions of frontier zones (e.g. aluminum tolerance, post-harvest characteristics), and dissemination of the results. Of prime importance, however, are the legalization of land holdings and elaboration of policies that promote appropriate patterns of land use through the use of such instruments as land taxes (at the regional and municipal levels); land concessions; easy access to loans for investment or operating capital; eligibility for support services; and marketing, extension, and veterinary services, among others (Dixon et al., 2001).

4.2.2.9. Seeking greater energy efficiency in production systems

This option seeks to promote know-how that leads to energy efficiency and a positive environmental impact of agro-ecological systems in combination with the knowledge that has resulted in productivity for conventional systems. Energy efficiency is understood as the cost benefit ratio, in other words,

the investment of crop energy in the agro-ecosystem (or water system) versus the energy benefit obtained in production (KCAL) and the diversity of products (National Research Council, 1989).

The oil crisis is another factor that reinforces this need for KSTAI to give priority to the search for more efficient alternative energy sources, in keeping with the characteristics of the various sub-regions of Latin America and the Caribbean. Wind and solar energy are very rarely used in the region but have great potential in the tropics, particularly in rural areas.

4.2.3. Climate change and bio-energy

4.2.3.1. One of the options proposed to mitigate the impact of climate change is to develop alternative systems of production designed to mitigate the negative impacts of climate change.

With the help of indigenous / traditional and scientific (agro-ecological and conventional) knowledge it may be possible to promote research into the use of perennial plants and agro-forestry for carbon sequestration (see option 6). The aim is also to promote the development of new plant varieties that are more resistant to climate change, in particular to the increase in temperature and variability in dry and rainy seasons; more efficient methods of water use and management of soils that are vulnerable to erosion (management of plant cover, green fertilizers, wind breaks, drainage) (Murgueitio, 2003).

Studies of the impact of climate change in the region confirm the negative effects that global warming will have on the incomes of producers, particularly small/traditional producers who have less resources to adapt to these changes (Mendelsohn et al., 2006; SEO et al., 2006). These same studies propose policy alternatives in science and technology and knowledge to mitigate these impacts (Lima et al., 2001). The KSTAI systems of Latin America and the Caribbean should strengthen their technical and scientific cooperation in seeking joint solutions for minimizing the impact of climate change on regional producers. A research and development program should be established for adding value to forestry resources through innovation, agreements with companies, training to gradually take charge of the productive process, and institutional support. The latter is designed to focus on the reality of these actors. Use of forest products is irreversible and alternatives must therefore be developed for sustainable use based on empirically observed realities (Floury, 2005). The socioeconomic sciences must also take account of environmental services when evaluating production systems (Altieri et al., 2003; Chavarria et al 2002).

4.2.3.2. Research to expand the contribution of agricultural and cattle raising activities to the production of renewable energy.

Agricultural production for use in alternative energies to fossil fuels (crops that can be used to generate energy, the conversion of waste from harvests and biogas) could constitute an opportunity to revitalize primary sectors, provided that it is based on local resources and does not endanger food security. For this, bio-energy (not only bio-fuels) should be developed for local use while local knowledge and general environmental-friendly principles should be disseminated at the regional and international levels. In ongoing programs, existing knowledge should be organized and new studies undertaken on energy resources based on knowledge of the flora of neo-tropical forests (Amazonia, rain forests, dry forests, pre-montane, gallery or riparian forests). As this know-how becomes better known and more widely disseminated, it will be appreciated more and more by Latin American communities, especially the urban population. Reforestation can be undertaken in degraded zones to produce bio-energy in already cleared areas, given that the extraction of wood to produce energy is one of the causes of deforestation (Homma, 2005).

Brazil's new national agro-energy program, for example, offers a series of options for increasing the share of bio-fuels in the national energy grid with the very active participation of KSTAI systems (creation of a center and of specific agro-energy research programs) and with supportive public policies. This experience should be shared with the countries of the region, particularly through multilateral cooperation programs between KSTAI systems, such as Procisur, Procitrópicos and Prociandino.

4.2.3.3. Use of KSTAI systems to achieve a development in which these crops (bio-fuels) genuinely contribute to the goals of sustainability and equity.

These commitments to equity and sustainability have been avoided thus far (analysis of cases such as Brazil, the world leader in the production of ethanol). The establishment of agro-industrial cooperatives of small and medium-sized producers could promote greater equity in this sector. A program should be developed to organize existing know-how and experiences in the production of bio-fuels in Amazonia. Research is also needed into the ultimate consequences of the entry of the currently dominant global development model to gasoline and petroleum in order to ensure that crops previously used for food are now not used for energy. If the profit motive is the one that provides the incentive for this sector, the goals of IAASTD would be seriously be endangered.

In the case of C4 oilseeds (soya) which are already in use in other regions of Brazil, studies are needed of the varieties that are best adapted to Amazonia. Among the perennial crops that are producers of energy biomass is the African palm (Elaeis guineensis Jacq.) (Kaltner et al., 2004), which is prey to the fatal yellowing pest. Research is therefore needed in this area (Muller et al., 2007).

4.2.4. Biodiversity

4.2.4.1. Development of strategies to protect biodiversity in Latin America and the Caribbean

The development of KSTAI systems through agro-ecological and traditional know-how should focus on strategies for protecting the immense biodiversity of Latin America and the Caribbean and on the right of the peoples of the region to understand them, to have access to them, and to use them sustainably. Biodiversity holds the greatest potential for the development of new products and can satisfy the emerging demand both for food (quality and quantity) and for other products. There is need for common management of a research system and for the comparing of experiences in order to facilitate the regulation of and greater access to traditional knowledge. Traditional knowledge has sometimes been used by the different actors for economic ends while the population at large receives no reward of any sort (Santilli, 2002; Lima and Bensunsan, 2003).

It is necessary to promote adequate training to permit precise and prompt inventories to be made of biodiversity and reference databases to be created. This knowledge will enable an evaluation to be made of the impact of public policies in this area and also the impact of different types of land uses and landscape on diversity. Many biodiversity products cultivated by small-scale producers have a significant potential to capture specialized international market niches. The evidence suggests that there could be substantial increases in this land area by introducing into these markets Alpaca and lama wool, quinine, specialized varieties of potato and similar products, especially if there are possibilities of having labels or indications of origin. The establishment of equitable commercial markets also create opportunities to increase incomes, but its scope is limited. Diversification aimed at supplying the demand of export markets will require improved organization on the part of producers in order to ensure coordination and the volumes of output required for exports as well as efficient mechanisms for the supply of inputs (including financing). Technical assistance to ensure adequate

control of product quality, the development of adequate post-harvest processing and packaging and the creation of effective marketing chains will also be indispensable (Dixon et al., 2001).

The options also include the deepening of knowledge in hydro-ecology and water dynamics. In the countries of South America, there is need for a multidisciplinary approach to resource management, based on integrated management of water basins, multiple use of water resources, recovery of waste water, and protection of fragile zones that are important for the conservation of water resources, such as wetlands and hillsides. Urgently needed also are adequate legal and programmatic frameworks, such as a national water resources policy, water legislation and a national plan for the use and conservation of water resources.

Inadequate knowledge of the state of water resources is one of the impediments to effective management of these resources. However, the increase in conflicts arising from the scarcity of this resource, as a result of natural disasters, inadequate use and pollution, has sparked interest in this important sector for national development. Elements of conventional knowledge must therefore be incorporated in order to restore diversity, integrity and productive capacity to water systems (DeClerk et al., 2006). Elements of agro-ecological knowledge (DeClerk et al., 2006) and traditional know-how must also be incorporated to restore diversity, integrity and the productive capacity of soils. An inventory of local know-how is needed as a way of protecting such knowledge (Shiva, 2000).

Market conduits for biodiversity products need to be identified. The broad biodiversity of sub-regions such as the Andes, Amazonia, Mexico, and Central America, among others, and access to these resources is a strategic factor that can not only be translated into monetary value but also into easy and preferential access to generic technologies. The challenge is to design legal frameworks and to develop adequate institutions for the commercial exploitation of biodiversity products. There are significant opportunities in this sector since the international markets for biodiversity products and services is expanding significantly (Garrido, 2006). Many developing countries could benefit from the expansion of the market for biodiversity products and services and exploit the potential value of biodiversity.

Another option is the development of technologies that incorporate local knowledge for the conservation and sustainable use of biodiversity (integration of traditional and agro-ecological know-how). The region has great potential based on its natural riches, especially those related to its

biodiversity. Many plant and animal species are native to the region and can form the basis of poverty reduction strategies. Biotechnology and other niches offer opportunities for improving agricultural productivity without increasing the use of inputs. A key element of this strategy is to ensure the participation of producers and the identification and development of opportunities throughout the food chain.

In order to succeed in the options described above there must be an inventory and study of local and regional biodiversity (conservation and sustainable use). The study on biodiversity must be carried out in close association with the taxonomy, evolution, bio-geography and ecology, but on its own terms from which it is hoped that new paradigms will emerge (IavH, Alexander von Humboldt Institute, 2006). The most notable lines of work are related to the role of biodiversity in organisms, the structure and functioning of ecosystems, their value to and use by man, and their inventory and monitoring. It is important that the valuation, monitoring and inventory of biodiversity are done under common research guidelines that ensure that data is compiled in a comprehensive way. The aim is to make estimates that allow for a comparison of critical sites for protection, the identification of key and indicative species, development of the procedures to be used in the exploitation of resources, and evaluation of those production systems that have better yields and greater impact on biodiversity (Sosa-Escalante, date unknown).

4.2.4.2. Sustainability of cattle farming

It is necessary to identify and disseminate options for sustainable and productive cattle farming in Latin America and the Caribbean, such as silvo-pastoral systems, protein banks, use of diverse landscape elements such as tree barriers, significant shrub and tree biomass, protection of basins, and recycling of excreta in order to mitigate catrostrophic effects on soils and water. Know-how (local and imported) and technologies are needed to stabilize agriculture and preserve natural capital. Environmental management in areas where cattle farming takes place leads to a disordered occupation of land that is restored as a result of the creation of conservation units in regions of low agricultural potential, which could make the land resource more expensive and stimulate investment to increase productivity in areas already open or degraded in hopes of improving the environmental management of private land (Arima et al., 2005).

On the other hand, it is also necessary to develop criteria for the allocation of financial resources in accordance with the rate of compliance with environmental regulations (Arima et al., 2005). All of the above accompanied by technical solutions to increase efficiency in terms of head of cattle per hectare and improve the quality of herds. This option may limit the expansion of cattle farming in wooded areas (Floagri, 2005). However, the intensification of agriculture will not put an end to the destruction of forests if what is sought is wealth or the desire for profit (Vandermeer, 2003) and to a lesser extent achievement of the goals of IAASTD.

4.3. Options for strengthening the capacities of KSTAI

4.3.1. Creation of vertical systems for exchanges and for the socialization or dissemination of know-how.

The synthesis of know-how and its socialization/ dissemination in the three models identified (conventional, traditional and agro-ecological) require the use of new institutional tools that are appropriate to each context. The creation of specialized networks in certain sectors or cultivation of specific crops may be another option to strengthen interaction between these three levels. For this it is necessary to have training and the generation of know-how by the direct actors, in other words, local producers and consumers. Mechanisms should also be developed (by KSTAI systems) to better organize small and medium-sized producers. In order for the actors to contribute to the KSTAI, they need to be empowered in terms of access to natural resources, particularly land and the sustainable use of biodiversity (Via Campesina, 2003; Perfecto et al., 2007), and have access to natural resources, particularly water (fisheries) (Pimbert et al., 2005).

4.3.2. Promotion of participatory research

Participatory research can be geared towards the establishment of endogenous development models that reconcile the goals of the different groups of farmers (agro-industrial, agro-ecological and family), respond to local needs, and, above all, promote social equity. The new development models place emphasis on sustainable development, protection of the environment, energy efficient systems, and popular participation to ensure that development is socially equitable. A number of studies on initiatives to diversify activities in rural areas (tourism, arts and crafts etc.) have shown that such diversification makes it possible to design land-use development models. The attraction which rural

areas holds for urban residents is gradually increasing demand for new services whose impacts are now not sufficiently known (Graziano da Silva and Del Grossi, 1998; Graziano, 1999).

Participatory research is today a reality in the KSTAI systems. The integration of this concept into the research process is leading to significant changes in the efficiency of national (INIAs) and international programs of agricultural research (CGIAR Centers).

More research is needed on short-cycle and drought resistant crops which are suitable for small producers, particularly research into technologies that increase labor productivity in systems with high levels of poverty. In order to increase the capacity of small producers to compete efficiently in expanding international markets, it will be necessary to conduct research in such areas as:

(i) adapting existing and potential post-harvest technologies to the needs of small farmers; (ii) adopt appropriate practices and tools in MIP and in organic production (for example, biological controls); and (iii) field test the new varieties/species and define appropriate agronomic practices (Dixon et al, 2001)

4.3.3. Strengthening of national agro-ecological universities and local universities and other educational centers.

Investments must be made in the training of personnel and in improving the research and socialization infrastructure. Given the low levels of investment in KSTAI systems in Latin America and the Caribbean and the trend observed in the majority of countries of the region, greater investment in the various components of the KSTAI system is also needed in order to reverse this trend and reduce dependency on technological innovations from outside of the region. This increase should take place at the sub-regional and regional levels also in order to take advantage of experiences and minimize the duplication of research and development (R&D). Agro-ecological and indigenous systems have received almost no financial support in comparison with conventional (productivist) systems. Nevertheless agro-ecological systems have made great progress over the last decade. (e.g. Cuba; Funes, 2001; Campanioni, 2001) and investment in these KSTAI systems can contribute significantly to the goals of IAASTD. Investment in training and in the improvement of research and socialization infrastructure are also necessary.

The University of Camponesa offers a successful example of the exchange and systematization of experiences in the launching of social movements that seek a change in the current paradigm of productive systems and the development of agro-ecology (Graziano da Silva, 1999; Unicamp, 2005).

Another option being considered is the strengthening and building of new decentralized institutions for the generation and validation of agro-ecological, indigenous and traditional know-how, including technologies geared to the localities of the different sub-regions of Latin America in order for them to be adapted to local needs. Educational centers for urban agriculture can also be maintained and educational programs that promote values and culture in Latin America established or maintained in educational curricula. Knowledge in the fields of agro-ecology or eco-agriculture (Altieri, 1995) should also be expanded without neglecting conventional knowledge (World Bank, 2004).

4.3.4. Strengthening of R&D networks

It is acknowledged that generally speaking in Latin America and the Caribbean the various KSTAI systems are isolated both within each country and at the sub-regional and regional levels and one possible solution is the promotion of cooperative work through the establishment and operation of cooperative programs.

The formation of partnerships and research platforms in sectors of common interest, with the involvement also of international centers of excellence such as the research centers of CGIAR and universities in developed countries. Given that these centers have in the past generally advocated a model of development that satisfies external and not local interests, in order to have a positive impact on the countries of Latin America they should redirect their research to satisfy the goals of reducing poverty and inequality and promoting greater sustainability. Moreover, it is becoming increasingly clear that research and development and innovation activities must be coordinated at the regional and sub-regional levels through the organization of networks and similar governance structures.

There currently already exists within the international scientific community and among donors a recognition that both organized actors and research centers should develop projects that are more directly geared towards the generation of technologies and products that contribute to the reduction of poverty, with priorities being subject to change (CGIAR, 2003). The same is true considering that Africa is the priority and it is therefore important that centers of excellence in agriculture research, such as those associated with CGIAR, should also expand their projects in this field in the region. In

Latin America and the Caribbean there are large pockets of poverty where international cooperation in research activities into areas related to poverty reduction is necessary and should be strengthened. Networks must also be established to protect and disseminate innovations that benefit rural populations in accordance with their local conditions (Durston, 2002).

A recent report on agricultural research and development cooperation programs in Latin America and the Caribbean clearly points to a lack of coordination between the regional initiatives and the need for the organization of similar networks and governance structures for research and development and innovation activities. Cooperative programs, such as PROCIS (PROCITROPICO, PROCISUR, PROCIANDINO, see option 15) are increasingly concerned with the organization of research networks and partnerships (Forango, 2006; Salles-Filho et al., 2006).

4.3.5. Organizational and management models (governance models)

Given the weaknesses of the structure, design and management of KSTAI systems in Latin America and the Caribbean, one option proposed is that of new models for the exchange of experiences in the adoption of different models of organization and management by the governments of the region that seek greater efficiency and effectiveness of their respective systems.

The principal challenge today in almost all countries of Latin America is how to develop and strengthen an institutional capacity that promotes the development of their KSTAI systems. While many countries of the region have made tremendous efforts to modernize their States within the framework of the first and second generation of reforms[2.], the results have been inconclusive – in particular those of the second generation – and did not form part of a comprehensive set of policies to promote capacity building that would create the minimum conditions necessary for the development of KSTAI systems in the region.

The governance capacity of a State refers to its capacity to coordinate the efforts of the various organizations around public policy goals. Many authors who participate in the current debate on modern governance maintain that in order to be successful the State must strengthen its role in

[2.] In the early stage of the so-called first-generation reforms, emphasis was placed on the objective of deregulating and reducing waste and the size and intervention of the State in the economy. These reforms took place at the end of the 1980s and early 1990s (as one of the main pillars of the so-called Washington Consensus). In the second stage, the second-generation reforms, emphasis was placed on the development of State capacity.

coordination, cooperation, moderation, guidance and mediation and monitoring of functions. For this, there are various institutional designs for different types of capacities. The existing literature refers to three models of governance: bureaucratic-hierarchal, management and networks[3.]

The fact that forms of public management and social conduct in general have become more complex requiring components that are analytically different from each other (and which can even be considered as opposing, such as the management and bureaucratic components) requires the simultaneous presence of various forms of governments. It is certainly possible to note that a formal institutionality is inclined more towards one or another form of governance and may thus be characterized as more bureaucratic or more management oriented or even as a network. But the fact that there are also other forms creates tensions in the institutions arising from the relationships of power between the actors, the design of incentives for private actors to participate in initiatives, the relative resources of organizations, the preferences of participants, and the technologies available.

In the countries the Southern Cone (Argentina, Brazil, Chile and Uruguay) generally speaking, the KSTAI systems do not have a clearly dominant institutional form of governance. On the contrary, the systems are generally little coordinated and structured and are derived more from the transformation of the State that is half way complete and in which very different structures of governance coexist without any one form clearly dominating the others. This structure superposes agents and various initiatives and is the cause of the weakness of State capacities which for that very reason are seen as very uncoordinated in terms of their objective, incentives and dominant agents.

[3.] The first corresponds to the hierarchical and formal paradigm of organization of authority and command of the State. The organization of the central government occupies the center of public policy, with the heaviest responsibility on the policy cycle. The central organization exercises its prerogatives in the implementation of policies through standardized procedures. The objective of public bureaucracies is to produce stable and reliable results and public policies provide standardized products in relatively routine contexts.

The management or executive agencies model considers public and private management as relatively interchangeable. Management is comprised of a series of universal regulatory principles beyond their sectoral application. According to this model, the state should focus on strategic management and supervision rather than on the implementation of policies. Execution remains in the hands of agencies that are quasi-autonomous, involved in management and directly responsible for implementation. Lastly, the model of organizational networks is a multi-organizational, multi-government and multi-sectoral form of governance under which decisions on the design and execution of policies are made within a network of actors of various kinds. In this organizational field, which is more horizontal, no actor possesses the power to determine the strategies of others, given the inter-dependence inherent in obtaining various types of resources. The central government is limited to collaborating with the network by convening participants, establishing linkages, stabilizing them and providing resources.

The option proposed is to establish a state that is powerful enough to regulate and organize civil society. In this sense, modern governance can only emerge in societies in which there are certain institutional structures both in the political regimen as well as in civil society. The political authorities must be powerful but not omnipotent, must be democratically legitimate, and must be "accepted as the guardians of public well-being". On the other hand, civil society must be strong, functionally differentiated and organized.

A successful form of governance is a complex economic system in the contemporary global environment and requires a strategic and interactive approach. This approach can be summarized as a combination of a central strategic guide and decentralized and associative governance. The key condition for the interactive social design is the guidance or strategic conduct which should be provided by creative actors. Only this type of actors will be capable of coordinating the actions of different and autonomous structures.

Greater use must also be made of participatory approaches in areas such as the selection of varieties and in field tests for new crops that offer potential for diversification. Achieving this goal will require a considerable restructuring of national research institutions in many countries of Latin America and the Caribbean that place particular emphasis on the mechanisms for the allocation of funding for research and on the training of personnel in participatory methods. There must also be a strengthening of the response capacity of research systems to market demands, even though hybrid genetic material may be acceptable for diversification purposes, material that is capable of being multiplied on farms is likely to be a prerequisite for traditional crops (Dixon et al., 2001).

Another option suggested is the establishment of a new form of governance in the PROCIS system (cooperative programs for technology research and innovation). These programs are important cooperation arrangements that still need a new focus, in the sense of coordinating not only researchers from participating countries but also other actors, going beyond scientific and technological exchanges (Salles-Filho et al., 2006).

4.3.6. Interaction of KSTAI with social movements

Research through KSTAI systems into social and farmers movements (Via Campesina, MST) and the promotion of structures that facilitate dialogue between them and other actors of the society and of

KSTAI systems. Identifying why social movements have achieved a recognizable positive impact on the goals of IAASTD.

One option for achieving interaction with social movements is the maintenance of a framework for research into these peasant and social movements and their forms of inter-relationships with other actors, providing constant evidence of the importance and potential for improving the quality of life, environmental sustainability and the conservation of biodiversity. Studies of this nature (also involving the actors themselves, and a bottom-up approach) would demonstrate the impact of democratization of access to land on the quality of life of producers and consumers (Leit, 2004).

4.3.7. Monitoring and evaluation of the impact of KSTAI

The development of methods of socioeconomic analysis for the introduction of new technologies into a socioeconomic context is essential for improving their impacts. KSTAI systems must be aware that it is not sufficient to identify the potential positive impacts of a technology or know-how, but that this technology must be introduced into a socioeconomic context. Given that the relationship between know-how / science and the society is very complex, it is necessary to include in the research agenda the full participation of producers, especially the poorest and most marginalized, into the networks. The studies of the economic, social and environmental impact of technologies carried out by KSTAI systems must be prioritized both ex-ante and ex-post. The experiences of impact evaluation are very different throughout the region and, in particular, there are no permanent programs in this area (Alston et al., 2001; Avila et al., in press). A study is needed on the profile of producers and a socioeconomic study is needed on including small producers in credit schemes (Arima et al., 2005).

4.3.8. Options related to intellectual property rights

Given the limited protection of intellectual property right (IPR) for products generated and the appropriation of know-how, the weakness of the regulatory framework in which the actors participating in KSTAI systems in Latin America and the Caribbean operate, it is necessary for KSTAI systems to develop legal regimes for the protection of the intellectual property of their creators.

One option advocated is that there is scope for this within the existing multilateral international cooperation framework. But legal channels may not be the most suitable for protecting the know-how of ethnic communities. The proposals advanced have been aimed at recognizing collective intellectual property rights. The first of these advocates the establishment of an international fund to

collect and redistribute earnings from the transfer of indigenous know-how. The creation of a regional body comprised of representatives of the indigenous communities of the different countries would be another option for regulating the transfer to traditional knowledge. A final option is to develop a participatory approach to research that provides training and research opportunities for members of the communities themselves, which would guarantee the exchange of knowledge for knowledge.

Currently IPRs are at the center of an extremely polarized debate on technology and development. IPR, from registered trademarks and patents to copyrights and geographical labels, offer an incentive for developing the technology because they help innovators earn returns on their investments. Trade related intellectual property rights (TRIPS) [4.] between the member countries of the World Trade Organization (WTO) commits governments to implementing national IPR systems based on a set of agreed minimum norms. The result of the generalization and implementation of TRIPS is a global system in which IPR will become increasingly strict. It is still difficult to foresee the consequences of this phenomenon on the capacity for local innovation in the countries of Latin America and the Caribbean and on human development in the region. While the enforcement of IPRs creates new opportunities, since it creates incentives for innovation, learning and a willingness to assume risks, it also increases the cost of imported technology and limits the capacity to develop reverse engineering and to learn from foreign technologies.

A study by UNDP (2001) argues that in this new global regime two problems are creating new obstacles to human development. Firstly, a consensus is emerging that IPR can go too far and impede instead of encourage innovation by unfairly redistributing the ownership of know-how. Secondly, there are signs that the circumstances are unfavourable to the fair application of TRIPS.

In the first case, the example is cited of the transfer of traditional knowledge to private hands. The system of patents allows claims for protection of the indigenous and community innovations of developing countries, which allows them to be formally represented and patented by others. To claim, use and defend patents is easier for private industry than for institutes and innovative communities. The section below proposes options for resolving this problem.

In the second case, it is argued that the minimum norms of TRIPS for intellectual property should be reflected in national legislation, but there is scope for formulating national strategies within a

multilateral framework. The impact of TRIPS will depend in part on countries selecting strategies that are best adapted to their interests. Indeed, within the framework of TRIPS, countries may, for example, use the mandatory granting of licenses, thereby permitting the use of a patent without the consent of the patent holder in some circumstances, which should be enshrined in their own laws. Typical uses are cases of medical emergency and anti-trust measures to maintain market competition. Many industrialized countries include these measures in their laws and practices as part of their strategy for utilizing property rights. However, under pressure and without adequate advice, many countries in Latin America and the Caribbean have not included them in their legislation or are attacked when they try to put them to use. One example of the scope that a clear policy in this respect can create is the access of some under-developed countries to AIDS medicines (for example, Brazil).

TRIPS, for its part, urges its developed country members to provide incentives for companies and institutions in their territories in order to promote and encourage the transfer of technology to the less developed member countries so that they can create a solid and viable technological base. However, little attention has been paid to the obligations that this entails and insufficient measures have been taken in this regard. The problem is that, while technology may be useful for development, it is also a form of competitive advantage in the global economy and the developed countries have economic and political interests in maintaining their advantage. For example, the new environmental technologies could be critical for combating global warming, but for the countries that possess them and sell them they represent a market opportunity. The fair enforcement of TRIPS would become a real possibility, according to UNDP (2001), only when the two interests are reconciled through adequate public funding, for example.

TRIPS covers three areas that are directly related to agriculture: geographic markings (articles 22 to 24); patent protection for chemical products for agriculture (articles 70.8 and 70.9); and protection of plant derivatives (article 27.3 b). The latter entails an obligation on the part of WTO members to protect plant derivatives through patents, through an effective sui generis system or through a combination the two[5.]

[4.] Trade-Related Intellectual Property Rights

[5.] There are two ways of recognizing intellectual property rights to seeds: rights of the holder and patents. Rights of the holder are controlled by the Union for the Protection of New Varieties of Plants (UPOV). This

Traditionally, farmers have had access to seeds which they use in their farms (either because they buy them, exchange them or inherit them from their forebears) and keep for future crops. This is why it has been difficult for companies to transform them into an item of merchandise since, unlike other products, seeds are living things that can reproduce, which makes their monopolistic control difficult. To that end, two mechanisms have been created that are mutually complementary: technological changes in plant improvement (through the development of hybrids and genetically modified organisms – GMOs); and the enforcement of IPR.

Until the early 1990s, almost no third-world country recognized any type of IPR on seeds. The pressure brought to bear by the United States has caused a number of countries to adopt legislation for the protection of plant varieties. A typical case is Uruguay which , consistent with the provisions of TRIPS, adopted a patent law in 1999. This law permits the patenting of plant and pharmaceutical products resulting from biotechnology or, where appropriate, the procedure for the genetic engineering techniques used to produce them. This is in violation of the provisions of The Union for the Protection of New Varieties of Plants (UPOV), of which Uruguay is also a member, which allow farmers to retain for themselves (not to sell) protected seeds for future crops. However, according to the patent law, they must in this case pay royalties.

The reasonable option for Latin America and the Caribbean within the framework of the goals of IAASTD is to support the appropriation of the intellectual property of local and indigenous communities. The knowledge that ethnic communities have accumulated in their habitats for centuries is being increasingly used for commercial purposes in such sectors as pharmaceuticals and agriculture. Technological development based on this know-how has produced a significant increase in the supply of food crops and new health-related products, among other uses.

The idea of protecting this know-how is gaining ground. However, numerous proposals made to protect indigenous knowledge have failed because such knowledge is the result of a social construct. Indeed, two institutional and cultural systems clash in the exchange of traditional ethnic know-how. One is the modern technology market, in which individual property institutions (rights to tangible and intangible property) are created and maintained within a legal framework. This system has relatively

---

recognizes two principles: (a) the privilege of farmers to keep seeds for their own use and (b) the exception for improved plants, that is to say, that they can use seeds that are registered for use in genetic improvement

transparent information frameworks and functions at a global level. The other is the system of know-how of the local community in which ownership of knowledge is not defined or is collective. Both the scope of their activities and the information available are local. Tensions arise in this clash because the market institutions of intellectual property rights allow for the appropriation by individuals of knowledge that belongs to the community.

In the last two decades, transnational corporations, academic institutions and independent research laboratories have patented indigenous knowledge or have reached agreements with ethnic groups. Various normative frameworks have been suggested. Various types of contracts have been proposed to test market the know-how and the environment in which the community lives. In all of these, there are compensations to the group that include the construction of health or education centers, or the preparation of brochures to educate the public about these practices and their origin. Occasionally, these contracts provide for a right to share in the benefits of products derived from their know-how but these payments have not really been made in any known case. Transnational corporations, laboratories and universities have also patented indigenous knowledge without the participation of the community in the process. In some cases, the protests of communities supported by NGOs have resulted in either the cancellation of the patent by the authorities or the abandonment of their use by the patent holder.

The proposals put forward by authors and NGOs have been centered on recognizing collective intellectual property rights. Some include the creation of an international fund to collect and redistribute earnings from indigenous know-how. One of the proposals put forward is the idea that the shaman for the community could be compensated for the know-how that he provides. However, one of the characteristics of the information in the literature is that once the knowledge has been transferred, it cannot be taken back. Therefore, once the shaman has transferred his know-how, there can be no negotiation between the company and the community. In such a framework, an incentive would be sought to encourage the shaman to “desert”.

---

programs. The 1991 Act of UPOV recognizes intellectual property rights to varieties that are essentially derived from registered varieties, for example, by spontaneous mutation.

Another proposal is that the protection of property rights to indigenous know-how can be ensured in the context of TRIPs and the Biodiversity Convention (CBD)[6.] based on the concept of community property rights, which would be treated as a special type of innovation. However, it is far from certain that the rights of small ethnic groups would be guaranteed by the State that signs the TRIPS. Moreover, innovation would require the creation of a special authority to provide and ensure respect for a sui generis protection.

The creation of a regional forum consisting of representatives of indigenous communities from different countries would be necessary for elaborating a consensus agreement to regulate bioprospecting and the use indigenous of know-how. This agreement could contemplate alternative models for the negotiation of frameworks and mechanisms for compliance in order to regulate the transfer of traditional know-how from these communities to transnational corporations, research laboratories and universities. This general agreement should establish a balance between preservation and the development of systems of community knowledge and their use by science and the market.

Negotiations can be difficult because, despite existence of cultural hybrids, ethnic groups are not accustomed to thinking in terms of profits or sharing in benefits. The creation of a global fund to administer the monetary benefits from the commercial exploitation of know-how and to finance efforts of common interest is an important additional measure. Income can also be redistributed between the ethnic groups that share a partnership in the fund for investment in health infrastructure, development and education of the community in accordance with their own criteria. Local capacity building can also be achieved in various ways. A participatory approach to research achieved through the creation of local research foundations dedicated to the preservation of knowledge and indigenous culture. Indigenous groups should participate in the research and documentation of their knowledge, history and oral culture. Another of the priorities of this fund would be higher education and scientific research programs based on traditional know-how and which offer training and research opportunities to members of their own communities, which would guarantee the exchange of knowledge for knowledge (Zerda-Sarmiento and Forero Pineda, 2002).

[6.] International agreements such as the Trade Related Intellectual Property Rights (TRIPS) Agreement of the World Trade Organization (WTO) or the Convention on Biodiversity (CBD) provide for the possibility of protecting indigenous know-how through property rights.

Support is needed in the international debate on the question of the protection of the traditional know-how associated with genetic resources in national and international forums. The approaches that are used in this area are very different and vary according to the institution (Bayão and Bensunsan, 2003).

Questions related to intellectual property are today absolutely critical for the establishment of networks of cooperation in research and development and innovation. Neither regional nor local cooperation is possible without the prior definition of property rights. An absolutely fundamental element is therefore training in the use of instruments for the protection of property rights.

4.3.9. Options related to food sovereignty and rural exodus

The strengthening of organizational know-how through KSTAI systems is proposed so that small scale producers, local fishermen and indigenous peoples would have adequate and equitable access to land, water, genetic resources and other resources necessary for sustainable food production. There is also need for the promotion of family and community agro-ecological models both in practice and through policies, and for research and development to guarantee food security, especially in the sectors that are most vulnerable to hunger and malnutrition through sustainable management of local agro-ecosystems for food production, mainly for local markets.

One option for the sustainable exploitation of water systems is research into methods of conservation and adding value to fish and other fresh products to facilitate the distribution of products. Many Amazonian, Andean or plain populations face problems in the transport of quality fresh products to local markets. Serious studies are needed on the quality of the diet of foods traditionally consumed and which risk being substituted for by the adoption of new food habits. Studies should also be conducted on the diversity of diet, especially in rural area, since ease of access to industrialized foodstuffs are causing changes in habits and greater intake of fats and sugars (e.g. bottled soft drinks) (Maluf, 2004a; 2004b).

Poverty reduction in rural populations that are incapable of diversifying their product or of obtaining non-farm employment should focus on facilitating external migratory flows. The empirical evidence suggests that the poorest segments of the population do not migrate as occurs with many of the rural inhabitants that have greater resources, since they lack the necessary resources to do so. An appropriate strategy would be to approach the problem from two perspectives – provide the

necessary resources for migration and try to increase the liklihood of successful insertion in the place of destination. The initial capital for migrants could be provided through: (i) payments for transfers of traditional land holding rights to groups interested in the conservation and protection of biodiversity in order to remove sub-marginal land from circulation; and (ii) financing the purchase of land rights for more successful producers. Literacy efforts and vocational training are also important for families that are prepared to migrate in order to equip them with the basic skills that would allow them to find jobs in their places of destination (Dixon et al., 2001).

4.3.10. Marketing study for the establishment of a direct link between local producers and consumers of foodstuffs in peri-urban areas

In order for this proposal to succeed, it is necessary to promote research into marketing systems in order to identify local and regional particularities and to provide updated information to farmers and their representatives. A large part of the problems of farmers lies in poor marketing of their products (Dürr, 2002a; 2002b). Similarly, research and dissemination of studies on an integral approach by the productive chain in the territory should be included in the agenda of KSTAI systems. It would be possible in this way to identify opportunities for business for different segments of the rural space (Santana, 2002).

Associated with the above option are proposals for the development of know-how for peri-urban agriculture. Urban agriculture is characterized by making dynamic use of the land (Luc, 2006; Companioni, 2001), which is rapidly adapted to the growth and development of the city, but it suffers from a problem of image and is rarely recognized as a valid category of use of urban land. By combining the productive systems of urban agriculture with open urban space, it is possible to identify areas in which urban agriculture is more stable (such as right of ways and “non-buildable” land) as well as areas in which it may be temporary (for example, zones for future building). The restricted areas in the city center could benefit from more intensive activities, which are generally more profitable, such as the production of mushrooms, silkworms or medicinal plants. Site exposed to pollutants could be used for decorative crops instead of risking health through the cultivation and sale of market garden produce. Assigning areas within or on the periphery of cities for the exclusive and permanent use of the AU is quite unrealistic and is doomed to failure. On the one hand, it ignores the economic reality of land prices in expanding cities. Moreover, and more importantly, it takes no account of the interactions that urban agriculture may have (and should have if it is to succeed) with

other urban activities. If the municipal authorities involve a broader base of stakeholders, they would have more possibilities for developing policies that cover the needs both of the city and of their voters, particularly from the poor and disadvantaged sectors. Moreover, more equitable decision-making promotes participation and acceptance by citizens at all levels. As part of any political initiative for development, structures and processes must be established to identify problems, prioritize actions and undertake and implement activities for the monitoring of programs.

Workers in the urban agricultural sector and poor producers in particular cannot work as effectively as they might have, unless they are organized and their legitimacy recognized. Municipalities would clearly benefit from a better organization and representation of urban producers in local political decision-making processes.

4.3.11. Design of a KSTAI system of South-South cooperation and exchange between countries of the region and between the latter and countries in other continents.

The experience of sub-regional cooperative systems in Latin America and the Caribbean basically involves the INIAs and, under the leadership of IICA, have been, generally speaking, quite successful. The evaluations of these programs implemented at various levels (Evenson and Cruz, 1989; Cruz and Avila, 1990; Avila et al., 2005; Sales-Filho et al., 2006 a, b, c), demonstrate that cooperation has had many spillover effects between countries, in other words, neighbouring countries would benefit from research done on the other side of the frontier. In the meantime, evaluations have clearly shown that these programs need to be restructured in order for them to more effectively fulfill their respective mandates (Sales et al., 2006a, b, c).

Regional, and in particular sub-regional cooperation, in which the cultural, soil and climatic conditions are more similar, should be greatly strengthened. In this area too, there is need to promote exchanges of experiences between the other actors of the sub-regional and national systems of innovation, in addition to the INIAs, such as universities, NGO's, cooperative and producers' associations, and the private sector (Bisang et al., 200).

4.4. Relevant stakeholders (collective or individual) and their capacities

The stakeholders in Latin America and the Caribbean are extremely diverse, which makes it extraordinarily complex to generalize for the region (see section on Ethnic Groups in chapter 1). The conceptual principle for seeking options for the future is respect, tolerance and valuing cultural

diversity, which represents the human capital of a region. The diversity of ethnic groups is part of the conditions that make it possible to integrate the various types of knowledge so that they could contribute to achieving the goals of sustainability and to improving quality of life and equity. One of the areas of knowledge that has not been developed and which represents extraordinary scientific, sociological and technological potential is agro-ecology. Agro-ecology brings together various types of knowledge, social classes and races all participating in innovation and knowledge production. As explained in Chapter 1 citing Pretty et al., (2003), the University of Exxes in England conducted a study in 52 countries encompassing 45 projects in Latin America. The authors found that 9 million producers use agro-ecological methods in approximately 29 million hectares (throughout the world) and that the yield from land that uses agro-ecological or organic methods in sustainable agriculture is equal to and in the majority of cases significantly greater than the yield from land under conventional production (see Figure in Chapter 1). This type of agriculture benefits in particular farmers and small producers of under two hectares.

4.4.1. Capacities needed to strengthen different types of networks

There are common themes (horizontal) which in any of the scenarios or models of governance affect quality of life, environmental sustainability and equity. A number of key themes have been proposed for the goals of sustainability in multidisciplinary exercises in Latin American and the Caribbean (Red Nuevo Paradigma, 2005)

Some themes that should be pursued in order for capacities to be strengthened in various types of networks are:

(i) Themes associated with quality of life: as discussed above, the concept of human development is more than national income (GNP) or per capita income. It depends on the existence of an environment in which individuals can fully realize their potential and live productively and creatively in accordance with their needs and interests. Consequently, the quality of life, in addition to satisfying primary organic needs, consists in expanding the range of options that individuals have for living in accordance with their values.

(ii) Themes associated with environmental sustainability: (a) land conservation and management; (b) sustainable use of biodiversity; (c) relationship between indigenous cultures and conservation; (d) Germoplasma, prospection and conservation in-situ and ex-situ; (e) valuing of biodiversity and of

natural resources; (f) traditional know-how in biodiversity; (g) conservation and management of pollenizers; (h) ecology of biological controls; (i) organic fertilizers; (j) prospection and sustainable management of plants (especially native plants); (k) urban agriculture; (l) management of fisheries resources; (m) impact of the agriculture and cattle farming sector on fauna; (n) native flora and microorganisms; (o) impact of fragmentation on natural habitats (on hydro-biological cycles, soils, biological interaction); (p) impact of genetically modified organisms (GMOs) on the environment and human and animal life; (q) zonification, management and agro-ecological agriculture; (r) invasive varieties (existing and potential, exotic and native); (s) management of forestry resources; (t) management of the quality and use of water.

(iii) Themes associated with equity: (a) legislation for the protection of the rights of all citizens without distinction based on race, age, sex, origin, traditions, ideology, power or social or economic condition; (b) education without discrimination for all under equal conditions; (c) numerous and sufficient educational centers by number of inhabitants and by area of influence both in cities and in the countryside; (d) compulsory education in human rights, ethics (Pérez, 2005), philosophy and ecology from a very early age; (e) study of the origins of inequality; (f) study of the origins and consequences of extreme wealth and extreme poverty; (g) decision-making power of communities; (h) provision of space and promotion of democratic organizations in rural and urban communities (discussion and solutions to problems arising from inequality).

4.4.2. Options for institutional responses to strengthen capacities

This section proposes a model (successful institutional arrangements) for strengthening capacities under the scenarios set out in chapter 3.

Salles Filho et al., (2006) found that various countries have undertaken institutional innovations in their agricultural research systems, which can serve as a reference for Latin America and the Caribbean. The Janssen study (2002) of five industrialized countries demonstrates the diversity of initiatives and the area of influence of changes which have led to significant impacts on the financing and organization of research. One of the conclusions of the author was that “the new systems of research reflect the new conditions that society is imposing on agriculture, science and public sector management”. In short, changes introduced in the countries studied would present the following characteristics and tendencies.

4.4.2.1. Governance

Reduction of expenditures through compliance actions (return) for: a new approach to public management; planning and support; review of responsibilities for P&D companies. The different parts interested in the decisión-making process are involved and this is influenced by the financial contribution. Flexibility in the management of human resources: adoption of more flexible mechanisms such as short-term contracts (doctoral projects), greater rotation (renewal) of researchers. Disadvantages, reduced possibilities of long-term research. Advantage, increase in the process of dissemination of know-how.

4.4.2.2. Financing

Separation between financing and evaluation. Diversity of sources available through competitive funds. The model of government – producers co-financing has not developed sufficiently. The trend has been to provide financing to producers or their interests. The participation of private initiative: as occurred in Australia, in the other countries studied private expenditures on research are greater than public expenditure. Development of competition by seeking greater quality through competitive funding, mainly to promote research into new sectors that involve changes in direction.

4.4.2.3. Research activities

A study is needed on the following important research areas: interaction with universities; strengthening and consolidation of integration between the educational and research systems. Public/private research: efforts to establish common mechanisms, programs or research institutes. Emphasis on the joint generation of know-how. International collaboration: recognition of the importance of this type of action (joint generation of know-how). Initiatives for participation of countries in regional forums. Initiatives for specializing and merging areas of knowledge using a heuristic approach. Legal frameworks: development of the legal framework for research. Legal management is seen as an essential factor for the effectiveness of the research system.

With regard to initiatives that lead to changes in the paradigms, a process is currently underway in Latin America to promote rural development experiences whose principal characteristic is innovative solutions to basic problems of rural development; improvement in the quality of life of the population, sustainable income-generating activities, increase in the voice and presence of farmers and indigenous populations in decision-making forums, or qualitative modifications in gender relations,

using various approaches, both organizational and institutional. An urgent challenge for rural development is learning from experiences that are underway to develop new approaches and perspectives. These are emerging elements that provide messages that are useful to an understanding of the initiatives undertaken by local communities to deal with their forms exclusion. One question, perhaps the most important, is how to establish a fruitful relationship between knowledge, innovations and rural development.

As Orlando Plaza correctly stated in a recent text, most of the rural development programs have had in common a weak theoretical and conceptual framework and a limited capacity to analyze the dynamics of rural societies, and a limited capacity for learning from similar experiences. Resolving this complexity may contribute in our view to a solution to the challenge (Chiriboga, 2003). Chiriboga posits that it is necessary to view rural development as a learning process in which creative thinking is needed to improve the relationship between the innovative agents on the ground and researchers. In this connection, there are significant processes in Latin America which for some decades now a number of organizations and institutions have been promoting and highlighting such as the peasant experiment, which establishes relationships between peasants and between peasants with problems and researchers who play a role as facilitators of this process. Specificially, note should be taken of the reference in a section of the report of FAO; Forests, Trees and Communities II Phase, which develops this concept of peasant experimentation.

There is a logic to rural farming research. The rural farmer relies on observation, experimentation, correction, conversation, etc. in order to understand the immediate environment that surrounds him in accordance with the needs of his daily life. This knowledge is simply not systematized in the way scientists and technicians do, in writing, which does not mean that a system of transmission is lacking. The farmer does not do it systematically nor in writing but it is spontaneous and with emphasis on the oral approach: conversation, sharing with neighbours, trials are all part of the range of resource that he uses. Although the method applied is not strictly the same used in formal research in universities and other extension entities, at heart its process responds to a similar logic to that used in the scientific method. In this sense Rhoades says “both farmers and scientists follow the steps: formulation of a problem, formulation of a demonstrable hypothesis and testing that hypothesis empirically to validate or invalidate it” (Haverkort et al., 1988). The main difference is that the degree of formalization of the process is far from being the same. However, while accepting the existence of

a logic of farmers research, it should be clear that this should not be considered as the realization of a potential that can be separated from the rest of the so-called “scientific” knowledge. On the contrary, the farmer takes aspects of scientific knowledge, adapts them, adds to them, modified them and the same is trae for the technical expert. “that trend gave Central America a stronger agricultura education system. Agronomy is an important career in universities. The Univerisdad de San Carlos In Guatemala has one of the oldest Agronomy Schools in the region. The Agrarian National University in Nicaragua teaches exclusively agronomy. In Honduras the most important agriculture school is the Pan-American School of Agriculture – Zamorano (EAP), which is internationally funded and attended by students from the Americas under a scholarship program. In Costa Rica, the four public universities offer agronomy as a discipline, although the emphasis and professional profile are slightly different. Thus, the developing countries of Central America maintain a series of higher education institutions enabling students to promote technological innovation in small farmer production systems” (Arana 2006 Com. Pers).

A number of sound innovations that small farmers have had to introduce in order to reduce costs, for example, end up being taken over by the technical experts and through them by large businesses or by other groups of farmers to whom the technical experts in many cases provide their services.

What is relevant therefore about small farmer experimentation is not so much the existence of “small farmer knowledge” that is separable and distinguishable from “scientific knowledge”, but rather a specific process, a special way of processing things and of acting in relation to the universe of values that is specific to small farmers. What is important is this drive that leads them to seek innovation, which is coordinated with their lifestyles, available resources, worldview and values, in short, the social symbolism of which the small farmer is the representative and which gives sense both to his life and to the innovations that he makes.

4.4.2.4. The management of motivation of talent: motivation is an important dimension for the success of agricultural research and development organizations.

In order to strengthen capacities, it is necessary to evaluate a number of elements such as (modified from the New Paradigm Network, 2005); (a) occupational stability; (b) possibility for (post-graduate) academic training; (c) honors and distinctions; (d) flexible work day; (e) facility for geographic moving; (f) financial rewards; (g) easy funding and execution of research projects; (h) creative and pleasant environment; (i) competitive environment between teams and centers; (j) cooperative atmosphere

between and among groups; (k) management geared towards results and efficiency; (l) management geared towards relationships and negotiated solutions to conflict; (m) high salaries; (n) participation in research groups; (o) recruitment for specific periods for the execution of specific projects; (q) development of long-term research programs; (r) values and social commitment to beneficiaries; (s) effective dissemination of results; (t) participation of the community in research (u) involvement of children and young people in research and conservation as inheritors of the earth.

4.5. Final considerations

The World, and particularly Latin America and the Caribbean, is experiencing a period of unprecedented change because of the magnitude (spatial and temporal), profundity and pace of these changes. Globalization is an inexorable phenomenon and a historic law that is a consequence of the development of productive forces (although there is controversy, for example, Saul, 2005). The results of sustainability, equity and quality of human life in the medium and long term depend on the actions taken today. There are very big differences between technological development on the one hand and poverty and backwardness on the other. Traditionally, innovation has been marked by linear logic in which a few generate while others transfer and the majority adopt (Gibbons 2000 in New Paradigm Network, 2005). Although it is impossible for decisión-makers to control all the variables, it is fundamental that these individuals, when making decisions, clearly define the philosophical and ethical vision venid each decision (Pérez, 2005). Economic growth does not necessarily lead to greater equality or to less discrimination or to a better quality of life or to greater environmental sustainability.

The different types of know-how in Latin America and the Caribbean must be distributed in a more homogenous way, that is to say, technological knowledge must be more accessible to indigenous peoples and responsive to ecological concerns, and vice versa. The scientific method and any other pragmatic method can illuminate the research procedures. There is a need for changes in the content of educational curricula, in other words, to strengthen the various systems. If we agree that there are four levels of education, we must ensure that these are better connected and that their content is improved and diversified, that each level has elements of the other levels, that the connection between them is easier, and that there is easier access to each level by small farmers, technical experts, women, indigenous groups who can all have access on a larger scale to scientific and analytic training.

4.6. Bibliography

Adis, J., & M.O. Ribeiro. 1989, Impact of the deforestation on soil invertebrates from central Amazonian inundation forests and their survival strategies to long-term flooding, Water Quality Bulletin 14:88-98 + 104.

Almeida, W.B. de. 2006, Terras de quilombolas, terras indígenas, “babaçuais livres”, “castanhais do povo”, faxinais e fundos de pasto: terras tradiciónalmente ocupadas, Manaus: PPGSCA-UFAM, 2006. 140p.

Alpizar, A., H.W. Fassbender, J. Heuveldop, H. Fölster, and G. Enriquez, 1986, Modelling agroforestry systems of cacao (Theobroma cacao) with laurel (Cordia alliodora) and poro (Erythrina poeppigiana) in Costa Rica-I. Inventory of organic matter and nutrients. Agroforestry Systems, 4:174-189.

Alston, M.J.; C. Chan-Kang, C.; Marra, M.C.; P.G Pardey, and T.J. Wyatt. 2001, A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem Evaluatión and Priority Setting, IFPRI, Washington. 148p. (Research Report, 113).

Altieri, M. A. 1995, Agroecology, Westview Press, Boulder, Colorado. U.S.A.

Altieri, M.A., E.N. Silva and C.I. Nicholls. 2003, O papel da biodiversidade nomanejo de pragas, Holos, Editora Ltda-ME. Ribeirao Preto SP. Brazil

Amaral, Neto, M. 2004, Manejo florestal comunitário na Amazônia brasileira: análise da participación e valorización de saberes de grupos locais na implementación de três projetos pilotos, Dissertación de Mestrado em Agriculturas Familiares e Desenvolvimento Sustentável, Belém: NEAF/CAP/UFPA; Embrapa Amazônia Oriental. 99p.

Armbrecht, I., J. Vandermeer & I. Perfecto. 2004, Enigmatic biodiversity correlations: leaf litter ant biodiversity respond to biodiverse resources, Science 304:284-286

Arima, E., P. Barreto, and M. Brito. 2005, Pecuária na Amazônia: tendências e implicaçõews para a conservación ambienta, Belém, IPAM. 2005

Avila, A.F.D., L. Romano, and F.L. Garagorry (in press 2007), Agricultural and Livestock Productivity in Latin America and Caribbean and Sources of Growth in: Evenson, R.E. and Prabhu, P. (eds.) Handbook of Agricultural Economics: Agricultural Development: Farmers, Farm Productión and Farm Markets. 44p. Chapter 30.

Avila, A.F.D.; G. Sain, G., and S. Salles Filho. 2005. Evaluación de los Impactos Potenciales de los Proyectos Financiados por el Fontagro. 1ra Convocatoria: Informe Consolidado, San José, Costa Rica. Junio 2005. 82p.

Badgley. C., J. Moghtader, E. Quintero, E. Zakem, M.J. Chappell, K. Aviles-Vazquez, A. Samulon & I. Perfecto. 2006, Organic agriculture and the global food supply: Renewable Agriculture and Food Systems.

Baltazar, A. 2005, Peixe e Gente no Alto Rio Tiquié, Istituto Socioambiental: São Paulo. 339 p.

Barros, A. C.; Veríssimo, A. (eds.) 1996, A expansão daa atividade madeireira na Amazônia: impactos e perspectivas para o desenvolvimento do setor florestal no Pará. Belém: Imazon, 1996. 168p.

Bayão, R. di, and N. Bensunsan, 2003, Questão da proteción dos conhecimentos tradiciónais associados aos recursos genéticos nos fóruns internaciónais in Quem cala consente? Subsídios para a proteción aos conhecimentos tradiciónais, São Paulo, Instituto Sócioambiental.

Benatti, J.H.; McGrath, D.G.; Oliveira, Ana Cristina Mendes de 2003, Políticas públicas e manejo comunitário de recursos naturais na Amazônia. Ambiente & Sociedade, v.6, no.2.

Bensusan, N. 2002, Seria melhor mandar ladrilhar? Nurit Bensusan (org.), Brasilia, Editora Universidade de Brasilia: Instituto Sociombiental.

Berendse, F., D. Chamberlain, D. Kleijn, & H. Schekkerman. 2004, Declining biodiversity in agricultural landscapes and the effectiveness of agri-environment schemes, Ambio 33(8):499-502.

Bisang, R., G. Gutman, C. Roig, and R. Rabetino, 2000, Los Sistemas Nacionales de Innovación Agropecupária y Agroindustrial del Cono Sur: Transformaciónes y Desafíos, Montevideo, PROCISUR, BID 2000, 82 (Série Documentos, 14).

Blann, K. 2006, Habitat in agricultural landscapes: how much is enough- A state of the science literature review, Defenders of Wildlife. West Linn, Oregon, Washington D.C. (available at http://www.biodiversitypartners.org).

Brosset, A., P. Charlesdominique, A. Cockle, J.F. Cosson, and D. Masson, 1996. Bat communities and deforestation in French Guiana, Can J Zool 74:1974-1982.

Brown, S. 1993, Tropical forests and the global carbon cycle - the need for sustainable Land-Use patterns, Agriculture Ecosystem & Environment 46:31-44.

Buck, L.E., J.C. Milder, T.A. Gavin, I. Mukherjee. 2006, Integrating biodiversity conservation, agricultural production and livelihood benefits in ecoagriculture landscapes: a framework for measuring outcome, background report for a workshop: Ecoagriculture outcomes: assessing trade-offs and synergies between agricultural production, rural livelihoods and biodiversity conservation at a landscape scale, World Bank and Ecoagriculture Partners, Cornell University. USA.

Cairns, M.A., and R.A. Meganck, 1994, Carbon sequestration, biological diversity, and sustainable development - integrated forest management, Environmental Management 18:13-22.

Caporal, F.R. & J. A. Costabeber. 2004, Agroecologia: alguns conceitos e princípios, Brasília, DF: Ministério do desenvolvimento Agrário – SAF\DATER: IICA.

Cavalcanti, J.S.B.; Mota, D.M. da. 2002, Olhando para o Norte - Classe, genero e etnicidade em espacos de fruticultura, Revista Areas, Espanha.

Calle, Z; Murgueitio, E; & Calle, N. 2000, Enfoques silvopastoriles integrados para el manejo de ecosistemas, Fundación Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria – CIPAV, 2ª edición, Pág. 65, Cali, Colombia.

CGIAR. 2003, América Latina y el Grupo Consultivo sobre Investigaciones Agrícolas Internacionales, Breve síntesis de una asociación existosa, Secretaria del CGIAR, Washington, 2003. 12p.

Chavarría, Hugo; Sepúlveda, Sergio y Rojas Patricia (compiladores), 2002, Competitividad: cadenas agroalimentarias y territorios rurales: Elementos conceptuales, IICA. 380 p.

Chauvel, A., 1996, Réactions du milieu forestier amazonien aux essais de mise en valeur agrosylvopastorale, C.R. Acad. Agric. Fr. 82:91-106.

Chiriboga, M. 2003, Innovación Conocimiento y Desarrollo Rural, Memorias del Segundo Encuentro de la innovación y el conocimiento para eliminar la pobreza rural, FIDAMERICA.

CIP BM 2003 http://www.agassessment.org/docs/Reporte_de_Limafirst.pdf

CIFAA (Comisión Internacional sobre el Futuro de los Alimentos y la Agricultura) 2006, Manifiesto sobre el futuro de los alimentos, Press Service Srl, Sesto Fiorentino (FI), Arsia, Regione Toscana, Italy.

Companioni, N., Y. Ojeda, E. Páe and C. Murphy 2001, La agricultura urbana en Cuba, p. 93-110. In F. Funes et al. (ed.) 2001, Transformando el campo cubano. Avances de la agricultura sostenible. ACTAC, Asociación Cubana de Técnicos Agrícolas y Forestales. ISBN 959-246-032-9. Centro de Estudios de Agricultura Sostenible, CEAS, Universidad Agraria de la Habana, La Habana, Cuba. 285 p.

Cortes-Marin E. 2004. Ciencia y desarrollo: ¿Para qué? www.agro.unalmed.edu.co/departamentos/iagricola/docs/ciencia_y_dllo_tecnologico.pdf

Cruz, E.R. and A.F.D. Avila. 1992, Impactos Económicos de la Cooperación Tecnológica entre los Países Andinos in Investigación Agraria: Economía. 7(2): 283-89, INIA, Madrid, España. 1992.

Decaens, T., J.J. Jimenez, E. Barros, A. Chauvel, E. Blanchart, C. Fragoso, and P. Lavelle. 2004. Soil macrofaunal communities in permanent pastures derived from tropical forest or savanna. Agriculture Ecosystems & Environment 103:301-312.).DeClerk, F, J.C.Ingram & C.M Rumbaitis del Rio 1196. 2006. The role of ecological theory and practice in poverty alleviation and environmental conservation. Frontiers in ecology and the environment 4(10):533-440

DeClerk, F.A.J., and P. Negreros Castillo, 2000, Plant species of traditional Mayan homegardens of Mexico as analogs for multistrata agroforests. Agroforestry Systems 48:303-317.

Deere, CD. 2005, The feminization of agriculture? Economic restructure in rural Latin America, occasional paper, United Nations Research Institute for Social Development, 78 p. UNRISD. Geneva. Switzerland.

Dixon, J., A. Gulliver & D. Gibbon 2001, Sistemas de producción agropecuaria y pobreza. Como mejorar los medios de subsistencia de los pequeños agricultores en un mundo cambiante, Capitulo 7 1- 39 pp, Editor Principal: Malcolm Hall. http://www.fao.org/DOCREP/003/Y1860S/y1860s00htm

Daily, G. C. 1997, Nature's Services: Societal Dependence on Natural Ecosystems, Washington: Island Press

Dietsch, T.V., S.M. Philpott, R.A. Rice, R. Greenberg, P. Bichier. 2004, Conservation policy in coffee landscape. Science 303:625.

Downs, C.A., C.M. Woodley, R.H.Richmone, L.L. Lanning, R. Owen, 2005, Shifting the paradigm of coral-reef “health assessment”, Marine Pollution Bulletin 51:486-494.

Durston, J. 2002, El capital social campesino en la gestión del desarrollo rural. Díadas, equipos, puentes y escaleras. Comisión Económica para la América Latina (Cepal) Naciones Unidas, Santiago de Chile. ISBN 92-1-322050-2.

Dürr, J. 2002ª. A comercialización de produtos da produción familiar rural: o caso de Cametá. Belém, NAEA/UFPA, DED, 2002a. 58p. (Papers do NAEA 162).

Dürr, J. 2002b, Cadeias produtivas no "Pólo Altamira": um estudo de caso. Versão preliminar, Belém: NAEA/UFPA, DED, 2002b. 45p. (Formato Pdf).

Ellingson, L.J., J.B. Kauffman, D.L. Cummings, R.L. Sanford, and V.J. Jaramillo, 2000, Soil N dynamics associated with deforestation, biomass burning, and pasture conversion in a Mexican tropical dry forest, Forest Ecology and Management 137:41-51.

EMBRAPA. 2004, IV Plano Diretor da Embrapa: 2004-2007, Brasília: Embrapa, Secretaria de Administración e Estratégia. 48p.

EMBRAPA. 2006, Marco referencial em agroecologia, Embrapa Información Tecnológica, Brasilia, 70 p.

Evenson, R.E., and E.R. da Cruz, 1989, The Impacts of technology PROCISUR Program: An Internatiónal Study, New Haven (USA), IICA/BID/PROCISUR, June 1989, 70p.

Fabricius, K.E. & G. De´ath. 2004, Identifying ecological change and its causes: a case study on coral reefs, Ecological Applications 14:1448-1465.

Fachinello, J. C. 1999, Producción integrada de frutas (PIF) in Seminario Estadual de Fruticultura, Palmas / PR. Anais do Seminário Estadual de Fruticultura 1:1-11.

FAO, 2001 (Food and Agriculture Organization of the United Nations) 2001, The international treaty on plant genetic resources for food and agriculture, adopted by the 31st session of the Conference of FAO, 3 November 2001, Rome, Italy.

FAO- Food and Agriculture Organization (Organización de las Naciones Unidas para la Agricultura y la Alimentación), 2002, Agricultura mundial: hacia los años 2015/2030. Roma, Italia 95p.

FAO. 2003, International Code of Conduct and the Distribution and Use of Pesticides, Rome.

Fearnside, P.M. 1999, Biodiversity as an environmental service in Brazil's Amazonian forests: risks, value and conservation, Environmental Conservation 26:305-321.

Floagri. 2005, Sistemas Integrados de Gestão Participativa dos Recursos Florestais e Agrícolas pelas Populações Rurais na Amazônia Brasileira, Proposta Original, mimeo. 27p.

Funes, F., L. García, M. Bourque, N. Pérez, and P. Rosset (ed.) 2001, Transformando el campo cubano: avances de la agricultura sostenible, ACTAC Asociación Cubana de Técnicos Agrícolas y Forestales, ISBN 959-246-032-9, Centro de Estudios de Agricultura Sostenible, CEAS, Universidad Agraria de la Habana, La Habana, Cuba.

Gallina, S., S. Mandujano and A. Gonzalezromero, 1996, Conservation of mammalian biodiversity in coffee plantations of Central Veracruz, Mexico, Agroforest Syst 33:13-27.

Garrido, M S. 2006, Recomendaciones y estrategias para desarrollar la agricultura ecológica en Iberoamerica, CYTED, mazinger.sisib.uchile.cl/repositorio/lb/ciencias_agronomicas/ g2006681059librorecomedacionesaecyted.pdf.

Ghuman B.S., a.L.R, 1983, Effects of deforestation and land use on soil, hydrology, and micro-climate at okomu, south Nigeria:1-15.

Gliessman. S.G. (ed.) 2001, Agroecosystem sustainability: developing practical strategies, CRC Press, Boca Raton, Florida, U.S.A.

Gonzáles, T. 1999, The cultures of the seed in the Peruvian Andes, pp. 193-216, in S. B. Brush (ed.), Genes in the field: on-farm conservation of crop diversity, International Plant Genetic Resources Institute (Rome), International Development Research Centre (Canada), Lewis Publishers, Boca Ratón Fla.

FORAGRO. 2006, Elementos para el Plan de Acción de Foragro: 2006-2008, San José, 2006.

Graziano Da Silva, J.; Del Grossi, M.E. 1998, A pluriatividade na agropecuária brasileira em 1995. Estudos Sociedade e Agricultura, Rio de Janeiro, 11, p.26-52.

Graziano Da Silva, J. 1999,O novo rural brasileiro, 2. Ed. Campinas: UNICAMP, IE. 151p.

Guzmán, E. S. 2004, Agroecología y agricultura ecológica: hacia uma “re”-construcción de la soberania alimentaria, VI Congresso de la SEAE. Almeria, set.

Hardin, G. 1998, Extensions of the tragedy of the commons, Science, 280:682-683.

Homma, A.K.O. 2005. Amazônia: como aproveitar os benefícios da destruición? Estudos Avançados. 19(54). USP – São Paulo 115-135p.

IAvH, Instituto de Investigación de recursos Biológicos Alexander von Humboldt (IAvH). 2006, Informe sobre el avance en el conocimiento y la información de la biodiversidad 1998-2004 in Chaves, M.E. and Santamaría, M (eds), Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá D.C., Colombia, 2 Tomos. ISBN 958-8151-783.

Unicamp 2005. .http://www.ufcg.edu.br/~unicampo/textos/ProjetoUniCampo2005versao7 so.pdf. Acessado em 05/02/2007.

IICA, 200, Seminário Internaciónal Equidade de Gênero e Desenvolvimento Sustentable dos Territorios Rurais. Cristina Buarque (org.). São Luis, 2004. 216p. Instituto Nacional de Pesquisas da Amazônia, 1995. p.75-82.

Janssen, W. 2002, Institutional Innovations in Public Agricultural Research in Five Developed Countries, ISNAR.

Jong, B.H.J.d., G. Montoya-Gomez, K. Nelson and L. Soto-Pinto, 1995, Community forest management and carbon sequestration : a feasibility study from Chiapas, Mexico. Interciencia 20:409-416.

Kaimowitz, David, 1996, La investigación sobre manejo de recursos naturales renovables para fines productivos en América Latina, Environment Division, IDB, Washington D.C. 67 p.

Kaltner, F.J., Furlan Junior, E.B. da Silva, and A.S. Veiga 2004, Viabilidade técnica e econômica da produción de ésteres de óleo de palma para utilización como substituto do óleo diesel na Amazônia, Belém, PA: Embrapa Amazônia Oriental, 54p. (Embrapa Amazônia Oriental. Documentos, 193).

Kursten, E. and P. Burschel, 1993, CO2-Mitigation by agroforestry, Water, Air and Soil Pollution 70:533-544.

Leahy, S. 2006, Global food supply near the breaking point, May 18, 2006, Inter Press Service, Available at http://www.ipsnews.net/news.asp?idnews=33268

Leite, S., Heredia, B.; Medeiros, l.; M. Palmeira, R. Cintrão. 2004, Impacto dos assentamentos:Um estudo sobre o meio rural brasileiro, NEAD, Editora UNESP, 2004, 392p.} Lavelle, P., L. Brussaard, and P. Hendrix, 1999, Earthworm management in tropical agroecosystems CAB-International, Wallingford, UK.

Lavelle, P., M. Blouin, J. Boyer, P. Cadet, D. Laffray, A.T. Pham-Thi, G. Reversat, W.H. Settle, & Y. Zuily-Fodil, 2004m, Plant Parasite control and soil fauna diversity, C.R. Biologies:629-638.

Lima, A., and N Bensunsan 2003, Quem cala consente? Subsídios para a proteción aos conhecimentos tradiciónais, São Paulo, Instituto Sócioambiental.

Lima, M.A., O.M.R. Cabral, and J.D.G. Miguez, 2001, Mudanças Climáticas Globais e a Agropecuária Brasileir,. Embrapa. Embrapa Meio Ambiente, Jaguariúna, 2001, 397p.

Luc J.A.M. 2006, Cultivando mejores ciudades: agricultura urbana para el desarrollo sostenible, IDRC 2006. ISBN 1-55250-228-7. 132 pág. www.rlc.fao.org/prior/segalim/aup/ Agricultura Urbana y Peri-urbana (AUP).

Maluf, R.S., F. Menezes, and S.B. Marques 2004a Caderno segurança alimentar, disponível em: http://www.dhnet.org.br/direitos/sos/alimentación/Conferências.html, Acesso em 07/07/2004a.

Maluf, R.S. 2004b, Consumo de alimentos no Brasil: traços gerais e ações públicas de segurança alimentar, Disponível em http://polis.org.br/publicações/papers/20006.html, Acesso em 11/07/2004b.

Mann, C.C. 2006, 1491, Una nueva historia de las Américas antes de Colón, ed. Aguilar, Altea, Taurus, Alfaguara S.A. Bogotá. 632p.

Markewitz, D.; Davidson, E. Atlas; Figueiredo, R. de O.; Victoria, R. L; Krusche, A. V. 2001, Control of cation concentrations in stream waters by surface soil processes in an Amazonian watershed, Nature, England, v. 410, p. 802-805.

Markewitz, D.; Figueiredo, R. de O.; Davidson, E. A. 2006, CO2-driven catión leaching after tropical forest clearing, Journal of Geochemical Exploratión, v. 88, p. 214-219, 2006.

Mathieu, J., J.-P. Rossi, P. Mora, P. Lavelle, P.F.d.S. Martins, C. Rouland, and M. Grimaldi. 2005, Recovery of soil macrofauna communities after forest clearance in Eastern Amazonia, Brazil, Conservation Biology, in press.

Mattison, H., and K. Norris. 2005, Bridging the gaps between agricultural policy, land-use and biodiversity, Trends in Ecology and Evolution 20:610-616.

Mattos, L., Faleiro, A., Pereira, C. 2001, Uma proposta alternativa para o desenvolvimento da produción familiar rural da Amazônia: o caso do Proambiente, in IV Encontro Naciónal da Sociedade Brasileira de Economia Ecológica - ECOECO, Belém.

Mendelsohn, R., and N. Seo. 2006, “An Integrated Farm Model of Crops and Livestock: Modelling Latin American Agricultural Impacts and Adaptation to Climate Change”, draft report of the Latin American project, Yale University, New Haven, June, 43p.

Mendelsohn, R.; A.F.D. Avila and N. Seo. 2006, Synthesis of Latin American Project: draft report, Yale University, New Haven, Oct. 62p.

McNeely, J.A., and S. J. Scheer 2003, Ecoagriculture: strategies to feed the world and save biodiversity, Island Press Washington.

MMA - Ministério do Meio Ambiente, 2004, Relatório Final do Grupo de Trabalho do MMA. Proambiente: Um novo modelo de desenvolvimento rural para a Amazônia, Brazil.

Monro, A., D. Alexander, J. Reyes, M. Renderos & N. Ventura. 2002, Arboles de los cafetales de El Salvador, The Natural History Museum, London.

Mori-Pinedo, L.A. 1993, Estudo da possibilidade de substituición do fubá de milho (Zea mays L.) por farinha de pupunha (Bactris gasipaes H.B.K.) em racões para alevinos de tambaqui (Colossoma macopomum CUVIER, 1818), Manaus: Instituto Naciónal de Pesquisas do Amazonas/Universidade do Amazonas, 65p, dissertacion (Mestrado em Biologia de Água Doce e Pesca Interior) - Instituto Naciónal de Pesquisas do Amazonas/Universidade do Amazonas, 1993.

Muller, A.A., J. Furlan, C. Filho, P. 2007, O agronegócio do dendê no estado do Pará: contribuições da Embrapa Amazônia Oriental, Belém, PA: Embrapa Amazônia Oriental, 2007, 65p. (Embrapa Amazônia Oriental. Documentos- no prelo).

Murgueitio, E. 2003, Impacto ambiental de la ganadería de leche en Colombia y alternativas de solució,. Livestock research for rural development, 13 (10).

Nair, P.K.R. 1997, Directions in tropical agroforestry research: past, present and future, Agroforest Syst 38:223-245.

National Research Council, 1989, Alternative agriculture, National Academic Press, USA.

Neill, C., J.M. Melillo, P.A. Steudler, C.C. Cerri, J.F.L. deMoraes, M.C. Piccolo and M. Brito, 1997, Soil carbon and nitrogen stocks following forest clearing for pasture in the southwestern Brazilian Amazon, Ecol Appl 7:1216-1225.

Nivia, E. 2003, Mujeres y plaguicidas, estudio de caso en Palmira, Colombia, pp. 28-61 in. Asociación Colectivo de Agroecología del Suroccidente Colombiano-ACASOC, Aportes a la agroecología Colombiana, Litocencoa, Ltda. Cali, Colombia.

Ortiz, Ramiro 2004, Análisis comparativo de las modalidades de asistencia técnica del INTA: enfoques y modelos de extensión, estructuras de costos y beneficios generados, FAO-Nicaragua,www.pesacentroamerica.org/doc_hssh/investigacion/analisis_%20comparativo_Ramon_Ramiro.pdf

Ostertag, C. 1999, Identificación y evaluación de oportunidades de mercado para pequeños productores rurales, Gui 7, Instrumentos metodológicos para la toma de decisiones en el manejo de Recursos Naturales, CIAT, Colombia. 191 p.

Pegape, 2007, Site acessado em 1/02/2007. http://www.sectam.pa.gov.br/pesca/pegape.asp

Pereira-Filho, M. Alternativas para a alimentación de peixes em cativeiro, in Val A.L., Honczaryk, A. (eds.), Criando peixes na Amazônia. Manaus.

Pérez, J.J.,Dimensión ética del desarrollo sostenible de la agricultura, rcs. [online], ago. 2005, vol.11, no.2 [citado 04 Febrero 2007], p.246-255. available at <http://www.serbi.luz.edu.ve/scielo.php?script=sci_arttext&pid=S1315-95182005008000004&lng=es&nrm=iso>. ISSN 1315-9518.

Perfecto, I. and I. Armbrecht, 2003, The coffee agroecosystem in the Neotropics: combining ecological and economic goals, pp. 159-194 (Chapter 6) in J. Vandermeer (ed.) Tropical agroecosystems, CRC Press, Boca Raton, Florida. ISBN 0849315816. CAT. # 1581. pub. 12/03/02. Advances in Agroecology series, 268 pp.

Perfecto, I., R.A. Rice, R. Greenberg and M.E. Van der Voort, 1996, Shade coffee: a disappearing refuge for biodiversity, Bioscience 46:598-608.

Perfecto, I., I. Armbrecht, S. M. Philpott, L. Soto-Pinto & T.V. Dietsch. 2007, Shade coffee and the stability of forest margins in Northern Latin America in Tscharntke T, Leuschner C, Zeller M, Guhardja E, Bidin A (eds), The stability of tropical rainforest margins: linking ecological, economic and social constraints of land use and conservation, Springer Verlag Berlin 2007, pp 227-263.

Pimbert, M., K. Tran-Thanh, E. Deleage, M. Reinert, C. Trehet & e. Bennett (eds) 2005, Visión de los agricultores sobre el futuro del alimento y de los productores a pequeña escala, International Institute for Environment and Development (IIED), London, Reclaiming Diversity and Citizenship, Ed. M. Pimbert.

PNUD 2001, Human Development Report, Making New Technologies Work for Human Development, UNDP, United Nations, New York.

Polcher J., L.K. 1994, The impact of African Amazonian deforestation on tropical climate, Journal of hydrology 155:389-405.

Portela, R., and I. Rademacher, 2001, A dynamic model of patterns of deforestation and their effect on the ability of the Brazilian Amazonia to provide ecosystem services, Ecological Modelling 143:115-146.

Pretty, J.N. 1995, Participatory learning for sustainable agriculture, World Dev 1995, 23:1247-1263, UN-Millennium-Project: Halving Hunger: It can be done, Task Force on Hunger, 2005, 123, Promanejo, 2001, Manejo de florestas secundárias por agricultores familiares do nordeste paraense, Belém, 2001, mimeo.

Rasmussen, L. 1998, Effects of afforestation and deforestation on the deposition, cycling and leaching of elements, Agr Ecosyst Environ 67:153-159.

Red Nuevo Paradigma, 2005, Proyecto Quo Vadis: el futuro de la investigación agrícola y la innovación institucional en América Latina y el Caribe, Artes Gráficas Silva, 2551-236, Quito, October 2005, ISBN-9978-44-633-8.

Ruiz-Rosado, O, 2006, Agroecology: a discipline leading towards transdiscipline, Interciencia 31:140-145.

Francis, C., G. Lieblein, S. Gliessman, T.A. Breland, N. Creamer, R. Harwood, L. Salomonsson, J. Helenius, D. Rickerl, R. Salvador, M. Wiedenhoeft, S. Simmons, P. Allen, M. Altieri, C. Flora, and R. Poincelot. 2003, Agroecology: the ecology of food systems, Journal of Sustainable Agriculture 22:99-118.

Sánchez, P.A. 1994, Tropical soil fertility research : towards the second paradigm, XV International Soil Science Congress, Acapulco, Mex. Vol 1:1 - 24.

Saul, J. 2005, The collapse of globalization and the reinvention of the world, Penguin Books, Toronto, Canada.

Sá,T.D.D.A.; Alegre, J.C.; Vielhauer, K.; Mochiutti,S.; Ferrerira, M.D.S. 2002, Fallow management initiatives in tropical South América: an overview with emphasis on the Amazon región, Agric. Ecosystems Environ.

Saint-Paul, U. 1998, Potential for aquaculture of South American freshwater

Salles Filho, S. 2006, Trajectorias y Perspectivas del Procisur: Informe Preliminar de Evaluación. Montevideo, October 2006. 45p. (restricted circulation).

Salles Filho, S.; Souza, A.C. de. 2002, Agricultura familiar e investimento em desenvolvimento tecnológico in Dalmo Lima, Jonh Wilkinson et al (orgs.), Brasilia, CNPq/Paralelo 15,. 400p.

Salles Filho, S., M.B. Bonacelli, and A. Bin. 2006ª, Documento de Evaluación de Procitrópicos, Brasilia, Marzo, 2006. 87p. (restricted circulation).

Salles Filho, S.; E. Pedro and PJ. Mendes, 2006b, Conceitos, Elementos de Políticas e Estratégias regiónais para o Desenvolvimento de Inovações Institucionais, FORAGRO/IICA, Unicamp, Campinas, Brazil, April 2006. 56p.

Salles-Filho, S.L.M., E. Pedro and P.J. Mendes, 2006c, Conceptos, políticas y directrices para el desarrollo de innovaciónes institucionales en la investigación agropecuaria, IICA, San José, 2006.

Santana, A.C. de; M.M. Amin, 2002, Cadeias produtivas e oportunidades de negócio na Amazônia, Belém, UNAMA. 454p.

Santilli, J.A. 2002, A biodiversidade e as comunidades tradiciónais, Nuria Bensusan (org.), Brasilia, Editora Universidade de Brasilia, Instituto Sociombiental.

Schmitz, H., and D.M. MOTA, 2006, Métodos participativos para a agricultura familiar in Monteiro, Dión Márcio Carvaló; Monteiro, Maurílio de Abreu (Orgs.), Desafios na Amazônia: uma nova assistência técnica e extensão rural.,Belém, NAEA/UFPA, 2006, p.75-102.

Seo, N., and R. Mendelsohn 2006. “A Ricardian Analysis of the Impact of Climate Change Impacts on Latin America Farms”, draft report of the Latin American project,Yale University, New Haven, June, 38p.

Sevilla-Guzmán, E. 2006, Agroecología y agricultura ecológica: hacia una “re” construcción de la soberanía alimentaria, Agroecología 1:7-18.

Shiva, V. 2000, Stolen harvest, South End Press, Cambridge, MA.

Sosa-Escalante, J. (date unknown), Valoración y seguimiento de la biodiversidad: implicaciones en conservación y manejo, Facultad de Medicina Veterinaria y Zootecnia, Departamento de Zoología, Universidad Autónoma de Yucatán, www.ine.gob.mx/dgoece/diplomado/download/sosa.pdf

Swift, M.J., J. Vandermeer, P.S. Ramakrishnan, J.M. Anderson, C.K. Ong and B.A. Hawkins. 1996, Biodiversity and agroecosystem function, pp.261-298 in Mooney, H.A., J.H. Cushman, E. Medina, O.E. sala and E.D. Schulze (eds), Functional roles of biodiversity: a global perspective, John Wiley and Sons Ltd.

The Economist 2006, Good food? Why ethical shopping harms the world, The Economist, 15 – 19 December, p. 11.

Tian, H., J.M. Melillo, D.W. Kicklighter, A.D. McGuire, J. Helfrich, B. Moore, and C.J. Vorosmarty. 2000, Climatic and biotic controls on annual carbon storage in Amazonian ecosystems, Global Ecology and Biogeography, 9:315-335.

Van Damme Paul 2002, Disponibilidad, uso y calidad de los recursos hídricos en Bolivia, World Summit on Sustainable Development, Johannesburg, 2002.

Vandermeer, J. 1995, The ecological basis of alternative agriculture, Annual Review of Ecology and Systematics, 26:201-224.

Vandermeer, J. (ed). 2003, Tropical agroecosystems, CRC Press, Boca Raton, Florida, ISBN 0849315816, CAT. # 1581, pub. 12/03/02. Advances in Agroecology series, 268 pp.

Veiga, I. 2002, Saber e participación na transformación dos sistemas de produción da agricultura familiar amazônica. Anais do V Simpósio Latino Americano sobre Investigación e Extensão em Sistemas Agropecuários – IESA e V Encontro da Sociedade Brasileira de Sistemas de Produción – SBSP, Florianópolis, 20 - 23 May 2002.

Veiga, I., and C. Albaladejo. 2002, Gestão da fertilidade dos solos de uma localidade na Amazônia Oriental: a formalização dos pontos de vista dos agricultores visando um diàlogo entre agricultores e agrônomos, Agricultura familiar: Pesquisa, Formação e Desenvolvimento, 1:109-137.

Vía Campesina, 2003, Global campaign for agrarian reform, working document, commentary on land and rural development policies of the World Bank, Via Campesina and FIAN (Food First Information and Action Network): for the human right to feed oneself.

Vielhauer, K; Anashiro, O.M.; As. T.D.D.A.; Denich, M. (in press), Cooperación científica com a Alemanha ajudando a revitalizar a agricultura familiar do nordeste Paraense, Lusorama.

Vohland, K., and G. Schroth. 1999, Distribution patterns of the litter macrofauna in agroforestry and monoculture plantations in central Amazonia as affected by plant species and management, Applied Soil Ecology, 13:57-68.

Von Maydell H J. 1991, Agroforestry for tropical forests, Agrofor Syst. 13:259-267.

Zbiden, S., Lee, D.R., Payment for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program, World Development, Vol.33, No.2.

Zbiden, S., Lee. D.R. 2005, Payment for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program, World Development,Vol.33, No.2, pp.255-272.

Wood, S., Ehui, S et al. 2005, Food in Millenium Ecosystem Assessment, Conditions and Trends, Chap.8, pp. 211-238, Island Press.

World Bank, Agriculture & Rural Development Department, 2004, Agriculture and Achieving the Millennium Development Goals, report No. 32729-GLB, 85p, pdf. http://www.worldbank.org/rural.

Zerda–Sarmiento A. y Forero-Pineda C. 2002, Los derechos de propiedad intelectual sobre los conocimientos de las comunidades étnicas, Revista Internacional de Ciencias Sociales, March, No.171, La sociedad del conocimiento.

Zoby, J.L.F., J.H.V. Xavier and M.LGastal 2003, Transferência de Tecnologia, Agricultura Familiar e Desenvolvimento Local: a experiência do Projeto Silvânia, Planaltina Embrapa–CPAC, 2003, 45p (Embrapa–CPAC. Documentos, 101).