Chapter 4 – Latin America and the Caribbean (LAC)

AGRICULTURAL KNOWLEDGE, SCIENCE AND TECHNOLOGY SYSTEM (AKST)

OPTIONS FOR THE FUTURE

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KEY MESSAGES

1) Interaction of systems. While the great diversity of AKST systems is a major strength in Latin America and the Caribbean, these systems need to interact with each other. The interaction can be achieved through the generation, sharing and dissemination of experiences and by combining and developing the knowledge inherent in the three production systems (conventional, agro-ecological and traditional) in order to overcome weaknesses and share strengths.

2) Systemic vision. Develop a systemic vision of production systems by combining the strengths of the agro-ecological, conventional and traditional approaches in assessing (in the short, medium and long term) the results of all three in terms of cost-benefits and in light of the goals of IAASTD, in other words, to ensure environmental, social and economic sustainability. This approach considers the social, economic and environmental impact of the application of technologies to agricultural, forestry and livestock production, regulatory and support environmental services and farming extension services.

3) Prevention and environmental restoration. Poor management of water, soils and forests is a serious problem throughout Latin America and the Caribbean. The AKST systems should therefore focus urgently on prevention, conservation and environmental restoration and seek to reverse the degradation caused by intensive agriculture. One option may be to adopt technologies that help to restore the natural capital (soil, water, etc.) while at the same time achieving the goal of production of environmental goods and services.

4) Recovery and conservation of traditional knowledge. Promote and intensify efforts to rescue, develop and preserve ancestral knowledge by and for local and indigenous communities by empowering local communities and combining their know-how with agricultural knowledge. Promote training and the generation and ownership of fresh knowledge by local producers and consumers. Develop mechanisms for more effective organization (developed by AKST) of small and medium-sized producers.

5) Biodiversity. AKST systems should focus their strategies on the conservation and proper management of biodiversity. Biodiversity, at different levels (genes, species, ecosystems and landscapes) performs ecological functions, which are the functions that produce environmental goods and services. Biodiversity is an important source of opportunities for the development of new products and new economic activities. Through proper management, it is able to respond to the growing demand for food and other products in a context of economic and climatic changes. Environmental services (such as carbon sequestration, eco-tourism, landscaping, or the storage and purification of water) need incentives for conserving biodiversity, beginning with the preservation of natural habitats and the diversity of landscape ecosystems.

6) Participatory approach. Promote a participatory approach in processes for the generation and socialization of knowledge and in the various development strategies. This approach will help to reconcile the different expectations of the various actors, producers, researchers, officials and others.

7) Research for small producers. AKST systems should prioritize research (basic, applied, adaptive and strategic) to meet the demands of small producers: to improve the quality of life of local populations and to promote social and gender equality and a healthy environment and not only to improve productivity. Without an understanding of the underlying environmental and social mechanisms that result in inequality, hunger and environmental degradation, it is difficult to address the root causes. Basic research is therefore also necessary. One option is to promote interdisciplinary research to identify the relationships that were never established between the socioeconomic environment, productive landscapes, the biodiversity that is present in these landscapes and the ecological functions that it performs.

8) New institutional mechanisms for knowledge sharing. Create institutional mechanisms to promote knowledge sharing between AKST stakeholders. The synthesis of knowledge and its socialization/dissemination within the three production systems (conventional, traditional and agro-ecological) requires the use of new institutional tools tailored to each situation. It would be particularly useful to institutionalize the knowledge sharing systems used by private organizations (NGOs, foundations, etc.) and various research and development programs. This would allow for the continuous training of all sectors of society geared to the needs and technologies for the sustainable management of resources.

9) Strengthening of networks. Promote cooperation among AKST systems in the countries of Latin America and the Caribbean in the sharing of knowledge and skills. Given the limited human, financial and infrastructural resources available at the national level, research programs (platforms) among AKST stakeholders must be integrated by strengthening existing regional networks and cooperation programs. Regional networks and programs should also extend their activities to other AKST stakeholders, since they are currently mainly restricted to public actors, particularly Nacional Agricultural Research Institutes (NARIs).

10) International cooperation. Expand and strengthen cooperation activities and promote joint research by AKST systems in Latin America and international centers (for example, the Consultative Group on International Agricultural Research (CGIAR) and the Tropical Agricultural Research and Higher Education Center (CATIE)), national research institutes and universities, among others, in developing countries. The AKST systems in Latin America and the Caribbean must place emphasis on the development of research projects and on the training of personnel in centers of excellence so that the region could reduce the current technological gap and not remain on the margins of the major technological advances being made in other parts of the world. These efforts to promote cooperation must be aimed at strengthening the technical and scientific capacities of AKST stakeholders and thereby improve their impact on reducing poverty and hunger in the region.

11) Emerging technlogies. Channel research in new fields of knowledge (biotechnologies – molecular or other – and nanotechnogies, among others) towards the achievement of the goals of reducing poverty, hunger, malnutrition, human health and environmental conservation. Give priority in this process to the development of products based on these new technologies that benefit small producers (family businesses) by seeking to maximize their social,

economic and environmental impact while observing the precautionary principle. AKST systems must exploit the advantages of these emerging technologies while ensuring their biosecurity.

12) Biosecurity. Contribute to the strengthening of national bio-security committees. AKST systems must act effectively in the development of impact analysis and assessment of the potential risk of the products they research to ensure that their adoption would not cause problems for the environment or for consumers. AKST systems must ensure the biosecurity of the results of their research programs, based on the principle of precaution.

13) Organizational models. Create and/or strengthen AKST organizational models. Given the limitations of the organizational (structural) models of the various actors that comprise the AKST in many countries of Latin America and the Caribbean, one option would be to create new models or to strenghten the existing ones. Emphasis should be placed on sharing experiences in the adoption of different organizational models by the governments of the region and AKST stakeholders that enhance the efficiency and effectiveness (while preserving democracy and equity) of their respective systems.

14) Models of governance. Strengthen and modernize management models. One of the main problems of AKST stakeholders is the absence of models for the management of their organizations. Since there are many successful experiences in AKST management in the region, these experiences should be shared among AKST stakeholders.

15) Interaction between AKST systems and the society. Promote interaction between AKST systems and consumers, movements and social organizations. Promote structures that facilitate dialogue between them and other social actors and AKST systems. There must be greater participation by social actors in the identification and especially in the selection of research priorities and in the evaluation of results.

16) Intellectual property. Enactment of national legislation that recognizes collective intellectual property rights. National TRIPS legislation provides for the possibility of formulating strategies within the established multilateral framework. However, legal recourses may not be the most appropriate ones for protecting the knowledge that traditional (ethnic) communities have accumulated over centuries and must be adapted to their new purposes.

17) Teaching and training programs. Teaching curricula may be revised to include elements of AKST. For its part, AKST must also evolve to adapt to the transitions in formal education (from primary school to university) and in continuing education and training programs for all members of society. Advantage must also be taken of other types of training and information such as the communications media, which can be associated with this effort through special programs. In this way, it may be possible to preserve crops and agricultural knowledge and research by and for local and indigenous communities.

18) Inclusion of women in AKST systems. Promote increased participation by women in the management of organizational models, the generation and socialization of knowledge, and in the various development strategies. The participation of women in each aspect of AKST has

increased over the past 15 years but is still very limited, despite the increasing numbers of women in leadership positions in both productive activities and producer associations and organizations.

19) Accountability to society. Impact studies must be carried out by AKSTs to account for investments and to demonstrate to society the importance and impact of the products they generate. These studies should include an analysis of all the impacts of their products (economic, social, environmental and others) together with a program to communicate their results that is geared to the various stakeholders (actors- individual and collective – have very different levels of training and access to information).

20) Formulation of public policies. AKSTs should participate proactively in the formulation of public policies related both to the system itself and to the policies supporting the system. AKST stakeholders, including publicly funded national agricultural research institutes, have traditionally had little real participation in the preparation of the legal framework in which they operate (bio-security and intellectual property legislation, financing of research and development, credit policies, etc.). Generally speaking, their impact on public policies is limited to submitting reports with the results of their research.

4.1. Conceptual framework

For purposes of the IAASTD, the agricultural production systems in Latin America have been classified as follows (Chapter 1):

1. Traditional/indigenous production systems;
2. Conventional/agro-industrial production systems;
3. Agro-ecological production systems.

Each system of production is associated with a body of knowledge, science and technology that sustains and promotes it. Together these bodies of knowledge comprise the system of agricultural knowledge, science and technology. However, while this store of knowledge belongs to very different institutional and social systems, they are – or will have to be – permeable and must interact with each other, and it makes no sense therefore to establish vertical limits between them.

Chapter 4 identifies the principal options for making AKST work more effectively to achieve the goals of reducing hunger and poverty, improving rural living systems, improving nutrition and human health; and promoting equitable and sustainable environmental, economic and social development in Latin America and the Caribbean.

In terms of structure, the chapter has been divided into two main sections:

(1) Options for enhancing the impact of AKST systems.

(2) Options for strengthening the capacities of the System to generate, socialize, access and adopt AKST.

The system of knowledge and the institutions and organizations concernid with its generation and socialization are very separate and in most cases do not interact with each other. None of the systems of production, in their current state, whether conventional, traditional or agro-ecological, contributes at the same time to meeting the requirements of environmental sustainability and social and economic development. Thus, for example, it is evident that the conventional system has negative impacts on the environment, that the traditional system is failing to bring populations out of poverty and that agro-ecological systems still have not acquired the technological maturity that would make them acceptable and applicable under any conditions. However, Badgley and colleagues (2007) found, in a quantitative meta-analysis, that organic agriculture could today succeed in feeding the human population of the world (Badgley et al. 2007).

The different social groups in Latin America and the Caribbean exhibit a sometimos marked separation between land-use methods and the AKST storehouses on which they rely. The knowledge is generated and acquired in five main types of institutions that are generally separate and which can be completely unaware of the knowledge possessed by other types. This is the case in the institutions identified in the diagram in Figure 1 in which local knowledge (disseminated locally within the family and social groups) has very few or no links at all to the conventional/agro-industry model (see Chapter 1) taught in universities and centers of advanced learning.

Insert figure 1

The future development of agriculture in Latin America will depend on improvements in each one of the three bodies of knowledge mentioned above and, more than anything else, on the incorporation into each one of them of the elements needed to mitigate the negative effects of each one: the negative environmental impacts of some, and the low productivity or incapacity of others to reduce poverty and inequality.

4.1.1. Conceptual framework

The relations expressed in the triangle in Figure 2 are explained by the following examples:

Insert figure 2

Example 1. Pole 1 represents a system of traditional agriculture in tropical forests of Latin America and the Caribbean (clear, slash and burn), where traditional local AKST is used. The introduction of the practice of leaving land fallow and improved with the planting of vegetables shifts this category towards number 1; a situation in which the availability of good quality forage reduces the pressure on pastureland and therefore allows degraded areas to recover and/or the need to transform more forest into pastureland. The use of improved varieties and the inoculation of beneficial organisms (e.g. Rhizobium or Bacillus thurigiensis) would move them towards pole 3.

Example 2: pole 2 is an agro-forestry system based on an agroeological AKST, using greenery of multi-use leguminous plants and annual crops of maize. The addition of chemical fertilizers (e.g. P, K) to organic fertilizers in order to improve the balance between the supply of available nutrients and the needs of plants, use of better selected plants and crops that trap certain pests (e.g. rows of okras between maize) would take it towards pole number 2.

Example 3: lastly, pole 3 is a Soya monoculture based on a conventional AKST with annual plowing, fertilizing and pest control with chemical products. The abandonment of arable land and the movement towards a system of reduced plowing and the application of organic fertilizers and plant cover move it towards pole number 2.

The methodology used to identify options for improving the impact of the system of scientific and technological knowledge in agriculture was based on a double entry matrix in which each option proposed was analyzed in the context of the sub-regions and the goals of IAASTD. The options for the future were analyzed schematically based on the three extreme systems of agricultural production (and the bodies of knowledge that sustain them) (See Figure 1)

This chapter seeks to identify the principal options for making AKST work more effectively to achieve the goals of sustainability in Latin America and the Caribbean. It is therefore necessary to seek options for: (1) improving the impact of the AKST. This section contains four parts: diversity of AKST in Latin America and the Caribbean; sustainable environmental and socioeconomic development; climate change and bio-energy; and biodiversity. (2) Strengthen capacities to generate, socialize, access and adopt AKST. The options in each one of these two parts are presented below.

4.2 Options for strengthening the impact of AKST systems

4.2.1 Diversity of AKST bodies in Latin America and the Caribbean

AKST systems must interact more and differently. This goal could be achieved by exchanging experiences and comparing the different types of know-how and skills in order to address weaknesses and share strengths. The great diversity of AKST systems in Latin America and the Caribbean is its main strength. One type of knowledge does not exclude the other.

4.2.1.1 Integration of AKST systems

The management options being pursued in Latin America and the Caribbean combine in different proportions the various types of knowledges and technologies (see Chapter 1 and Figure 1). The conventional approach taught by universities and advanced technical institutes strongly advocates agro-industry; the agro-ecological approach espoused by 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 imparted by families and local social groups is based on extraction and low-input family-based agriculture. It is clear that in the particular case of each management typology, the AKST system used employs different proportions of each type of AKST. While projects undertaken have shown how systems interact with each other (FAO, ***http://www.fao.org/ag/agl/aglI/farmspi/*** Settle et al., 1996), greater effort is needed to expand and institutionalize these initiatives.

It is argued that the different systems replicate their drawbacks and reinforce their potential through the integration of elements of other typologies directed always towards the achievement of the IAASTD goals. 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 access to resources and economic assets and possible access to formal education, but rather on how producers can adapt to the restrictions imposed by the environment and to market conditions.

There is need for partnerships between researchers, extension workers, producers and producer associations for the pursuit and sharing of research. This would be 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, above all, from those who use the resulting product showed that many of the alternative technologies generated are of little use, 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 AKST and which scientific, technological and innovation policies should be applied in rural areas of Latin America. Parallel initiatives result in wasted efforts, resources and time and do 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 for 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 market demands in which protecting the environment and the health of consumers are prerequisites (Embrapa, 2004; FAO 2004).

4.2.1.2 Priority to research that supports the goals of IAASTD.

AKST systems should give priority to research whose practical results demonstrably contribute to the goals of IAASTD, that is to say, that can point to improvements in the quality of life of local populations, promote social and gender equality (in other words, respect for the differences between men and women), a healthy environment and increased productivity. Basic research is essential to understanding the underlying ecological and social mechanisms that create inequality, hunger and environmental degradation.

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 degradation of environmental functions make it unsustainable. Only a holistic vision in which the different goals are all considered together and the best trade-off sought between them in the socio-economic and biophysical conditions of the land can achieve this goal.

The need for a holistic approach to research is related to the analysis of the relationships between the different parts of the system on the property but also between the socio-economic environment and the landscape created by human activities that tranform the natural environment. In the mountainous regions of Central America, for example, primary forests are being transformed into a mosaic of secondary forests, coffee plantations, pasture land and fields of maize. The proportion of this type of use depends on market conditions, means of access to land ownership and on many other socio-economic variables. Depending on the diversity of the landscape, the degree of transformation and the intensity of use of the land, this landscape may include different levels of biodiversity that in turn will participate in different ways in the provision of environmental goods and services (for example, soil conservation, storage and purification of water, carbon sequestration or bio-control of pests) (Mattison and Noris, 2005). Implicit in this representation is the improvement of human well-being with sustainable production at a high level of environmental goods and services (Millennium Ecosystem Assessment, Human Well-Being, 2004).

It is essential to understand the relationships between these different entities, identify the drivers and the threshold impact in relationships in order to model this system of interactions and improve the management of all resources, whether human, economic or ecological. For example, it is known that transformed landscapes are capable of resisting the invasion of (invasive) species if the proportion of the natural ecosystem does not fall below a certain threshold and if the trend toward more intensive land use is slowed. However, the inner workings of the mechanisms affecting these qualities of the various agroecosystems (and various landscapes) are not known, although the positive role of biodiversity is well established (Kennedy et al., 2002).

It is also necessary to prioritize the research on options for increasing incomes (returns) and conserving 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 is only now beginning to be recognized (Cavalcanti and Mota, 2002; IICA, 2004).

4.2.1.3 Development and strengthening of agricultural programs to generate and increase the value of knowledge for local and indigenous communities

Of the three types of knowledge of AKST that have been identified, the traditional/indigenous is the least formalized and thus the most threatened. Preservation of the cultural services and biodiversity that this system sustains can be done by the development and strengthening of educational programs, crop preservation and knowledge retention, and agricultural research by and for local and indigenous communities. This, in turn, can be achieved by empowering local communities and combining their know-how with agro-ecological expertise, taking into account the fact that local and indigenous know-how is generated and disseminated within small social groups (family, town, association).

Rarely is this local and indigenous 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 that depends to a great extent on intimate knowledge of the natural conditions that are peculiar to each region/crop. This knowledge should also enrich conventional knowledge to help correct any negative environmental impacts of these practices without reducing their productivity and economic value. To this end, one promising option would be to put in place instruments to regulate access to traditional knowledge.

Properly focused, traditional knowledge, science and technology can 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 and scientific research institutions 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 agricultural revolution that is under way, while also combating and managing the crushing force of this very revolution as we enter into a new paradigm of agricultural science and technology (Sanchez, 1994).

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

Agro-ecology needs incentives for it to become cutting-edge technology, while evaluations (short, medium and long-term) are made of its results in terms of cost benefits. Agro-ecology has the potential to efficiently reverse the trend towards degradation of the environment and to contribute to 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, agro-industry that holds the promise of achieving the goals of poverty reduction through the production of food and other agricultural, forestry and livestock goods and, on the other, the maintenance of biodiversity and other environmental services while also pursuing the goal of social well-being. 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, and water percolation, detoxification, regulation and storage (Altieri, 1995). Agro-ecology cannot be developed without the active participation of an entire social network. One possibility is therefore to introduce agro-ecology into agricultural research and extension programs and in rural schools. It is also necessary to promote internal changes in the institutions seeking to adopt 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 agro-industry 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 sharing 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, a development style consistent with these goals must be sought. 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). Comprehensive studies are also needed to analyze and objectively test the assumptions about the low productivity of unconventional systems (for example, 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. This means that, among other things, governments should offer institutional support in the form of technical assistance to producers for production, processing and marketing; a reduction in the costs of certification; and the launching of demonstration projects that facilitate the supply of inputs and services, manage financing, promote arrangements for marketing and finaning of production, and help provide the equipment necessary for production (Ortiz, 2004; Garrido, 2006).

*4.2.1.*5 Redirecting new areas of research towards IAASTD goals

AKST systems in Latin America and the Caribbean can seek to increase their technical training in the new areas of knowledge and those generated under the conventional system, although with a critical and cautious attitude (applied to bio-technology, niche 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. 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 or not reputed leading-edge technologies satisfy the goals of the IAASTD 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), but this has not necessarily meant greater access by the poor to food (see chapters 1 and 2). 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 (one that provides ecological services) 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.

Educational systems should also promote solid ethical principles. It is becoming increasingly necessary to incorporate into educational programs a philosophical discussion of the ethical principles of justice, equality, reciprocity, autonomy and responsibility, applying them to the topic of the management of resources, both private and public [Hardin, 1998].

4.2.2 Sustainable environmental and socioeconomic development.

There is currently no State policy that does not set as a priority goal sustainable environmental and economic development. Achieving this goal requires greater efforts in the search for technical solutions, a more practical knowledge of the dynamic of soil and water resources, and urgent reform of management systems to mitigate their negative impact on the environment.

*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. Many unsound management practices have had a severe impact on natural resources (“Natural Capital) and environmental services (Ghuman B.S., 1983; Adis, 1989; Brown, 1993; Cairns, 1994; Polcher J., 1994; Brosset, 1996; Neill, 1997; Rasmussen, 1998; Fearnside, 1999; Ellingson, 2000; Tian, 2000; Bierregaard et al., 2001; 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), but the long-term effect of these programs are still not known. Studies are needed on the value and impact of the environmental services provided by ecosystems and on identifying the type of human communities that sustain them (Mattison and Norris, 2005). Such understanding would he helpful in finding strategies for continuity (and respect) of the lifestyles of the local populations directly associated with the management of native ecosystems, thereby balancing the need for rural production with environmental conservation (Daily, 1997; Mattos et al., 2001; Bensusan, 2002; MMA, 2004; Zbiden, 2005).

Another priority need is for research into and dissemination of the use of secondary and other degraded or abandoned habitats. Secondary forests, if properly 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 burning has a negative impact on the atmosphere (carbon emissions) and leads to the loss of the nutrients retained by the biomass. New 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). One option being proposed for the sub-region of Amazonia is the development of a program of study, dissemination and exchange of experiences on the communal management of the natural resources of the Amazon in order to promote public policies that take account of 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. Such experiences should therefore be pursued as an option for promoting conservation and social and environmental sustainability, which are the goals of IAASTD (Barros, 1996; Benatti, 2003; Amaral Neto, 2004).

4.2.2.2 Study and understanding of the dynamics of basic natural resources

Water, soils and the biological processes associated with biodiversity are one of the acknowledged bases of environmental and economic sustainability. Generally speaking, there is an urgent need throughout Latin America and the Caribbean to generate technologies for controlling the erosion and degradation of soils and these should go together with the creation of more economic opportunities for small producers, while at the same time recognizing the limitations imposed by the low productivity of labor and the small size of landholdings (Dixon et al., 2001).

Many studies have demonstrated the need to promote practices that 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, 1996; 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 AKST 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 the Amazon and other regions. Expansion of agricultural frontiers is a reality and the use of soils for agriculture leads to chemical modifications of underground and surface waters (Markewitz et al., 2006). It is necessary to identify which alternatives for 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 enterprises through community partnerships for the exploitation of forests and development of non-wood forestry products (Promanejo, 2001; Floagri, 2005).

Moreover, depending on the Latin American landscape in question, the management plan may be supplemented by the introduction, development and dissemination of aquaculture technologies that rely on local ingredients (residues, fruits and seeds) (Mori-Pinedo,1993; Pereira-Filho, 1995; Saint-Paul, 1998) while continuing to further develop 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 models for enhancing the efficiency of this activity are dispersed and do not include existing production systems. It is necessary to explore fisheries management systems with a view to developing balanced models that would strengthen the capacity of local populations to support themselves. 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 technologies need to be developed (Calle et al., 2002). Such technologies would combine the herbaceous, shrub and plant strata to improve production (production of bio-mass stockfeed for cattle) and to expand the services provided by ecosystems (Murgueitio, 2003). However, it is difficult to achieve the goals of IAASTD as long as the paradigm remains economic growth alone (individual enrichment) without taking into account external factors (environmental and social damage). The intensification of cattle farming should therefore be avoided and emphasis placed on the generation of knowledge 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 in order to reduce and mitigate their negative environmental impacts

Conventional systems may also be gradually transformed into more sustainable systems with the support of the AKST. 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 communal management of water resources. There are currently few technical models for an activity that can reduce the pressure on resources at the same time as it generates income for the local population (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 sustainable production styles that can be easily adopted with limited resources and which produce relatively quick and attractive 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 (Dixon et al., 2001); (x) and management of invertebrate fauna in a way that is beneficial for the soil (Lavelle et al., 1999). 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 for the management of natural resources are extremely important. 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 resources, 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 management of water basins (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 must be strengthened (Dixon et al., 2001).

4.2.2.4. Use and control of the application of new technologies

AKSTs in Latin America and the Caribbean need to prioritize research and the training of native personnel in centers of excellence in order for the region to narrow the current technological gap and not remain on the margins of the great technological breakthroughs taking place in new areas of research (agroecology, bio-technlogy, niche agriculture and biological controllers, for example) in the developed countries. This effort of cooperation must be directed towards strengthening the technical and scientific capacities of AKST actors in the region and should address the needs and particularities of each subregion of Latin America and the Caribbean.

This development and training in the use of new technologies should also be geared towards achieving the goals of IAASTD. This means that AKST systems should direct their efforts to take greater advantage of these technological innovations by placing emphasis on issues of biosecurity, for example in genetic modification programs. The adoption of any new technology (including GMOs) should be preceded by a careful analysis of risks to health, to genetic introgression in localities of evolutionary origin and other impacts on the environment, including considering the possible prohibtion of the release of GMOs in centers of evolutionary origin.

AKST systems should act effectively to carry out impact and potential risk assessments of the products being researched in order to prevent their adoption from causing problems for the environment and for consumers. In other words, they should ensure the biosecurity of the results of their research programs.

One option would be to direct efforts towards the adoption of the precautionary principle (through AKSTs) to prevent irreversible damage and promoting their observance through national, regional and international agreements.

4.2.2.5. *Investment* in AKST systems for the development of technological innovations to overcome health problems

This point refers in particular to the introduction of methods for the traceability and safety of foods (possible risks, nanotechnology) and methods for the control and detection of health problems, among others. In order for investment in AKSTs 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 for small producers, who lack large amounts of capital. Alternative approaches must therefore be sought that allow for the strengths of the less strong producer groups in the agricultural economy to be maximized (Embrapa, 2006).

4.2.2.6. Development of technologies to strengthen integrated pest management

Promotion of integrated pest management practices (IPM) and technologies that reduce or eliminate agrotoxins. The development of this type of research is today common in many of the AKST systems in Latin America and the Caribbean, but needs further strengthening since it can lead to substantial reductions in the use of agrotoxins in fields (Rodriquez and Niemeyer, 2005). In order to encourage this trend, it is proposed to establish strict rules for the use of agrotoxins, in particular for the protection of men, women and children who work in fields (Nivia, 2003). It is also necessary to combine conventional research with traditional research in order to identify bio-controllers, to develop strategies for the agro-ecological management of production systems (Buck, et al., 2006) and to improve conventional systems.

4.2.2.7. *Land* distribution

Access to land is a burning issue throughout the region. Promoting research and providing training in methods of distribution of productive land among social groups and their impact on the sustainable use of land and on poverty would be of great assistance in resolving the numerous problems. More families living sustainably in the countryside leads to greater diversity of decisions and consequently to greater diversity of landscape, biodiversity and crops and facilitates food security and the exploitation of biodiversity (Monro et al., 2002; Dietsch et al., 2004). Comparative research projects are also needed to identify the most sustainable distribution and land-use alternatives and thereby to promote diversity in the modes of distribution and use of land and diversity in modes of access to land and 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 production systems on agricultural frontiers, 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 together with appropriate resource management policies. This could be strengthened through research partnerships in the development of crop varieties that are adapted to the conditions of agricultural 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 by employing such instruments as land taxes (at the regional and municipal

levels); land concessions; easy access to investment loans and operating capital; eligibility for support services; and marketing, extension, and veterinary services, among others (Dixon et al., 2001).

4.2.3. *Climate change and bio-energy*

Energy efficiency understood as the cost-benefit ratio, i.e. the investment of crop energy in the agro-ecosystem (or aquatic system) versus the energy benefit obtained from the production (in Kcal) and the diversity of products (National Research Council, 1989) could be considered as a basis for evaluating production systems.

The oil crisis is another factor that reinforces this need for AKST 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.

4.2.3.1. Combating the effects of climate change by developing alternative systems of production

Regional studies of the impact of climate change 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). Alternative production systems could be used to mitigate the negative impacts of climate change, since agro-ecological systems have greater capacity to recover from environmental disasters (SOCLA, 2007).

With the help of indigenous / traditional and scientific (agro-ecological and conventional) knowledge, it is possible to promote research into the use of perennial plants and agro-forestry for carbon sequestration (see option 6). Efforts are also being made to promote the development of new plant varieties that adapt better to climate change, in particular to rising temperatures and to variations in the dry and rainy seasons. It is also necessary to identify more efficient methods of water use and management of soils that are vulnerable to erosion (eg. management of plant cover, green fertilizers, wind breaks, drainage) (Murgueitio, 2003).

Latin American and Caribbean AKSTs must strengthen its links of technical and scientific cooperation in the search for joint solutions to mitigate the effects of climate change on producers in the region (Lima et al.,2001). A program of research and development is needed to add value to forestry resources through innovation, commercial agreements, gradual training to take over the productive process, and institutional support. The latter should focus on the reality in which AKST actors operate. The use of forestry products is irreversible and it is therefore essential to develop alternatives for sustainable use based on empirically observed realities (Floagri, 2005). The socio-economic sciences must also be developed to take account of environmental services in the evaluation of production systems (Altieri et al., 2003; Chavarria et al., 2002).

4.2.3.2: Research to evaluate the contribution of agriculture and livestock farming to the production of renewable energy.

Agricultural production for use in fossil fuel alternatives (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 and local knowledge and general environmental-friendly principles should be disseminated at the regional and international levels. Existing knowledge should be organized in such programs and new studies undertaken on energy resources based on knowledge of the flora of new 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). This may offer a good opportunity to develop technologies for the recovery of degraded areas using local elements of biodiversity, plants, earthworms and other elements of soil fauna and microorganisms (Lavelle et al., 2006).

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 AKST 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 (although this has caused some controversy). Responsibility for ensuring equity and sustainability (related to the production of bio-fuels) has thus far been evaded (e.g. study of cases such as that of Brazil, a world leader in the production of ethanol). The formation of agro-industrial cooperatives or associations of small- and medium-sized producers could help to ensure greater equity in this sector.

Extreme caution is needed and studies undertaken on the large-scale environmental and social consequences of the production of agro-fuels in the countries of Latin America and the Caribbean. A program should also be developed to organize existing know-how and experiences in the production of bio-energy (including bio-fuels) in the various eco-regions. Research is needed too on the ultimate consequences of the addiction of the current dominant development model to gasoline and petroleum with a view to ensuring that crops now used for food are not converted into raw materials for agro-fuels (known as bio-fuels, such as ethanol and diesel) and to prevent more intensive use and further expansion of the agricultural frontier to the detriment of the last places of refuge for the biodiversity of neo-tropical forests.

4.2.4: Biodiversity

Biodiversity is the basis of all current services provided by ecosystems and the key to their sustainable use for the future. Special strategies are therefore needed to prepare inventories, expand knowledge and exploit this resource. Special attention will be paid to its conservation in recognition of the fact that Latin America and the Caribbean has high levels of biodiversity with countries such as Mexico, Colombia and Brazil among the most biodiverse in the world but also with the highest rates of extinction.

4.2.4.1. *Development* of strategies for the conservation and sustainable use of biodiversity in Latin America and the Caribbean

The development of AKST systems through agro-ecological and traditional know-how should focus on strategies for protecting the extensive biodiversity (both domesticated and wild) of Latin America and the Caribbean and on the right of the peoples of the region to have knowledge of them, access to them, and to use them sustainably. Biodiversity holds the greatest potential for the development of new products (plant breeding) and can satisfy the emerging demand both for food (quality and quantity) and for other products. There is need for management of a common research system and for the comparing of experiences in order to promote 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 work towards the elaboration of precise and up-to-date inventories of biodiversity, to establish reference databases and to train people in Latin America and the Caribbean in these fields. This knowledge will enable the region to assess the impact of public policies in this area and also the impact of different types of land and landscape use on biodiversity. Many biodiversity crops cultivated by small-scale producers have significant potential to capture international niche markets. The evidence suggests that there could be substantial value-added if products such as alpaca and llama wool, quinine, specialized varieties of potato and others are introduced into these markets, especially if there are possibilities of having labels or denominations of origin. The negotiation of equitable commercial agreements can also create opportunities for increasing incomes, although its scope is limited.

Diversification aimed at supplying demand in export markets will require improved organization on the part of producers in order to ensure coordination and the fulfilment of the quotas required for export shipments, as well as efficient mechanisms for the supply of inputs (including financing). Technical assistance to ensure adequate quality control, the development of adequate post-harvest handling and packaging, and the creation of effective marketing chains will also be indispensable (Dixon et al., 2001).

The options also include expanding knowledge of hydro-ecology and water dynamics, especially in the Caribbean, coastal areas and rivers. The countries of South America need a multidisciplinary approach to the management of their resources, based fundamentally on the 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 slopes. Urgently needed also are adequate legal and programmatic frameworks, such as national water resources policies, national water legislation and plans 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, unregulated use and pollution, has sparked interest in this sector which is so important for national development. Elements of conventional knowledge must therefore be incorporated in order to restore diversity, integrity and productive capacity to water

systems (De Clerk 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. At the same time, an inventory of local know-how is needed as a way of protecting such knowledge (Shiva, 2000).

Marketing channels for biodiversity products need to be identified. The extensive 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 value-added but also into easy and preferential access to generic technologies. The challenge is to elaborate legal frameworks and to develop appropriate 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 fast expanding (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. This is only true if biodiversity is protected, since it can easily become a non-renewable resource if there are threats, extinctions and vulnerabilities.

Another option is the development of technologies incorporating local knowledge for the conservation and sustainable use of biodiversity (combining traditional and agro-ecological know-how). The region has great potential based on its natural riches, especially in 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 agricultural inputs. A key element of this strategy is to ensure the participation of producers and the identification and pursuit 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 and related know-how). 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 value enhancement, monitoring and inventory of biodiversity, including the way in which inventories are carried out, are all done under common research guidelines that ensure that the compilation of data is standardized. The aim is to arrive at estimates that allow for comparisons of critical sites for protection, identification of key and indicative species, improvement of the procedures used in the exploitation of resources, and evaluation of production systems that have higher yields and less impact on biodiversity (Sosa-Escalante, date unknown).

4.2.4.2. *Sustainability* of livestock farming

It is necessary to identify and disseminate options for sustainable and productive livestock farming in Latin America and the Caribbean, such as forestry and pasture land systems, protein banks that use various plant species as a source of energy and of protein for cattle (in other words, 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 harmful or catrostrophic effects on soils and water. Depending on the type of biomass or ecosystem (since in Latin America there are savannahs, gallery forests, wetlands, foothills, the Brazilian “cerrado” and even the Andean high plateaux which, with global warming, are now being used for cattle farming), the AKST should carry out research into and implement ecological principles to maximize sustainability and production. Know-how (local but also the imported variety) and technologies are needed to stabilize agriculture and preserve natural assets. Environmental management in areas where livestock farming is practised leads to the unregulated 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). In sum, when land used for livestock farming is degraded, the inhabitants leave and the land remains degraded. The aim is therefore to reverse the trend so that the land becomes sustainable and the population remains.

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) (policy in support of AKST systems). The creation of options in the livestock sector requires technical solutions to increase efficiency in terms of head of cattle per hectare and improve the quality of livestock without degrading the soils, water or biodiversity. This option may limit the expansion of cattle farming in wooded areas (Floagri, 2005), but the harmful effects of intensive livestock farming models will not be mitigated if decisive and comprehensive acion is not taken to achieve the goals of IAASTD.

4.3. Options for Strengthening AKST Capacities

AKST capacities can be strengthened by creating new institutional mechanisms, promoting participatory research, and strengthening existing institutions, provided that they revise their teaching curricula. Special emphasis should be placed on the issues of property rights and gender equality.

4.3.1. Creation of institutional mechanisms for knowledge sharing

The synthesis of know-how and its sharing/ dissemination within the three models identified (Figure 1: conventional, traditional and agro-ecological) require the use of new institutional tools that are appropriate to each context. Projects designed to promote knowledge sharing have proven to be effective in many cases. This sharing has led to significant technological improvements with positive effects on the well-being of the participants and to improvements in the environment. However, in some cases the same initiatives can promote the spread of inappropriate and even dangerous technologies and management practices (for example, use of the pesticide Chlordecone, which is banned in Europe but still used in some Caribbean islands. (http://www.minefi.gouv.fr/dgccrf/03publications/actualitesccrf/chlordecone). Thus far there is no legal or institutional tool to regulate such practices.

A great variety of groups have engaged in knowledge sharing initiatives, but their different and uncoordinated forms of organization and their excessive dependence on a few people acting as leaders are a source of weakness and prevent their spread. There is also the problem of the lack of continuity of these initiatives. In order to redress this situation, one option would be to introduce an

institutional model that gives these initiatives greater visibility, connectivity and sustainability, while providing stable funding and monitoring the quality of the proposed activities and the competence of participants. An institution that is standardized at the national or regional level, based on the model of the primary or secondary school, with branches in all municipalities, can accomplish these goals.

4.3.2. Adoption of a participatory approach to research

Mainstreaming the participatory approach to systems (styles) of research requires the participation of different actors in the research activities. This is so in order to incorporate local knowledge in combination with scientific knowledge and to seek alternative and common solutions to the problems of producers. This will ensure that producers resolve their own problems, master new technologies and increase their knowledge and awareness of the problems currently being faced (Mota, Schmitz and Freitas, 2007). To this end, different participatory methodologies and tools (GTZ, CIAT, ASPTA, among others) that have produced good results in different countries should be used. The use of participatory methodologies in research and extension projects has proven to be of great use both for the potential to recover local know-how and for the acquisition of new knowledge, generated in conjunction with scientists. The adoption of technology can then be done much faster and more efficiently (CIAT, 2003; EMBRAPA, 2006; Pérez et al., 2001).

This means that, for example, greater use will be made of participatory approaches in such areas as the selection of plant varieties and in field tests for new crops that have potential for diversification. Achieving this goal will require significant restructuring of the national research institutions in many countries of Latin America and the Caribbean to put greater emphasis on disbursement mechanisms for research funding and on the training of personnel in participatory methods. The response capacity of research systems must be expanded to meet the demands of the market and while hybrid genetic material might be acceptable for use in diversification initiatives, material that can be replicated on farms is likely to be required for traditional crops (Dixon et al., 2001).

4.3.3. Strengthening of R&D networks

The creation of specialized networks in certain sectors or cultivation of specific crops may be another option for strengthening interaction between countries of the region and between knowledge systems. The creation of networks requires training and the generation of knowledge by the direct participants, namely local producers and consumers, and the establishment of mechanisms for the organization (generated by AKST systems) of small and medium-sized producers.

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 to the generation of technologies and products that contribute to the reduction of poverty, with priorities being subject to change (CGIAR, 2003). Networks must also be established to protect and disseminate innovations that benefit rural populations in accordance with their local conditions and which help to institutionalize knowledge sharing arrangements (Durston, 2002).

Regional and above all subregional cooperation, where planting, soil and climate conditions are more roughly similar, should be significantly strengthened. Knowledge sharing should also be encouraged

between other actors in subregional and national innovation systems, in addition to NARIs such as universities, NGOs, cooperatives and producer and private sector associations (Bisang et al., 2000).

A recent report on agricultural research and development cooperation programs in Latin America and the Caribbean clearly points to a lack of coordination between 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, PROCICARIBE; see option 15 under Key Issues) are increasingly concerned with the organization of research networks and partnerships (Forango, 2006; Salles-Filho et al., 2006).

The evaluation of these programs implemented at various levels (Evenson and Cruz, 1989; Cruz and Avila, 1990; Avila et al., 2005; Salles-Filho et al., 2006 a, b, c) shows that cooperation has resulted in a great deal of spill-over between countries. In other words, neighbouring countries benefit from research undertaken on the other side of the frontier. Evaluations have also shown that these programs need to be evaluated, restructured and extended to other actors so that they could more effectively fulfil their other objectives (Salles et al., 2006 a, b, c).

4.3.4. Organizational models

Currently the main challenge in nearly all Latin American countries is to build and strenghten their institutional capacities in order to promote the development of their AKST. While many countries of the region have made significant efforts to modernize the State, in terms of the first and second generation of reforms,[1] the results were incomplete – particularly those of the second generation – and were not part of a coherent set of policies that could help to develop the capacity to create the minimum conditions necessary for the development of AKST in the region. Actors in the system, especially those in the public sector, on the whole suffer more from the absence or unpredictability of the flow of financial resources, the centralization with limited autonomy of centers/stations, deficiencies, low wages and rotation of qualified personnel and the lack of administrative and financial flexibility (Bisang et al., 2000).

These problems are closely linked to the organizational models adopted by AKST stakeholders in the region where the most diverse models of organization coexist. When one analyzes the various stakeholders in this system, the differences are more substantial in the public sector where traditional national research or agricultural technology institutes exist (NARI in Chile, INTA in Argentina, INIAP in Ecuador, INIEA in Peru, and INIFAP in Mexico, among others) and agricultural research departments that are directly connected to Ministries of Agriculture (such as the DIA in Paraguay), alongside institutes or organizations with public funding but governed by private law (EMPRAPA in Brazil, NARI in Uruguay and CORPOICA in Colombia, for example) and private foundations, such as PROINPA in Bolivia which participates in the AKST system without depending on public funding. The alter, in comparison to NARIs and departments, have much more flexibility to manage their human and financial resources.

[1] Initially in the so-called first generation of reforms the emphasis was placed on the objective of deregulation and waste reduction, the size of the State and its intervention in the economy. These reforms were carried out in the late 1980s and early 1990s (as one of the main pillars of the so-called Washington consensus). Later, in the second generation of reforms, emphasis was placed on building the capacity of the State.

These public stakeholders in AKST systems use basically two research models: (1) the diffuse model, in which research is conducted by research centers or stations that cover the most distinctive products (the majority of NARIs), and (2) the concentrated model, in which the centers are concentrated in a few products, ecosystems or priority issues (EMBRAPA in Brazil). According to Alves (1985), the use of the diffuse model, which is very common in Latin America and the Caribbean, generates a great deal of information and is unlikely to be concentrated in new technologies and for this reason is a costly process that is feasible only in a rich society whose producers have high levels of education and which is prepared to invest large amounts in agricultural research. Developing countries, such as those in Latin America and the Caribbean, generally do not have the essential inputs for the functioning of that model, but perhaps may be able to develop it.

Salles Filho et al. (2006) found that a number of countries have introduced institutional innovations into their agricultural research systems, which may serve as models for Latin America and the Caribbean. The study by Janssen (2202), with five industrialized countries, shows the diversity of the initiatives and the area of influence of changes, which have produced significant impacts on the financing and organization of research. One of the author's conclusions was that "the new research systems reflect the new conditions that society is imposing on agriculture, science and public sector management".

In sum, the strengthening of AKST systems in Latin America and the Caribbean, particularly in the public sector, requires a review of its models of organization to improve their efficiency, flexibility and focus and thereby increase their impacts on society. In this process, it is important to review the experiences of the region with differentiated levels of success and to adapt them to the situation of each country. These considerations should not contradict the models of participatory research described in section 4.3.2 and in Key Issues (Option 6).

4.3.5 Models of governance - strengthening and modernization of management models

From Chapter 2 (section 2.5.30 - Management of the AKST system) we know that management of the system has become complex, particularly since it has been recognized that innovation comes from processes of interaction among social actors. In other words, there has been progress towards a contextual process of innovation, which implies a significant change in the rules of the game and structures of governance, thereby also increasing the vulnerability of traditional institutions.

The general tendency of national systems of innovation – and in particular AKST systems in Latin America and the Caribbean – to involve many different agents and organizations who exchange knowledge and cooperate in order to generate it, makes knowledge networks the new configurations of socioeconomic activity that address the need for interaction as a key factor in the generation and circulation of knowledge. These networks develop into subsystems of the national system of innovation, in other words, into specialized systems within the main system (Pittaluga et al, 2005).

The interactions between the agents in the network emphasize the relationships between users and producers of knowledge and innovations. These networks are the result of the efforts of agents to selectively internalize the various factors necessary to control the collective process of AKST (such as external factors). The simultaneous development of providers and users of AKST and their

ongoing and coordinated interaction therefore further stimulate their activity and create a kind of virtuous circle for technological change (Pittaluga et al, 2005).

There are a number of successful examples in the region where AKST activities have been reorganized guided by the general idea of knowledge sharing or network formation. Research institutions have pursued cooperation to take advantage of knowledge sharing and complementarity of skills and other assets, and to emphasize the approach of demand-driven research. Efforts have also been made to strengthen relations among universities, industries and the public in general (Salles Filho et al, 1998).

These institutional reorganizations require novel forms of governance, in other words decision-making methods and approaches to common problems in which the various actors participate. The idea of the network suggests the way in which a variety of actors situated in a labyrinth of public and private organizations with interest in a particular policy connect with each other. The actors in the network share ideas and resources and work out possible solutions to public problems. Connections are thus made that blur the distinctions between the State and society, and it is the network that merges the public and private.

It will also be necessary to establish a new form of governance in the system of *Procis* (cooperative technology and innovation research programs). These programs represent important cooperation arrangements that still lack a new direction, more particularly in the sense of giving direction not only to researchers from participating countries, but also to other actors so that progress could extend beyond scientific and technological exchange (Salles-Filho et al, 2006). In addition, there is an increasing need to coordinate research and development activities and innovation at the regional and subregional levels through the organization of networks and other governance structures.

4.3.6. Interaction of AKST and social movements

It is necessary that the AKST systems research social and peasant movements and development of structures to promote dialogue between them and other social actors and AKSTs. Determine through research why social movements have succeeded in having a recognizably positive impact on IAASTD goals. One way to ensure interaction with social movements is to establish a framework for research on these peasant and social movements and the ways in which they relate to other actors, while always emphasizing their importance and potential for bringing about improvements in quality of life, environmental sustainability and conservation of biodiversity. Studies of this type (also involving the actors themselves based on a bottom-up approach) reveal the impact of the democratization of access to land on the quality of life of producers and consumers (Leite, 2004).

4.3.7 Intellectual property rights (IPR)

The issue of ownership of knowledge generated in underdeveloped countries is currently at the center of an extremely polarized debate on technology and development. A number of options have been proposed to guarantee such ownership.

The result of the generalization and implementation of the TRIPS [2] Agreement of the World Trade Organization (WTO) is a global system in which IPRs will become increasingly strict. Another school of thought holds that there is room for national strategies within this multilateral framework (UNDP, 2001).

This will require legislation using all the available resources provided for in the Agreement. Many Governments have begun to draft their own legislation, while at the same time protecting the rights of farmers and of the patent holder as a means of promoting technological research and development on the one hand and agricultural productivity and biological diversity on the other (FAO, 2000).

Those countries that have the advantages of solid agricultural structures and abundant biological diversity as a support for their national economy, in particular, should protect their farmers and rural communities through specific rights adapted to the particularities of the issue in question. The TRIPS Agreement offers sufficient freedom of action to establish a system for the protection of new plant varieties that encompasses protection of the knowledge and practices of farmers and communities [3.] (FAO, 2000).

The Biodiversity Convention, signed in Rio de Janeiro in 1992, recognizes that patents and other intellectual property rights may have an influence on the implementation of the Convention[4.], and therefore provides that the Parties "….shall cooperate in this regard subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to its objectives" (Article 16-5).

Since then some progress has been made on this issue, although the interests at stake are very important. Within the framework of multilateral negotiations, a group of developing countries with a mandate from the Doha Ministerial Conference of the WTO has pushed for an amendment to the TRIPS Agreement that would provide for three conditions to be attached to requests for patents related to biological resources and traditional knowledge: revelation of the country of origin or source; proof of prior informed consent; and evidence of a fair agreement for the distribution of benefits, in accordance with national laws. The industrialized countries and the major industries have rejected these proposals in the WTO. As a result, numerous objections are raised in the negotiations on access and profit sharing within the framework of the Biodiversity Convention each time that the developing countries insist that the Parties fulfil their responsibility to ensure that the protection of property rights does not run counter to the objectives of the Biodiversity Convention (Yoke Ling and Shashikant, 2006).

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[2] Trade-Related Intellectual Property Rights.

[3.] The norms of the TRIPS Agreement allow countries not to patent higher-level plant or animal organisms or essentially biological processes for the production of plants and animals. Signatories are generally required to protect micro-organisms and non-biological or micro-biological processes through patents. Countries must also protect plant varieties by means of patents, through an effective *sui generis* system or through any combination of both. The provisions of the TRIPS Agreement on patents are not always appropriate for protecting living material or related products. A *sui generis* system can offer greater flexibility when a legal framework for protection is developed.

[4.] The objectives of the Biodiversity Convention are: "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding." (Art.1)

The adoption by FAO of the International Treaty on Phytogenetic Resources for Food and Agriculture in November 2001 marked an important step forward in this field. The Treaty covers all of the most important phytogenetic resources for food and agriculture and is consistent with the Biodiversity Convention. Under the Treaty, countries agree to establish an effective, efficient and transparent multilateral system to facilitate access to phytogenetic resources for food and agriculture and to share benefits in a fair and equitable manner. The Treaty's monitoring body, comprised of the countries that have ratified it, establishes the conditions for access to resources and distribution of benefits in accordance with the "Agreement on the Transfer of Material".

In their national legislation, more and more countries have been adopting laws to ensure that the protection of intellectual property rights does not run counter to the provisions of the Biodiversity Convention. Costa Rica, for example, has adopted a Biodiversity Law that requires decisions taken to protect biodiversity-related intellectual property rights to be compatible with the objectives of this Law. The State also grants protection through, inter alia, patents, trade secrets, recognition of the rights of a party that improves a plant variety, *sui generis* community intellectual rights, trademarks and farmers' rights.

But legal channels may not be the most appropriate way of protecting the knowledge about their habitat that ethnic communities have accumulated over centuries, since these are the result of a social construct. The system of patents invites claims on the indigenous and community innovations of developing countries, thereby making them vulnerable to formal representation and patenting by others. To claim, use and defend patents is easier for private industry than for institutes and innovative communities.

The above creates a situation in which the knowledge of traditional communities is increasingly being used for commercial purposes in such sectors as pharmaceuticals and agriculture. Technological developments based on this knowledge have produced a marked increase in the supply of crops of food products and new products related to health, among other uses. These developments were produced without the generators and owners receiving any benefits from their property (Santilli, 2002; Lima and Bensunsan, 2003). The idea of protecting this knowledge is gaining ground. However, many proposals made to protect traditional knowledge have failed. Indeed, two institutional and cultural systems clash in the exchange of traditional ethnic knowledge. One is the system of commercial exchange of knowledge in which privately owned (tangible and intangible property) institutions are created and maintained within a legal framework. This system has relatively transparent information mechanisms and operates at a global level. The other is the system of local community knowledge in which ownership of the knowledge is undefined or collective.

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. In all of these, there are compensations for 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 the group to have a right to share in the benefits of products derived from their know-how, but these

payments have not actually been disbursed in any known case (Zerda-Sarmiento and Forero Pineda, 2002).

The proposals put forward by authors and NGOs have tended mostly to recognize collective intellectual property rights. Some include the idea of creating an international fund to collect and redistribute the income derived from indigenous know-how. 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 bio-prospecting and the use of indigenous know-how. This agreement could provide for alternative models of framework negotiations and enforcement mechanisms to regulate transfers of traditional know-how from these communities to transnational corporations, research laboratories and universities. This framework agreement should establish a balance between preservation and the development of systems of community knowledge and its use by science and the market (idem).

Negotiations may be difficult because, despite the existence of cultural hybrids, ethnic groups are not accustomed to thinking in terms of profits or sharing in benefits. A participatory approach to research achieved through the establishment of local research foundations dedicated to the preservation of knowledge and indigenous culture may be one solution. Indigenous groups should participate in the research and documentation of their knowledge, history and oral culture (idem).

Another of the priorities 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 ensure knowledge sharing. Support is also needed in the international debate in national and international forums on the question of protection of the traditional knowledge of genetic resources (Bayão and Bensunsan, 2003).

4.3.8. Promoting the use of models that guarantee food sovereignty and stem or reverse the rural exodus

The strengthening of organizational know-how through AKST 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 those sectors that are most vulnerable to hunger and malnutrition, through sustainable management of local agro-ecosystems for the production of food intended mainly for local markets.

One option proposed for the sustainable exploitation of water systems is research into methods for conserving and adding value to fish and other fresh products in order to facilitate their distribution. Many Amazonian, Andean or plain populations encounter problems in transporting 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 by the adoption of new food habits. Studies should also be carried out on the diversity of diet, especially in rural areas, since ease of access to processed foods is causing changes in habits and increased consumption of fats and sugars (e.g. bottled soft drinks) (Maluf, 2004a; 2004b).

4.3.9. 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, research is needed into marketing systems 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, the agenda of AKST systems must include research and dissemination of studies on an integral approach to the productive chain in the territory in question. Business opportunities could therefore be identified for the various 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 the dynamic use it makes of land (Luc, 2006; Companioni, 2001), and its rapid adaptation to the growth and development of the city. It suffers, however, from a problem of image and is rarely recognized as a valid form of use of urban land. By combining urban agricultural production systems 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 center of cities could benefit from more intensive and generally more profitable activities, such as the production of mushrooms, silkworms or medicinal plants. Sites exposed to pollutants could be used for decorative plants instead of risking health by the cultivation and sale of plants for consumption.

Assigning areas within or on the periphery of cities for the exclusive and permanent use of urban agricultura is quite unrealistic and may be doomed to failure in certain countries. Firstly, it ignores the economic reality of the price of land in growing cities. Secondly, and more importantly, it fails to take into account the interactions which 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 in 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.

4.3.10. Strengthening the capacities of AKST actors

AKST actors in Latin America and the Caribbean are extremely diverse, which makes it extraordinarily complex to generalize for the region as a whole (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 are a region’s human capital. The diversity of ethnic groups is one 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, quality of life and equity.

4.3.11. Restructuring teaching curricula

At the same time, while strengthening institutions that promote the sharing and synthesis of knowledge (see 4.3.1), it is necessary at the same time to propose changes in the curricula of all educational institutions at different levels to ensure that they accomplish the goal of teaching skills that are clearly aimed at improving the quality of life and promoting environmental and economic sustainability. The reports clearly show how inadequate current systems are to the changing needs of agricultural, forestry and livestock farming activities. This concern is part of a global movement begun since the early 1990s by the United Nations. The Jomtien Conference organized by the United Nations in 1990 established a series of principles to guide the design and development of systems for lifelong learning, and stressed the importance of replacing the current approach to teaching which is based on passive learning substitution with an approach that is based both on knowledge and on logical and rational analysis (thinking). It also recognized that education is the responsibility of all concerned and not only of States (United Nations, 1990; Delgado, 2005). Five types of institutions are considered here; (a) local information obtained by the family, social groups, and the communications media; (b) primary school where children are taught the basic skills to enable them to perceive and evaluate their natural and social environment; (c) secondary school where the cognitive, scientific and technological foundations are introduced through scientific programs; (d) universities that generate, evaluate and disseminate various types of technological knowledge defined as conventional or agro-ecological; and (e) the numerous initiatives promoted by NGOs, universities and other actors.

Local information: educational programs in the media

This type of informal information is probably the most difficult to change because it includes local (experiences of neighboring producers), regional (discussions with merchants, local authorities, extension workers) and national (information through regional and national media) information. One way to improve it is to propose adequate educational programs directed to all actors for them to present in an accessible and synthetic way the different types of knowledge and to take advantage of information technology.

Primary school

Primary school has to provide the minimum foundations for awakening a sensibility for the fragility of the environment and the need to use natural resources in a sustainable manner. To that end, simple lessons should be taught about soils (how it is formed, its dynamics, life and functions), biodiversity (what it is and what it means for our own survival), agriculture and food (how it is obtained, the problem of producing it for a growing population, types of agriculture).

Secondary school

Adolescents can be taught to better understand and to value the contributions of the three main types of knowledge that sustain agricultural production. It is urgently necessary to strengthen the teaching

of ecology at all levels, introducing the subject of ecosystems and the environmental services they provide, with special emphasis on soils and biodiversity, so that students understand the mutual dependence between society and nature. Greater emphasis should also be placed on the subjects of genetics, plant physiology, economics, social and community organization, and other subjects that would help students to understand the strengths and problems of conventional agro-industries and other emerging models of agriculture. The description and history of indigenous lifestyles and technologies should also be taught.

Systems of higher education

Initiatives to develop agro-ecology curricula are multiplying throughout Latin America. In order to strengthen their impact, the creation of a regional system for the coordination of these curricula is necessary and can play a useful role. The content of the curricula is based on the paradigms of ecology and their application to agro-ecosystems, consideration of the sustainability of the ecological functions that produce environmental goods and services (production, storage of water, carbon sequestration, conservation of soil biodiversity). Curricula should include a synthetic presentation of other systems of knowledge, explaining their goals, restrictions, strengths, weaknesses and prospects for development in the medium and long-term. It is also necessary to consider the teaching of techniques of communication and pedagogy that would permit efficient exchanges of knowledge when studies, experiments or development activities are carried out in this field.

Agricultural and related sciences

Universities and technical institutes that teach intensive agricultural methods have already begun to include in their curricula certain elements of ecology, agro-ecology and high-yield but more environmentally friendly models of production. The evolution towards systems with better environmental and social impacts could be achieved by strengthening the presentation of traditional and ecological knowledge in order to integrate them into a systemic way of thinking. The pedagogical tools themselves would permit the communication and transmittal of the basic knowledge.

Cross-cutting issues

Certain common (cross-cutting) issues affect the quality of life, environmental sustainability and equity in any of the scenarios or models of governance. A number of key issues have been proposed for the IAASTD goals in multi-disciplinary exercises in Latin American and the Caribbean (New Network Paradigm, 2005). Some of the issues that could be included in the agenda of AKST in Latin American and the Caribbean are:

(i) Quality of life issues: as previously mentioned, the concept of human development is more than gross or per capita national income. It refers to the creation of an environment in which people can fully realize their potential and enjoy productive and creative lives in accordance with their needs and interests. Consequently, quality of life, in addition to satisfying basic organic needs, consists in expanding the options that people have to live in accordance with their values.

(ii) Environmental sustainability issues: (a) soil conservation and management: (b) sustainable use of biodiversity; (c) nexus indigenous crops – conservation; (d) germoplasm, prospection and conservation in-situ and ex-situ; (e) adding value to biodiversity and natural resources; (f) traditional knowledge of biodiversity; (g) conservation and management of pollinators; (h) ecology of biological control; (i) organic fertilizers (j) prospection and sustainable management of plants (particularly native plants); (k) urban agriculture; (l) management of fisheries resources; (m) impact of the agricultural sector on fauna; (n) flora and native micro-organisms; (o) impact of the fragmentation of natural habitats (on hydro-biological cycles, soils, biological interactions); (p) impact of genetically modified organisms(GMO) on the environment and human and animal health; (q) zoning, management and agro-ecological agriculture; (r) invasive species (existing and potential, exotic and native); (s) management of forestry resources; (t) quality control and use of water.

(iii) Equity issues; (a) legislation for protection of the rights of all citizens without distinction on the basis of race, age, sex, origin, traditions, ideology, power, or social or economic status; (b) education without discrimination for all under equal conditions; (c) a sufficient number of educational centers by number of inhabitants and by area of influence both in cities and in rural areas; (d) compulsory teaching of human rights, ethics (Perez, 2005), philosophy and ecology from a very early age; (e) study of the origin of inequality; (f) study of the origin and consequences of extreme wealth and extreme poverty; (g) decision-making power of communities; (h) provision of spaces for and promotion of democratic organizations in rural and urban communities (discussion and solution of problems that give rise to inequality).

4.3.12 Evaluation of the impact of AKST

Society does not have an accurate perception of the importance and impact of AKST systems, which means there is little support in areas where this weakness is most pronounced (Chapter 2). The experiences of impact assessment vary widely in the region, especially since there are no ongoing programs in this area (Alston et al., 2001; Avila et al., in press). These studies, moreover, focus on assessment of the economic impact of the technologies generated (profitability of investments), without evaluating their other impacts.

Given the multiplicity of the impacts of AKST products, impact assessments must be multi-dimensional, in other words should include analysis of the economic, social, environmental and other impacts (institutional training and policies). Moreover, analysis undertaken prior to the impact of the research proposals may help to improve the quality and usefulness of projects and strengthen the impact of the products generated.

It is also necessary to develop methods of socioeconomic analysis in order to place AKST stakeholders and their new technologies in a socioeconomic context, which is essential to improve their impact. AKST systems must recognize that it is not sufficient to identify the impact of a particular technology or type of knowledge, but that this technology must be placed in a socioeconomic context. Given the complexity of the relationship between knowledge/science and society and that in order to enhance the impact of AKST, particularly in terms of the IAASTD goals, the research agenda must

include the full participation of producers, especially the poorest and most marginalized. Profiles of producers and socioeconomic studies of small producers are also needed in order to enhance the efficiency of these impacts.

4.3.13 Participation of AKST systems in the formulation of public policies

Strengthening the impact and capacities of AKST requires greater participation of such systems in the formulation of public policies. Generally speaking, AKST stakeholders include publicly funded national agricultural research institutes, but these have little effective participation in the preparation of the legal framework in which they operate (laws on bio-security and intellectual property, financing of research and development, credit policies, etc.). Generally speaking, they are limited to sending or submitting reports with the results of their research, which is often demand-driven (reactively or by express request).

AKST stakeholders must adodpt a more proactive attitude in this process. The experiences of EMBRAPA (Brazil) with its closer relationship to policy makers in the Ministries of Agriculture, Science and Technology, the Environment and Agricultural Development, in particular, as well as to the Congress have been very successful and have helped to strengthen the impact of that organization on the various segments of Brazilian society. EMBRAPA is participating more and more actively in the elaboration of laws governing intellectual property, innovation, and the protection of farmers, etc., as well as in rural credit policies, among other types of policies.

According of Salles et al., (2000), participation in the formulation of public policies is vigorously pursued both by EMBRAPA and by FIOCRUZ, and this approach in the case of these two research institutions is indistinguishable from the process of creation and is a function that has been embraced by them throughout their existence in order to strengthen their legitimacy and institutional sustainability.

However, the active participation in the formulation of public policies seen today in Brazil, in the case of EMBRAPA, is not common in Latin America and the Caribbean. It is nevertheless clear that the strengthening of AKST systems in the region and enhancing their impact depend on the proactive participation of the system’s stakeholders.