Methodological Framework
Analyzing the Agricultural Science Technology and Innovation (ASTI) Systems in ACP Countries
CTA/UNU-INTECH/KIT
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1. Objectives

This research project aims to build ACP capacity to better understand the strengths and weaknesses of the local science, technology and innovation system in the agricultural sector. The results of the study should provide information on the nature of the system as well as alternative approaches that might be considered, with regard to complementary policies, programmes and support organizations that could contribute to strengthening the agricultural science, technology and innovation (ASTI) system, especially with regard to the sub-sector, commodity or products which are the focus of the analysis. It should also provide one set of inputs into future policies governing agriculture and science, technology and innovation and should demonstrate to all stakeholders the need to focus science and technology developments on the agricultural sector and more specifically as they relate to agricultural trade, competitiveness and food security within the context of broader development goals.

2. The Innovation System Framework

Innovation can be defined as the 'process by which firms master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors', their countries or the world.[1] For innovation to take place there must be continuous learning and the opportunities to learn depend on the degree and type of interactions between and among the different enterprises, organizations and related sectors, as well as institutional behaviours, which determine the extent and rate at which information and knowledge are produced, transferred and utilized. Small improvements in product or production design and quality, changes in processes, techniques, organization or management routines and creativity in marketing can make production, distribution and marketing of products and services more cost effective, efficient and competitive.

Innovations are therefore not solely the product of organized research and development activities undertaken within universities and research and development institutes. Neither can they be determined to be successful unless they result in economic gain or savings or improvements in social wellbeing or services such as health. It should therefore not be

[1] L.K.Mytelka, "Local Systems of Innovation in a Globalized World Economy" *Industry and Innovation*, Vol.7, No.1, June 2000, p.18.

assumed that the results of formal research or increased investments in research and development or science and technology infrastructure will automatically spur innovation or be put into economic use. It is the enabling environment that encourages continuous learning, creativity and knowledge flows which facilitates innovation for socio-economic development.

This research project applies an innovation system framework approach that takes as its point of departure the interdisciplinary nature of the system and the diversity of factors that shape the interactions among actors and how these impact on the actors' individual and collective ability to learn, adapt and innovate. This will be demonstrated by a broad systemic analysis of the actors in the ASTI system in a given sub-sector, their traditional habits and practices and linkages and the way these are shaped by different policies and reward structures. In addition, an assessment will be made of how the various actors contribute to the overall performance of the ASTI system.

3. The Methodology

3.1 Reviewing the Policy Environment

Policies can stimulate, support or hinder innovation. To positively influence the process, they must be relevant to the local context and the habits and practices of the actors whose behaviour they are designed to influence and or support. In doing an analysis of the agricultural science, technology and innovation system, there is need to look at policies that directly affect the agricultural sector – ***agriculture, fiscal, land use, and environmental policies***; policies that affect the inputs and outputs of the sector e.g. the incentives to producers, processors and exporters of agricultural products (***fiscal / tax policies, industrial policies, educational policies, transport policies, tariff policies***) as well as policies that affect learning and the nature of competition in the domestic, regional and international markets (***education, science and technology, intellectual property rights, foreign investment policies and so on***). In conducting the analysis, there might be need to identify policies that may have positively influenced the behaviour of actors in other sectors that are performing well - continuously learning, innovating, remaining competitive.

3.2 Identifying the Key Actors in the ASTI System

Different sectors of the economy are likely to have different sets of key actors that are actively contributing to the performance of the sector / industry. Choose a sub-sector or commodity within the agricultural sector which either has importance for food security, export diversification or traditional export. Identifying all the relevant actors who make up the ***agricultural science, technology and innovation*** (ASTI) system in the specific ***sub-sector or commodity*** and mapping ***their relationships*** is thus an important step in the diagnostic process since it helps ***to identify*** the actors who are involved and can contribute to continuous innovation.

Enterprises; firms and farms are core actors since they are central to applying knowledge in production, distribution and marketing for economic gain. They are supported by a variety of other organizations involved in research and development; education and training, extension, policy formulation and implementation, legislation, finance etc. Any of the following may be key actors in the ASTI system:

- Farms – small, medium and large;
- Firms that provide inputs and services (such as seed or feed, agro-chemicals, machinery / equipment, transport, credit, insurance);
- Agro-processing enterprises (small, medium or large);
- Intermediaries that bring producers into contact with markets;
- Wholesalers, retailers, super-markets, commodity boards;
- Organizations that influence policy and provide resources - Ministries of agriculture, science & technology, education, industry and trade, finance;
- Research and development organizations (national, regional, international whether public, quasi governmental, private);
- Universities and other institutions of higher learning;
- Organizations that provide information and services - extension and training services; plant and animal health services;
- Farmers associations, cooperatives or other non-governmental organizations (public, private, quasi-governmental) that facilitate networking;
- Institutes, firms or government offices that provide business services such as feasibility studies and business plans and help in the development of marketing strategy; and

This list is not necessarily exhaustive and could be further expanded depending on the specific innovation system setting. The actors should be grouped into five categories or clusters depending on their main activity ***(1) market / demand, (2) enterprise, (3) research and training, (4) diffusion, and (5) infrastructure***. These five clusters of actors are based on a paper by Arnold and Bell (2001), modified by Francis, J. (2005) and depicted graphically in figure 1. However, these clusters of actors are not set in stone. Other groupings are possible as well. See for example Paterson et al (2003).

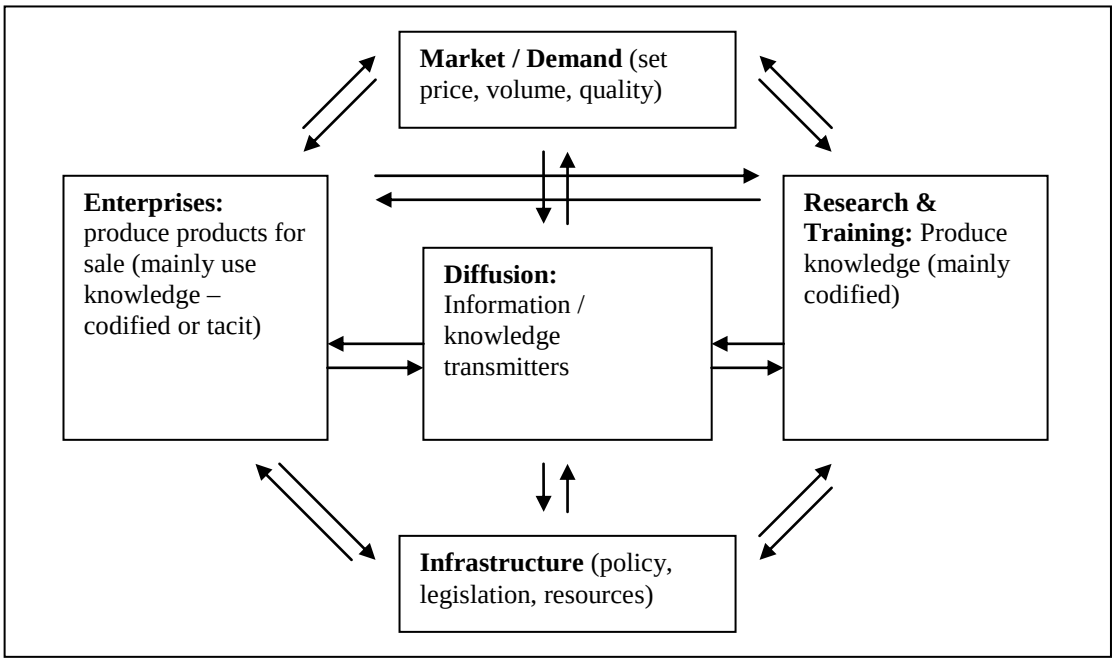

Figure 1: *Elements of an ASTI system*

Table 1 gives an indication of possible groupings of actors in each category. The infrastructure cluster covers all supportive actors within the innovation system, including those that set policies governing the system. Some actors may belong to more than one category but their primary role in the particular system should be used as the basis for determining which category they belong to. For example, an input supplier may also be involved in research and / or extension but its primary function is selling inputs to producers involved in the sub-sector and as such, it belongs to the enterprise category.

A preliminary mapping of the linkages that exist between the actors in the system can be done by group analysis. At the initial stakeholders' consultative meeting, let the various actors of the innovation system reveal through group work how they link up to each other and what they consider to be strong and weak linkages within the system. It is important, however, for all actors to be represented and equally willing to participate in such an exercise.

Table 1: *Categorizing actors in the ASTI system and their elements*

Component	Actors
Market / Demand	Consumers / buyers / retailers / wholesalers / middle men
	Consumers of raw materials for industrial / added value e.g agro processing industries, restaurants, hotels
	Commodity markets / traders /food banks
Enterprise	Farmers
	Input suppliers (seed /feed, agro-chemicals, machinery, packaging)
Diffusion	Extension services (public/private)
	NGOs and CBOs
	Farmer and trade organizations
Research and training	National, regional and international agricultural research and development organizations (public, quasi-governmental, private)
	Universities and other institutions of higher learning (public, quasi-governmental, private)
	Research foundations
	Private companies and NGOs with own research facilities
Infrastructure component	Policy making agencies (ministries; quasi-governmental agencies / state boards)
	Banking and financial agencies – private and public / quasi-governmental
	Transport and marketing agencies / commodity boards /exchange
	Information and communication infrastructure including libraries
	Organizations Networks - professional networks, farmer and trade
	Regulatory agencies (IPR, sanitary and phyto-sanitary regulations, etc)
	Standard setting bodies

3.3 Analyzing and Assessing the Habits & Practices, Competencies and Performance of the Actors in the ASTI System

Simply identifying the presence or absence of critical actors, does not tell much about their innovative behaviour nor how the policy framework or S&T infrastructure for example contributes to or supports innovation in the productive sectors. Attention to whether farms/firms tend to learn, to interact, to invest and to innovate and why they tend to perform the way they do will provide a better understanding of what could be done to reinforce behaviour that is positive for innovation or to create new incentives and reward systems that support a change in the old habits and practices.

A process of innovation can be triggered by many things – common problems in production, the supply of inputs or the provision of services; crises provoked by the imposition of new international rules or domestic policies, changes in consumer tastes, market structures or technological changes, and a variety of new competitive conditions. Key producers in the sector may respond by exiting or innovating or they may not respond at all and simply stagnate and ultimately decline. What are some of the factors that might shape which reaction takes place? This is where knowing something about the traditional habits and practices of the actors, the competencies and the resources that are available to them for innovation become important in the diagnostic process.

From an innovation system perspective, therefore, it is important to know something about the following attributes of the actors in the ASTI system and the policies that set the parameters within which these actors make choices about the innovation.

(i) ***What are the traditional habits and practices of the actors in the ASTI system with regard to three key elements in the innovation process***:

(1) **Learning** – Do actors in the system have built-in mechanisms for acquiring new information and for learning through feedback (this applies as much to producers and scientists as well as policymakers)? Do local S&T (R&D institutions and universities), farmers' associations or other intermediaries provide learning opportunities and are there incentives for taking advantage of these that help to stimulate learning. Is there evidence that the actors ***are learning, have learned and unlearned***?

(2) **Linkages** – Innovation is fundamentally a process of learning through knowledge and information flows that result through interaction. What are the traditional practices of the actors in the system with regard to forming linkages? Do they form linkages and if so with what kinds of actors? Are these long term and based on trust and cooperation? Have the S&T or other institutions provided useful knowledge and information that have been applied in production, marketing and distribution?

(3) **Investment –** Some innovations can take place without any capital investment. However, reorganizing production processes, developing training programmes for workers, introducing new/updated technologies or maintenance or quality control routines require investments in time and effort and capital. If capital investments are needed for new production technologies that will increase yields or lead to a higher quality output, who will bare the risks of such an investment? What has been the performance of actors in the system with respect to ***attracting / sustaining*** investment and how have the problems of risk and uncertainty been dealt with?

(ii) ***What is known about the appropriateness of their current competencies?*** For example, access to new information or technology or financing may be a critical element in the innovation process. But the presence of universities or banks alone is not enough to ensure that information or financing will be available to critical actors in the system. If the sector is composed of micro and small enterprises and the universities or research and development institutions or banks have not developed competencies in dealing with these enterprises and do not have the tools to evaluate their projects or the interest in working with such enterprises, then the necessary information or finance to support innovation may not be available. Once this problem is identified, the search must begin to explain why they have not developed the necessary competencies, for example, it may be that the reward structure within which they function does not stimulate them to

do so. Are there some complementary policies or different sorts of organizations and financing instruments that are available to help farms / firms work around this problem?

(iii) ***What data can be collected about the actual performance of the actors in the system?*** For farms / firms there is need to collect information about innovations that have led to changes in volume of outputs, whether they have introduced any new technologies or processes or changed the way they organize production, distribution and marketing and what factors led them to make these changes. There is need to know whether the information, financing and other resources were available. An attempt should be made to identify what triggered the innovation and how they came into contact with the providers of the information or resources.

For research and training institutions, there is need to know, whether the S&T community has developed / introduced any new technology or technology package or modified an existing technology for use by the actors in the sub-sector and if yes, whether there has been any uptake by the farms / firms and at what costs if any to the farms/firms. An attempt should also be made to determine if not, why not.

For actors involved in diffusion, there is need to know whether they have brought any new information to the attention of the farms / enterprises and if yes, whether there has been any uptake by the farms / firms and at what costs if any to the farms/firms. An attempt should also be made to determine if not, why not.

3.4 Are Key Functions Being Performed at the System Level?

There are key functions which an innovation system should perform hence it is important to have a broad overview of how the system is performing as a whole. The functional analysis starts off with a survey of all actors within the system and subsequently assesses them on "***How?***" and "***How well?***" they contribute to the key functions that the innovation system needs to perform. Usually this information is summarized in a matrix table with actors at one side of the table and key functions on the other. In the boxes of the matrix the contribution of each of the actors to a particular function can be described.

Table 2 gives an example of such a matrix based on an analysis of the national innovation system of South Africa. The key functions identified by Paterson *et al* (2003) are:

- Policy making and resource allocation;
- Regulatory;
- Financing;
- Implementation;
- Human resources / capacity building; and
- Provision of infrastructure.

Actors and functions in this table are highly aggregated, but can be further detailed in separate tables. For example, in the case of South Africa there are more than xx government organizations involved in STI policy making. Similarly, the implementation function can be further detailed into more specific activities such as research and diffusion. Similar sets of functions can also be found in various OECD studies on national innovation systems. What they have in common is that they look at the innovation system from the perspective of the government, emphasizing in particular the role of the government in such a system. The data

collected on the actors and the policy framework can be used to undertake the functional analysis.

Johnson (2002) provides a less government-centred approach to the ***functional analysis*** of innovation systems. In her paper, she reviewed the use of functional analysis across various innovation system studies and tried to identify whether there is something like a core set of functions that innovation systems need to perform. Although the terminology used across the studies varies widely, she identified two key functions directly concerned with the innovation process that most studies subscribe to, namely:

- ***Identify problems***
- ***Develop a solution to the identified problems*** (i.e. create new knowledge)

Johnson also identified several other functions that support the innovation process indirectly, namely:

- Supply incentives for companies to engage in innovative activities;
- Supply resources (i.e., funding but also trained personnel and R&D infrastructure);
- Guide the direction of search (i.e., influence the direction in which actors deploy their resources);
- Facilitate the exchange of knowledge and information;
- Recognize the potential for growth (technological opportunity, commercial viability);
- Stimulate/create markets;
- Reduce social uncertainty; and
- Counteract the resistance to change.

It would be useful to assess how and how well these various functions are being performed within the given ASTI system and by whom.

The list of functions presented here is not set in stone – depending on the specific situation other functions may arise as essential. Depending on the level of analysis, certain functions will be more pronounced than others. For example, training of the next generation of researchers is an important function of the national innovation system. At the sub-sector level, however, this function is especially relevant if the sub-sector needs research or technical staff with very specific qualifications, training and experience. For example, if modern biotechnology applications are important for new crop varieties with specific characteristics to overcome production constraints or enhance competitiveness.

Table 2: *The relative importance to stakeholders of the functions of a national innovation system*

Actors / stakeholders	Core functions of government		Implementation functions			
	Policy and resource allocation	**Regulatory (policy level)**	**Financing (performance level)**	**Performance**	**Human resources / capacity building**	**Infrastructure provision**
Government	Key function	Shared function – some standards set by government, some by business	Extensive involvement in supporting both business and tertiary education institutions	Extensive involvement	Some involvement in post-graduate training	Extensive involvement
Business sector	Some advisory function	Shared function – some standards set by government, some by business	Extensive involvement as source and recipient	Key function	Some involvement in post-graduate training. Should be important in life-long learning.	Some involvement
Tertiary education	Some advisory function	Advisory?	Key recipient	Extensive involvement	Key function	Some involvement
Other educational institutions	No involvement	No involvement	Recipient	Limited	Key function	Some involvement
Multipartite bodies	Key function as advisors	Advisory?	No involvement	No involvement	No involvement	No involvement
Organized civil society	Key function as advisors	Advisory?	No involvement	Limited function	Some involvement?	No involvement
Interested outsiders	Advisory function	Some important as global level	Some have this as a key function	Possible partners	Possible partners	No involvement

Source: Paterson, Adam and Mullin (2003)

3.5 Mapping linkages

A key area of focus of innovation system analysis is that of mapping the system linkages. ***"How do the various actors within the system link up?"*** and ***"Are those linkages sufficient and/or strong enough to facilitate innovation?"***

Various methodologies can be used to reveal system linkages. The survey questionnaire will be used to assess the quality of the linkages and the results will be verified during the stakeholders' consultative meeting when the draft report is being presented.

There are various ways of reporting the information on linkages. Biggs and Matseart (2004) present several methods, such as:

(a) The ***actor linkage map*** – linkages between the various actors are being depicted by arrows of varying thickness indicating the intensity of the link. Two arrows should be used in order to differentiate the link between a and b and that between b and a;
(b) The ***actor linkage matrix*** – linkages between the various actors can be described in the boxes of the matrix. This can be done with plus and minus signs, colours, or just text. This technique is in particular useful when there are many actors.
(c) The ***actor determinant diagram*** – complements the above techniques by further analysing the strengths and weaknesses of a particular link. It can provide more insight into how a particular link can be improved.
(d) ***Actor time lines*** – helps to analyse how certain innovations have evolved over time and how different actors have participated in this process.

Another and considerably more sophisticated technique to map linkages within an ASTI system is presented by Temel (2004), who introduced graph-theoretic techniques to map linkages within the ASTI system of Azerbaijan. This technique gives completely new dimensions to the actor linkage matrix and hence insights.

At the stakeholders' consultative meeting to present the case study report, present the results of the actor linkage maps and ask participants to validate the findings. Use the opportunity for them to explore how weak linkages could be improved, if necessary and include their recommendations in the final report. Note that the stakeholders' forum may help to identify recommendations for improving linkages but more permanent formal or informal platforms where the different actors can meet or collaborate will be crucial for the functioning of the ASTI system in the future.

4. Conclusions and Recommendations

The research project should summarize the main findings of the case study and contain recommendations to policymakers for strengthening the ASTI system and improving the performance of the sub-sector. These might include recommendations relative to the choice of policies and support structures that might need to be put in place to stimulate learning and a continuous process of innovation. The identification of problems and solutions and the channels whereby a vision for the sector could be developed might also be specified.

In making such recommendations, it is essential to have a sense of what national, regional and international factors affect opportunities in the sub-sector. Here it is important to know something about the trends in technological change, in market structure and competitive conditions, in consumer tastes and quality expectations and in national/regional /international rules and market access opportunities. One set of conclusions, therefore, should assess the current strengths and weaknesses of the ASTI system in relation to the opportunities and constraints flowing from these conditions. Another set of conclusions should deal with: (a) the presence or absence of critical actors; (b) the nature of the habits, practices and competencies of these actors in relation to the need for innovation; (c) linkages within the ASTI system; (d) the performance of key actors; and (d) a discussion of the channels for bringing about a consensus on the way to deal with these problems that might work in your particular country context.

5. Guidelines for Implementing the Case Study

The implementation of the case study comprises the following steps:

(1) Desk research on the policy environment within which the ASTI system operates (see annex I for checklist) and identification of one or more sub-sectors that will be the focus of the case study. If more than one sub-sector is selected, try to select contrasting ones – e.g., one that is important for food security or export (diversification or traditional).
(2) Make an inventory of all actors involved in the ASTI system, group them according to the clusters of actors provided and describe them briefly.
(3) Conduct a half-day seminar to present the NIS concept to the actors that will be surveyed → sensitization of actors. Use this workshop to identify if there are other actors and prepare a map of the perceived linkages within the system.
(4) Decide on what constitutes a representative sample of actors. The aim is to interview a representative sample of actors located within the different institutions. This may require interviewing ***approximately 50 actors in total*** (including individual scientists, farmers, engineers, and entrepreneurs) depending on the number of actors identified in each category.
(5) Survey the actors on the basis of the pre-scribed questionnaire. This can be done in a face-to-face interview, by telephone or by mail. If possible, pre-test the questionnaires developed for the case study and modify if necessary.
(6) Process and analyse the results; summarize the results in the form of tables and graphs and prepare a draft report. Circulate the draft report to the actors.
(7) Present the results to the actors/stakeholders within the ASTI system at a stakeholders' meeting specially convened to discuss the findings.
(8) Write up the final report.

Annex II provides sample questionnaires that can be used for specific categories of actors within the ASTI system.

6. Tentative Outline Case Study Report

The following outline for the case study report is recommended.

6.1 Executive Summary

6.2 Introduction

Prepare an overview the innovation system framework and relevance to agriculture. Aim and outline of the study

6.2 Overview of the agricultural sector and the sub-sector(s) / commodity

6.2.1 Overview of the agricultural sector

General background on the agricultural sector with some key performance indicators including historical evolutions should be provided. The role of international law and multilateral institutions in shaping the performance of the sector, promoting capability building, including on-going activities and debates should be discussed.

6.2.2 Overview of the specific sub-sector

Sectoral systems have specific products, inputs and markets. Market orientation of agents differs considerably and levels of specialization and process technologies are conditioned by a host of complimentary factors. The study should identify why the sub-sector is important and indicate trends over the last five to ten years in production, marketing and distribution. Some commodities require long-term investment such as cocoa, coffee and citrus; some require renewal as they age and their yields decline. Linked to the farmers are ancillary services such as ***extension, veterinary and plant health, pest management, input suppliers of chemicals and fertilizers***. Again there is also the agricultural machinery components subsystem with important linkages to core farm activities. There is an important link to food processing requiring considerable capabilities in food science and technology. Trends in the evolution of services e.g. research, training and extension and agro-processing should also be discussed including economic performance or contribution to food and nutrition security.

6.3 Review of the Policy Framework

Based on existing data sources, this section will review national policy documents and instruments such as the S&T, agriculture, fiscal, ICT, trade and industry and investment policies and government policy statements. Country coordinators are required to compile a bibliography of the relevant policies and provide a summary of the key elements. Information should be collected from relevant agencies (S&T, agricultural, environmental, Legal Affair / Intellectual Property Office) created within the countries, as well as other institutions as needed. Their relevance to agriculture in general and aspects that are especially useful to the case study should be presented.

The role of policies in strengthening learning, encouraging investment and facilitating linkages that constitutes the bases for dynamic innovative change on a continuous

basis should be assessed. Research should map policies that directly or indirectly affect technological capacity building, learning, linkages, investment and performance within the ASTI system. These might include:

(1) Policies affecting size and shape (demand characteristics) of the domestic market and export (e.g., taxation, wages, import/export restrictions);
(2) Policies that affect input costs or output prices for farmers (e.g., land prices, import taxes, exchange rates, subsidies);
(3) Policies that change the nature of competition, foreign investment, and those that promote local upgrading and linkages between foreign and local agents (e.g., privatization of the agricultural input industry);
(4) Policies that change or make possible access to training for farmers, extension services, the nature of R&D (e.g., farmer participation in setting research priorities);
(5) International rules that affect learning and innovation such as imposition of higher tariffs on processed foods (tariff escalation and tariff peaks), which creates disincentives for forward processing. The introduction and enforcement of intellectual property rights (such as patents and plant variety rights) or the imposition of sanitary and phyto-sanitary standards, which may stimulate innovation or force exit and the factors affecting the former rather than the latter incidence;
(6) Local capability and the ability to bargain in global markets and sustain competitiveness. How well each country is able to diversify into new markets (coffee, cocoa, banana). The development of substitutes (e.g. corn syrup to replace cane sugar) or high subsidies (beet sugar).

6.4 Mapping of Critical Actors

6.4.1 Identifying the actors

This section should focus on the principal actors within the ASTI system of the specific agricultural sub-sectors under study. This section should describe the key actors:

6.4.2 Analysis of actor characteristics, habits, practices, and competencies

For each set of actors the following information should be provided based on the survey results:

- Descriptive characteristics (e.g., roles, size, ownership)
- Habits and practices (e.g., learning, linkages, investment)
- Competences (e.g., trust, tools, knowledge information access)

Factors that can support or stifle technological change; affect productivity; limit or enhance the potential of the sub-sector especially in dealing with emerging issues are important for each country. Existing local capacities in the selected ACP countries; and on-going research collaborations and alliances within, and with international research partners for researching national priorities are important. The process and intensity of interactions may differ and point to the strength of the system. What types of linkages and with which organizations? How do actors relate to each other?

6.4.2 Analysis of linkages between and among actors

By using one or more techniques described in section 3.5, analyse the linkages among the actors within the ASTI system.

6.5 Performance and Functional Analysis

Based on the information collected in 6.4.1 and 6.4.2 analyse and assess the performance of the actors and how well the ASTI system is functioning. Section 3.4 provides some examples of key functions identified by other NIS studies. Describe the various public and private instruments and sources within the ASTI system to finance STI activities. Describe non-financial innovation resources such as availability and competencies of personnel, access to information, education level of farmers, and access to agricultural inputs.

6.7 Conclusions

Summarize the most critical strengths and weaknesses of the ASTI system.

6.8 Recommendations

Based on the strengths and weaknesses of the ASTI system identified by the study, formulate possible solutions and the type of interventions that are needed.

Annex I: Checklist of Useful Supporting Information, Sources and Documents

System of Innovation in Country

1. **A Review of the Agriculture and Education Sector and Policies**

   Focus on policies relating to agriculture and the education sectors including the universities and public research institutes. Structure and Performance of the sectors (the past 15-20)

2. **A review of the Agriculture Sector and Policies**

   Focus on agriculture system including livestock foods and beverages and their links with the farming sector. Structure and Performance (in the last 15-20 years)

3. **National Science and Technology (S&T) Policy**

   Evolution of S&T policy, particularly relating to new technologies with emphasis on biotechnology. What was proposed, what organizations and institutions have been set up, what concrete actions have been taken?

4. **Agricultural Institutions and Organizations**

   Public and private organizations involved in agricultural development: special inter-governmental committees; legislative and regulatory bodies. University departments dealing with biotech such as veterinary medicine, food science and technology, aquatic resources and technology. Issues: the mandate of organizations, strength and weaknesses, and their effectiveness; manpower profile matched with mandate, gaps in skills and prospects for meeting the gaps.

Annex II: Survey instrument

The central thesis guiding the survey questions will be, which actors are the major players in the ASTI system and how do these actors interact and with what intensity? How near or far apart are the key actors and what can explain this distance? Moreover, what are the key functions that such a system of actors needs to perform and how well are these functions being performed and by which actors?

Juxtaposing the general factors that affect innovative performance in national/sectoral contexts with the specifics of agricultural activities including R&D, production, processing, distribution and marketing, indicates the following types of interactions (among others) within the ASTI system could be examined:

- Knowledge interaction among research organizations and universities;
- Knowledge interaction between knowledge producers and agencies focusing on knowledge diffusion (such as extension services, farmer and trade organizations)
- Knowledge interactions between farmers and knowledge producing and diffusing agencies
- Knowledge interactions between policy, regulatory agencies and the other actors in the innovation process;
- Types of interactions among the actors; and,
- The determinants and variety of knowledge interactions.

See survey questionnaires.