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Making Agricultural Innovation Systems (AIS) Work for Development in Tropical Countries

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Abstract: Agricultural innovation in low-income tropical countries contributes to a more effective and sustainable use of natural resources and reduces hunger and poverty through economic development in rural areas. Yet, despite numerous recent public and private initiatives to develop capacities for agricultural innovation, such initiatives are often not well aligned with national efforts to revive existing Agricultural Innovation Systems (AIS). In an effort to improve coordination and responsiveness of Capacity Development (CD) initiatives, the G20 Agriculture Ministers requested the Food and Agriculture Organization of the United Nations (FAO) to lead the development of a Tropical Agricultural Platform (TAP), which is designed to improve coherence and coordination of CD for agricultural innovation in the tropics. This paper presents a summary of the results obtained from three regional needs assessments undertaken by TAP and its partners. The surveyed tropical regions were Southeast Asia, Sub-Saharan Africa and Central America. The findings reveal a mismatch in all three regions between the external supply of primarily individual CD and the actual demand for institutional CD. The misalignment might be addressed by strengthening south-south and triangular collaboration and by improving the institutional capacities that would render national AIS more demand-oriented and responsive to the needs of smallholders in domestic agriculture.

Keywords: capacity development; agricultural innovation systems; needs assessment; tropical agriculture platform

1. Introduction

Several reports and surveys on aspects of capacity development in tropical agriculture have recently been published [1–8].

There are five major findings that these reports have in common:

- (1) Current initiatives need to be better coordinated with national and regional policies to promote and sustain CD in agricultural innovation.
- (2) Overall national AIS in most low-income countries in tropical regions remain insufficiently connected to the local agricultural sector/economy. This is reflected in research priorities, education and training, and in the competences of extension services, which remain all insufficiently aligned with the priorities of farmers, farm cooperatives and agribusiness.
- (3) There is a need to develop a common framework for CD that enables less developed countries to learn more efficiently from southern innovation champions and to conduct effective reforms at the policy and the organizational level to facilitate sustainable structural change in agriculture.
- (4) CD in agricultural innovation often does not make reference to the policies and strategies related to National Innovation Systems (NIS) that cover all sectors of the economy [9,10]. While NIS usually involve the private sector in national innovation strategies to a great extent, many national AIS especially in Least Developed Countries (LDCs) have only weak links to the local private sector.
- (5) CD in agricultural innovation initiatives are often funded exclusively through foreign aid programmes and are hardly embedded in national innovation strategies.

The attention paid to these issues may have increased with the Paris Declaration on Aid Effectiveness and the Accra Agenda for Action in 2005 [11] as well as the 4th High Level Forum for Effective Development Cooperation in Busan in 2011 [12]. These were significant steps towards enhancing donor coordination and responsiveness to country strategies and priorities that asked for more institutional ownership, inclusive partnerships and better coordination in development projects in order to improve their long-term impact for rural people in developing countries. Improvement in capacity development “to build the ability of countries to manage their own future”, also lies at the heart of the Accra Agenda.

The High-level Task Force (HLTF) on the Global Food Security Crisis [13] also pointed out that despite valuable regional initiatives such as the Comprehensive Africa Agriculture Development Programme (CAADP) to promote coherent policy and institutional frameworks and translate them into concrete national action plans, there continues to be a substantial dependence on external sources for monitoring, information, policy research, analysis and advice. This is particularly true in Sub-Saharan Africa. The dependence primarily reflects the deficits in local CD at both national and regional levels.

1.1. Capacities That Enable Sustainable Change in Agriculture through Innovation

However, what is Capacity Development or “CD” exactly? Capacity is defined as “the ability of people, organizations and society as a whole to manage their affairs successfully”. CD is “the process of unleashing, strengthening and maintaining such capacity”. These definitions, based on the work of the Organization for Economic Co-operation and Development (OECD) [14], reflect the broadest consensus within the international community.

CD is a major component of Agricultural Research for Development (ARD), which in turn is mainly concerned with the identification, implementation and local adaptation of research with relevance to development [15]. In this context, CD played a major role in the National Agricultural Innovation Systems (NARS) perspective that mainly pursued a linear approach to agricultural innovation (transfer, adoption and diffusion of technologies) as well as the Agricultural Knowledge and Information Systems (AKIS) perspective that emerged as a response to the rather limited linear approach NARS. While AKIS is mainly concerned with studying why and how farmers adopt or disregard agricultural innovations and practices in the first place, it tends to produce little incentive for collaboration between research and education, and is focused on research dissemination that sometimes does not correspond to the actual knowledge needs of farmers and food business [16]. The AKIS concept was again criticized for still being focused on the formal research system as the only supplier of knowledge for agricultural innovation.

This shortcoming was addressed in the conceptualization of the AIS perspective which has been partially derived from innovation systems in the industrialized world, adding value to the conventional, linear perspective on agricultural research and development (R&D), by providing a framework for analyzing complex relationships and innovative processes that occur among multiple agents, social and economic institutions, and endogenously determined technological and institutional opportunities. Figure 1 provides a conceptual framework for a National Agricultural Innovation System that takes into account the innovation systems approach of AIS. It captures the essential elements of an innovation system, the linkages between its components, and the institutions and policies that constitute the enabling environment for innovation [17]. Within this AIS framework, agricultural producers must be understood as crucial actors in the value chain that are not just assisted by agricultural research and education systems via bridging institutions that build capacities for agricultural innovation, but also by other actors in the value chains such as the input suppliers and seed producers in agribusiness that provide valuable technical assistance, as well as retailers and their demands in order to comply with the standards of good agricultural practices. Consequently, innovation is not a one way street from research to users but can actually also be created by the users themselves. In fact, innovation primary takes place within value chains and should subsequently be integrated into a responsive and demand-oriented agricultural education and research system. The State of Food and Agriculture Report of FAO [18] argues that capacity to innovate must be promoted at multiple levels; the individual level, the organizational level and the policy level (enabling environment). Individual innovation capacity development requires investment in education and training. Organizational capacity development of producers and other community-based organizations needs to be developed to enable small-scale farmers to collectively act and innovate. Such organizations can facilitate producers’ access to knowledge sources, inputs and markets. However, their contribution to agricultural innovation varies, depending on their mission, mindset, background, assets and networks. Finally, a well-functioning enabling environment that

comprises policies and rules that govern the mandates and operations of research and extension organizations and their engagement with other actors in the system is vital for individuals and organizations to perform more effectively [18].

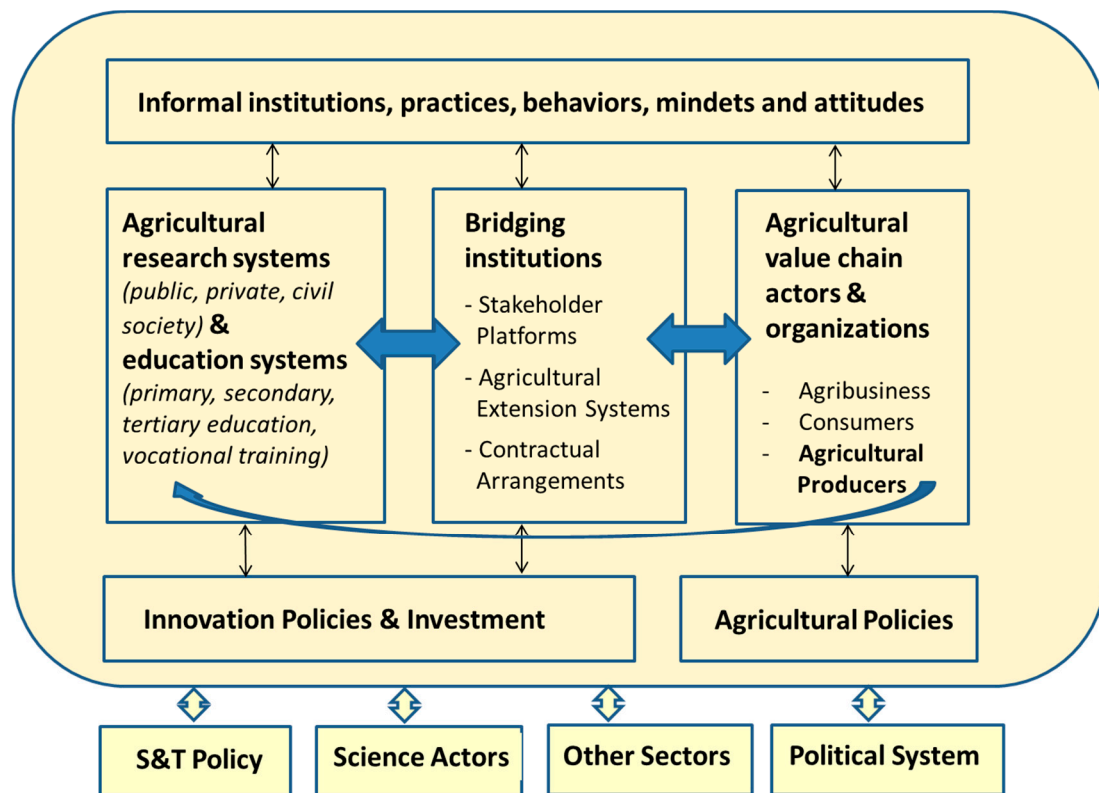


Figure 1. A conceptual diagram of an agricultural innovation system (a slightly modified version of Spielman and Birner [17]).

An AIS thus represents a network of organizations, enterprises and individuals that focused on “bringing new products, new processes and new forms of organization into economic use, together with the institutions and policies that affect their behaviour and performance” [19]. Ultimately, it is the policy environment and active government strategies to foster and award innovation in agriculture that stimulates or hinders CD for agricultural innovation within the AIS.

In short, agricultural innovation, which includes the successful development of new or traditional practices, their tailoring to the local needs of farmers, farm cooperatives and agri-business, and their adoption and up-scaling, requires adequate capacities on all levels of decision making. However, low-income countries often lack the resources and capacities to fully develop their innovation systems. The capacity gap is particularly large in tropical regions, where poverty is pervasive.

1.2. The Tropical Agriculture Platform (TAP)

The Tropical Agricultural Platform (TAP) is an FAO facilitated and G20-backed initiative designed to overcome the capacity gap that prevents many countries from developing their national agricultural innovation systems effectively. The Platform consists of a multi-partner dynamic facilitation mechanism on capacity development for tropical agricultural innovation that assists tropical countries in their efforts to increase the coherence and effectiveness of CD interventions, so that they can lead to sustainable

change and impact at scale. It takes into account the different dimensions of CD (individuals, organizations, enabling environment) as well as functional and technical capacities. TAP was officially launched at the first G20-led Meeting of Agriculture Chief Scientists (MACS) in September 2012 in Mexico and in the meantime has over 40 partners, including agricultural research institutions, regional and global fora and donor organizations among others.

In line with the Paris Declaration, the Accra Action Plan, and the Busan High Level Forum for Effective Development Cooperation, TAP's services will capitalize on and add value to ongoing initiatives that are owned and led by tropical LDCs by fostering greater coherence of capacity development interventions and strengthening collaboration for more harmonized action and greater mutual accountability.

In 2013 TAP conducted a needs assessment study to identify ongoing initiatives, current priorities, capacities and needs of national and regional AIS in selected tropical countries. This paper reports the main findings of the needs assessment study, draws some general lessons on the current status of the CD initiatives and hypothesizes corrective measures to improve their impact.

2. Survey Methodology for the CD Needs Assessment

The overall goal was to identify gaps in current capacities and the development needs as perceived by stakeholders involved in the national and regional AIS. The 27 tropical countries selected for the survey consisted of low-income countries in South/Southeast Asia, and Sub-Saharan Africa and middle-income countries in Central America.

The design and implementation of the regional needs assessments was done in collaboration with regional partners and under the guidance of the TAP interim-Steering Committee. A semi-standardized questionnaire was designed to obtain the perspectives on the AIS from key informants of organizations of the systems in the different regions. The questionnaire was adjusted to the respective regional context but largely consisted of three main parts in all the surveyed regions.

In the first part, respondents were asked to list and assess the challenges of the national and regional AIS. In the second part, they rated the different innovation challenges in their country and identified the principle actors. Finally, they were asked to assess the relevance of the national AIS in their particular field and provide some information about the organization they represent. A purposive sampling was applied in choosing the respondents. They were chosen on the basis of their varied roles and experiences as stakeholders in projects implemented under the national agriculture research and development system in each country. This was purposely done to ensure to have a wide range of experiences and sources of information as basis of the evaluation.

The selected regions are Sub-Saharan Africa, where the survey was conducted in collaboration with the Forum for Agricultural Research in Africa (FARA) based in Ghana; Central America, where the study was carried out by the International Center for Tropical Agriculture (CIAT) in Colombia; and South/Southeast Asia, where the survey was done in collaboration with the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) based in the Philippines. The three institutions had considerable independence in the choice of the relevant survey participants and the focus of the content. Whereas SEARCA had a main focus on non-governmental and donor organizations in the Southeast Asian countries, the African participants in the FARA survey were primarily government

and regional institutions (research institutions/universities)—with the exception of the eastern and central African region (ASARECA) where private sector institutions played an important role. Private sector institutions were especially dominant in the Central American survey conducted by CIAT. The selection of stakeholders in the different regions also reflects the respective involvement of non-government, government and private sector institutions in the regional AIS. The survey was carried out in the spring of 2013. The first draft report was submitted by the end of June 2013 and the synthesis report was prepared by end of August 2013 [20].

3. Results of the Regional Needs Assessment

The main objective of the regional needs assessments was to identify the needs in CD for agricultural innovation on the policy level, the institutional level and the individual level. The information obtained from the regions then provided the basis for the formulation of a strategic TAP Action Plan that is in line with the findings of the Needs Assessments and previous CD studies and surveys. The following subchapters represent summaries of the final report of the regional needs assessments. For a more detailed analysis on the survey content and results, the synthesis of the final regional reports can be downloaded on [21].

3.1. Sub-Saharan Africa [22]

FARA through its sub-regional fora surveyed countries in three regions of Sub-Saharan Africa:

- (1) Ethiopia, Rwanda, South Sudan, and Tanzania are linked to the Association for the Strengthening Agricultural Research in Eastern and Central Africa (ASARECA);
- (2) Angola, Comoros, Lesotho, Malawi, Mozambique, and Zambia are part of the Council for the Coordination of Agricultural Research and Development in Southern Africa (CCARDESA);
- (3) Benin, Burkina Faso, Liberia, Niger and The Gambia, being part of the Conseil ouest et centre Africain pour la Recherche et le Développement Agricole/West and Central African Council for Agricultural Research and Development (CORAF/WECARD).

The development indicators of the three sub-regions in Africa vary widely. There are big differences in terms of population growth, income/capita, agricultural yield increases and public investment in agriculture. Unlike in the other two regions, the governments in Africa have developed a common vision for agricultural development based on the CAADP. This initiative is African-owned and African-led. At the same time, donor initiatives to promote CD for agricultural innovation are highly concentrated on the African continent [23]. Africa thus plays a very important role in this needs assessment, not only because it is the largest recipient of funding for CD for agricultural innovation, but also because it is the continent that has so far only made slow progress in reducing poverty, hunger and malnutrition in the past two decades, even though many African countries have performed rather well in recent times. The questionnaire-based perception survey on the challenges and opportunities of the national AIS was completed by 33 stakeholders across all three aforementioned sub-regions in Africa—out of 107 stakeholders that were contacted. The relatively low overall response rate is attributed to the difficulty to reach the participants by phone or e-mail. However, there were great differences between countries. The response rate ranged from very low in Ethiopia, Kenya and Angola (around 14 percent) to very high in Lesotho

(100 percent) and in Zambia and Rwanda (71 percent). Figure 2 reveals that agribusiness stakeholders are not represented in surveys conducted in CCARDESA and CORAF/WECARD countries whereas the share of stakeholders representing agribusiness in ASARECA countries amount to 31 percent.

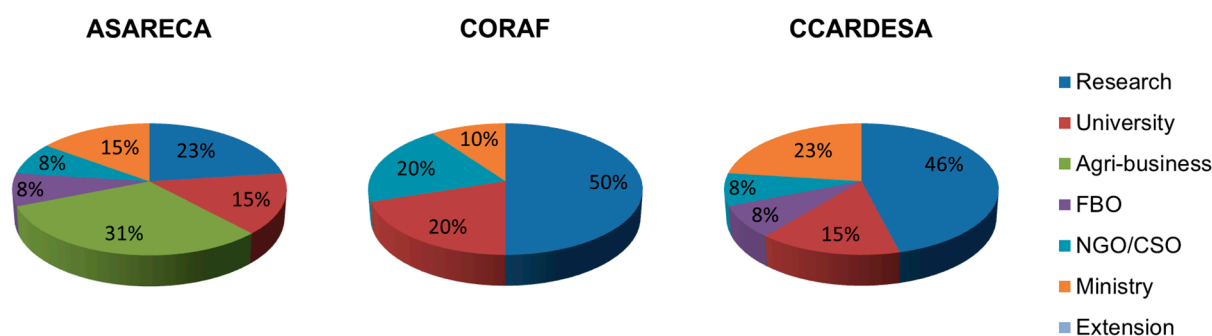


Figure 2. Stakeholder shares of responses (in percent of total responses) in the African sub-regions ASARECA, CORAF, CCARDESA [22].

Findings of the Sub-Saharan Africa Survey

The major challenges for innovation identified by the respondents of the stakeholder survey in all the three sub-regions could be broadly classified as: (1) resource endowments (insufficient access to innovation, lack of support from financial institutions, high cost of new technology and equipment, lack of farmer training centres for distribution of e-learning materials in remote areas, and lack of communication infrastructure); (2) lack of involvement that affects attitudes and mindsets (inadequate participation in innovation meetings); (3) environmental factors (desertification and climate change); and (4) access to markets for value added products.

Institutional innovation to facilitate better access to innovation finance and markets, training in entrepreneurship and management, and the development of new practices and techniques that allow farmers to adapt to climate change while increasing agricultural productivity have been suggested to address current failures to create value for farmers through innovation. In this context, research organizations engaging farmers in research priority setting and process (such as variety development and selection) play an important role.

As indicated in Table 1, the opportunities that motivated the adoption or development of innovations identified in the last five years included abundant natural resources, collaborative linkages and conducive investment policies, new markets for innovative products, innovation capacity and willingness to adopt innovative extension pathways such as e-extension.

Table 1. Key innovations, challenges and opportunities in the last five years in three African sub-regions [22].

| Issue | ASARECA | CORAF/WE CARD | CCARDESA |
|----------------------|---|---|---|
| Innovations | <ul style="list-style-type: none"> ▪ Review meetings on innovation awareness ▪ Banana product development and diversification ▪ Linking farmers with warehouse receipt systems ▪ Improved awareness on Sanitary and Phytosanitary standards | <ul style="list-style-type: none"> ▪ Irrigation skills ▪ New plant varieties ▪ Nature rehabilitation ▪ Transformation of aquatic plants | <ul style="list-style-type: none"> ▪ Drought tolerant maize and beans varieties ▪ Inclusive financing models ▪ Conservation agriculture ▪ Fruit processing ▪ New herbicides ▪ Better water utilization techniques |
| Challenges | <ul style="list-style-type: none"> ▪ Unwillingness by financial institutions to lend money for innovations ▪ Inadequate participation in innovation meetings ▪ Reluctance by farmers to use warehouse receipt system ▪ Lack of farmer training centres for distribution of e-learning materials in remote areas | <ul style="list-style-type: none"> ▪ Lack of communication infrastructure ▪ Desertification ▪ Language barriers | <ul style="list-style-type: none"> ▪ Climate change ▪ Negative cultural values towards new varieties ▪ High cost of new technology and equipment ▪ Lack of markets for value added horticulture products ▪ Application of new technologies is tedious/laborious ▪ Poor institutionalization of the technologies |
| Opportunities | <ul style="list-style-type: none"> ▪ Abundant natural resources ▪ Friendly investment policies ▪ Many stakeholders interested in e-learning channels for farm extension | <ul style="list-style-type: none"> ▪ Diverse food preferences ▪ Natural resource base | <ul style="list-style-type: none"> ▪ Collaboration with international organizations ▪ Skilled staff |

At the country level, the regional producer organizations have succeeded to a considerable extent in having farmers represented in the CAADP roundtable processes. However, producer organizations did not appear to be actively engaged in determining research and extension priorities, except in some isolated cases.

Many interventions have been small-scale with relatively high transaction costs, have had limited impacts on the ground, and have often been based on inadequate analysis of interdisciplinary needs and the demands of agricultural markets. Experience has demonstrated that enhanced coherence and stronger partnerships can improve the quality and impact of CD in innovation systems.

Although, almost all the reviewed African countries have national-level policies on agriculture, but very few of them have specific interventions that directly deal with development of innovations to support smallholders at the farm level. Thus, the national policies have not been implemented at the grassroots level.

Major obstacles in CD for agricultural innovation are: (1) lack of policy dialogue between government and private stakeholders; (2) lack of Public-Private Partnerships (PPPs); (3) lack of private sector incentives, rigid or high interest rates constraining access to business, finance, property or land rights not conducive to commercialization of agriculture; (4) lack of institutional and regulatory frameworks (especially under fragile political situations), import-based economies to the detriment of local products; and (5) other policy and institutional issues constraining private sector investment. Human factors included mindset of private sector actors that shows little inclination to participate in agricultural research and development and lack of long-term vision when it comes to the benefits of research. In turn, some stakeholders also have an inherent distrust in PPPs for R&D. They believe that access to new technologies may be hampered by Intellectual Property Right (IPR) protection and that this may constrain private sector participation in CD for agricultural innovation. Moreover, the private sector would only invest if it believed in the potential economic viability of an agricultural project.

3.2. Central America [20]

CIAT in Colombia was in charge of the needs assessment for Latin America, focusing on Central American countries. The countries covered in the survey are part of or will become part of the Central American Free Trade Agreement (CAFTA). The questionnaire-based survey included 33 key stakeholders involved in the debates on CD for agricultural innovation in Guatemala, Belize, Honduras, El Salvador, Nicaragua, Costa Rica and Panama; as well as in the region as a whole.

The CIAT team designed a questionnaire for its regional survey that slightly differed from the questionnaires administered to stakeholders in Africa and Asia. Figure 3 reveals the institutional and professional affiliation of the 33 respondents that completed the questionnaire (from a total of 100 stakeholders contacted). The sample was taken at random from the original file provided by the International Services for Agricultural Enterprise Development (SIDE), and included respondents in the following seven groups of actors: working at a national public institution, international public institution, national private sector organization, international private sector enterprise, university, supplier of technical assistance and managers of private firms in agriculture. Private sector organizations included representatives from producers of different scales and dedicated to different products.

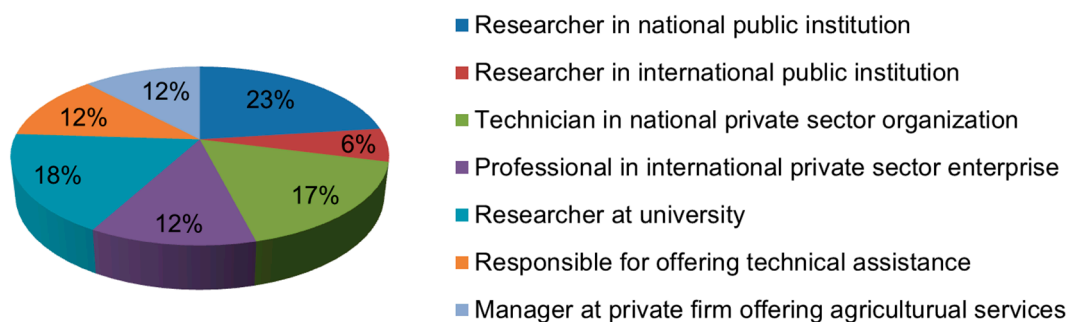


Figure 3. Current professional affiliation of actors (in percent of total responses) who have filled in the questionnaire in Central America [20].

The respondents' assessments of AIS indicate that innovation has taken place in Central America, but mainly with regard to the improvement of genetic material for higher yields and better quality of products, and to some extent better soil and water management techniques. A major concern was the limited rate of adoption of these innovations. The majority of the stakeholders believed that one reason for that is the belief that the type of innovation created was not sufficiently resilient to cope with weather instability and resistance to adverse climate conditions. Other reasons for the low adoption rates were considered to be: (1) the reluctance of farmers to follow recommendations made by advisory services (often neglecting the fact that farmers need to be an actor in the innovation process and are often excluded when the respective institutions continue to follow linear technology transfer approaches); (2) the ill-equipped state of extension and support services for producers; and (3) the lack of consideration of traditions and cultural preferences (in the case of beans, local seeds are preferred because of tolerance to weather instability, reduced cooking time and better taste of the product). Market-driven alliances and partnerships along the value chain were considered to be the best approach to increase the relevance and impact of research results and facilitate adoption of innovation, combined with improved support services for farmers and communication in an easy language, meeting the information and advisory needs of farmers.

As for the assessed importance of institutions in the AIS, the universities and national agricultural research centers rank very low and even international agricultural research centers did not seem to have significant influence on policies that are relevant for the fostering of greater innovation in agriculture. Their limited participation is due to their lack of involvement/ability to contribute to a useful information base for policy makers in the area of CD for agricultural innovation. Many academic institutions also tended to confuse policy advice with politics and therefore believed that they should not get involved.

In turn, integrated-value chain and commodity-based organizations were considered to be the most influential actors according to the respondents of the survey. They have been influential on government decisions regarding policies on agricultural health issues, and taxation of revenues from agriculture land. Regarding participation in market interactions, the most active participants are the dealers of inputs and seeds, who rely strongly on advertising. Some local producer organizations and cooperatives of dairy and coffee producers also became strongly engaged in market interactions.

Findings of the Central America Survey

The regional needs assessment in Central America found that institutional capacity to implement policies that enable agricultural innovation is limited. Instead there is a need to review policy instruments to cope with new challenges.

Innovations along value chains turned out to be important CD arrangements that are driven by market opportunities. Such innovations helped to increase not just agricultural productivity but also the quality of the output, especially in the area of dairy, coffee and sugarcane. They constituted a pull effect exercised by all actors in the value chain, and they resulted in great advances in CD for agricultural innovation. Complementary roles were played by various other institutional actors that are linked to national and regional AIS. Yet, these AIS were largely underperforming. Budgetary limitations often hindered AIS “bridging institutions” from becoming more active in the creation of innovation that respond to the needs of smallholders who were not yet integrated into a global value chain. Innovation corresponding to the needs of smallholders would also have required tapping into knowledge and investments from the private sector. Yet, government policies did not often provide sufficient incentives for the private sector to invest in agricultural innovation with a public good character.

In relation to the functioning of national AIS, the capacity and role of the system to stimulate and facilitate interaction between actors was reported to be very limited; alternative entities were needed for this role. Limitations in capacity were also evident among other actors in the national AIS, such as universities, affecting their effective participation. Among the weaknesses in the systems was the absence of facilitating mechanisms, such as innovation platforms, and of financial mechanisms, such as venture capital and competitive funds.

With respect to individual capacity created within the regional agricultural research system, some institutions have made valuable contributions to the development of human resources for research and education, with beneficiaries from all Latin American countries and some from other countries. Also, the outputs of research were well-recognized throughout the region. The Central American Research System (SICTA) has played a useful role in facilitating the dissemination of knowledge on relevant research issues and in the upgrading of research staff at the national public agricultural research institutes. However a strong need was identified for it to rethink its role and functions. For that purpose, it should include the participation of more actors beyond public research entities. This would address the crucial lack of institutional capacity for agricultural research and innovation and thus create great value for small-scale as well as large-scale agriculture. Respondents also stated that institutional capacity needed to become a top item on the political agenda and implementing institutions needed to have the personnel with the required qualifications.

International cooperation in agriculture, especially in the form of regional and national projects, was abundant and dispersed. The assistance consisted of improving the capacity of personnel, facilitating mechanisms for interaction among the national agricultural entities, and contributing to the quality of research. However, there is no strategy, nor evidence, that the capacity of public and private sector institutions has been improved through the contributions of the agencies and projects related to international cooperation in agriculture.

3.3. South/Southeast Asia [24]

The partner organization who carried out the regional survey in South/Southeast Asia was SEARCA. It covered in total five low-income countries, four of them in Southeast Asia (Cambodia, Laos, Myanmar, Timor-Leste) and one in South Asia (Bangladesh). SEARCA recruited country partner researchers to gather stakeholder perspectives using the semi-standardized questionnaire on the gaps and needs of the national as well as regional AIS in the Asian region. Their close follow-up by phone ensured that all stakeholders contacted completed the survey. From the 71 respondents, 13 were from Bangladesh, 11 from Cambodia, five from Laos, 25 from Myanmar and 17 from Timor-Leste. Figure 4 reveals that most of the respondents came from public institutions, 27 percent from NGOs and CSOs, and 10 percent from agricultural trading and journalists.

The results showed that according to the survey most stakeholders involved in agricultural innovation considered the lack of facilitating policies to promote CD in agriculture to be the most serious constraint in efforts to make the national AIS more effective and farmer-oriented. The prime concern was associated with the perception that there was a lack of private sector involvement in the national agricultural economy. This concern was again linked to the first observation about the lack of facilitating policies that often discourages private sector investment while a dominance of public sector and donor activities in rural areas can lead to the crowding out of private sector activities. The stakeholders that were perceived to play important roles in innovation enhancement include public advisory services, national research institutes, and the domestic private sector. There were generally very low expectations regarding the contribution of universities to AIS.

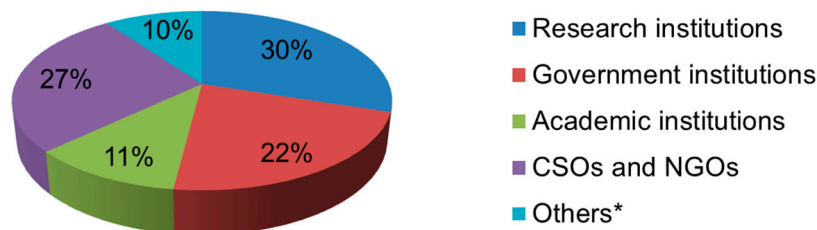


Figure 4. Stakeholder shares of responses (in percent of total responses) in South/Southeast Asia [25]. * Stakeholders representing agricultural trading and agricultural journalists.

Stakeholders considered innovation in the areas of agro-ecological techniques, biotechnology and solar technology to be very important, especially with regard to the need to increase agricultural productivity, environmental management and food quality. Platform technologies, such as biotechnology and information technology, that have resulted in low-cost and user friendly products (tissue culture laboratories, mobile phones) were perceived to have a positive environmental, economic and social influence. Respondents also found that institutional/organizational innovations could help address the identified bottlenecks within the regional AIS, such as government policies that enable provision of demand-oriented extension services, technology, microfinance, and business mentoring. Important tools to encourage PPP included government incentives (matching grants, tax credits, *etc.*), joint cooperation platforms, and presence of national marketing boards.

Findings of the South/South-East Asia Survey

The surveyed countries were net food-importing countries, despite the long-term presence of numerous external actors committed to enhance domestic food security through CD for agricultural innovation. This indicates that there might be a misalignment between current CD interventions and the effective needs for CD, especially on the demand-side represented by farmers, farm cooperatives and agribusiness. Many of the ongoing CD projects had increased efforts to integrate small-scale farmers and especially women into market-driven value chains and thus increase income and employment opportunities. Respondents stated that these projects should draw more on private sector expertise.

The regional assessment concluded that AIS must become more responsive to private sector needs in agriculture (e.g., supporting farmers, farm cooperatives and agribusiness with tangible and intangible goods and services that help them to increase productivity and participate in value chains), and increase their ability to innovate in collaboration with farmers to address the numerous environmental, technical, economic and social challenges.

4. Discussion

The three regional needs assessments surveyed the perception of the main stakeholders involved in the national and regional AIS, reviewed the institutional and political climate for CD in agricultural innovation, and identified capacity levels and needs at national and regional levels. Even though the needs assessment revealed some differences with regard to the priorities that ought to be addressed in agricultural development, they all observed a mismatch between the quality of the current supply and the actually demanded quality of CD for agricultural innovation. Even though respondents agree that regional and national AIS should share a vision of serving the production sector by responding to concrete capacity needs, the implementation record of this vision is mixed. Many actors within the AIS in all three regions were found to play a rather passive role, which was also related to budget limitations and lack of government incentives to innovate over the past two decades. Even though funding for AIS actors increased after the first global food crisis in 2008, views expressed in the regional assessments indicated that most of this funding did not go into new research and extension projects or programmes, but was mostly spent on urgently needed salary increases and the overhaul of AIS infrastructure.

Generally, many of the institutions involved in agricultural research and extension were highly dependent on development assistance and hardly autonomous. This limitation was particularly reported by the respondents in the Southeast Asia regional assessment. CD projects in these countries were mostly funded by external actors and then carried out in collaboration with local NGOs or government agencies. The African regional assessment highlighted a similar dependence on foreign funding in the field of CD for agricultural innovation, even though the CAADP framework endorsed by the African Union Assembly in 2003 is an Africa-owned and led initiative with a shared vision for sustainable growth in agriculture and a willingness for collective action.

However, many of the concrete positive examples of CD for agricultural innovation in Africa were related to public–private sector initiatives which CAADP welcomes as long as they contribute to the shared vision. These initiatives included innovation-promoting projects supported by development assistance agencies [25], by PPPs [26], by the World Bank [27], by South–South projects led by Brazil

and China [28], and by African-led projects such as FARA's Sub-Saharan Africa Challenge (SSA-CP). Countries such as Benin, Malawi, Mozambique, Rwanda, Tanzania and Zambia have made an effort to improve the enabling environment for PPPs through policy reforms in selected areas. Yet, considering that these African countries mostly fall short of meeting the benchmarks set by CAADP, more reforms may have to be undertaken to increase business opportunities for smallholder agriculture through enhanced private sector innovation and investment. In this context, the survey respondents in Africa identified four major challenges in efforts to unlock innovation for agricultural development: (1) insufficient resource endowments; (2) inadequate attitudes and mindsets; (3) unpredictability due to environmental challenges, such as desertification and climate change; and (4) access to markets for value added products.

The fourth constraint was also strongly emphasized by the authors of the regional needs assessment in Central America. They argued that innovations were driven by market opportunities, and that commodity-based organizations have performed best in enabling farmers to integrate into global value chains. These commodity-based organizations are considered to have contributed more to CD in agricultural innovation than the national and regional AIS at this stage. Market forces provided a pull effect that encouraged farmers to acquire capacities in agricultural innovation. AIS actors could potentially play an important complementary role by focusing on the integration of the more informal and less productive semi-subsistence farming sector that still relies on the production of beans and corn mainly for home consumption. Yet, the AIS in Central America was found to face budgetary limitations and a lack of expertise/incentives to collaborate effectively with the private sector in the field of agricultural innovation.

Although there have been numerous efforts by various external actors to improve CD in agricultural innovation, the respondents in Southeast Asia indicated gaps. They reported a lack of incentives to innovate, a lack of a clear innovation strategy in public policy, distrust in PPPs, and a lack of private sector investment in agriculture. In view of the rather passive role of AIS in Southeast Asia, a shift of CD for agricultural innovation from public to private sector organizations was observed, as in the case of Central America. This was especially the case in Myanmar, where commodity associations such as the Myanmar Rice Industry Association (MRIA) and the Special Agricultural Development Companies (SACs) established as rural township enterprises, were most engaged in direct support to farmers.

The consequence of the general neglect of AIS in the less developed countries in the three regions was found to be the persistence of a dual agricultural economy that is characterized firstly by a large informal farming sector with little growth potential and secondly by a relatively small but highly competitive formal sector that is growing rapidly through agricultural trade and innovation. The informal sector is dominated by semi-subsistence farmers who are assisted by a public system of agricultural extension that hardly responds to the real CD needs in agricultural innovation. Moreover, the majority of farmers do not have regular access to extension or advisory services in the first place [18]. The formal sector, in turn, is largely organized through private initiatives to upgrade CD to an extent that enable producers to comply with the strict business requirements of a growth-oriented and innovative agricultural sector. This also explains the success of privately-organized commodity-based organizations in CD for agricultural innovation in Central America and selected Asian countries and innovative forms of PPP in the African region. LDCs in South/Southeast Asia benefited from a large number of CD projects funded through development assistance that were mainly focused on improving resilience and

livelihoods of small-scale farmers. However, the main drivers of value chain integration tend to be agricultural investors from emerging economies in the region.

These trends do not suggest that national AIS actors have insignificant roles to play in assisting producers in the informal sector to improve the quantity and quality of their production and eventually benefit from integration into larger value chains that encourage innovation. However, such producers need to be assisted not just through the development of their individual capacities, which had been the predominant focus in international assistance to date, but through a coordinated effort by the public and private sectors to create an enabling environment and improve organizational capacities for innovation organizations. AIS needs to have incentives to seek and sustain more collaboration among the various actors involved including producer organizations. In addition, the private sector may need more policy incentives to work with actors in the national AIS and in the international development arena to improve the impact of CD interventions. All this would create an enhanced awareness that only full integration of all relevant actors in the AIS would result in innovation that assist producers, producers' cooperatives and agribusiness facing obstacles in their efforts to make agricultural practices more sustainable, adapt technologies and knowledge to local conditions and improve their post-harvest management and marketing skills in order to generate more revenues and employment for their respective community. It would also help to create a different mindset among AIS actors, as well as in the tertiary agricultural education systems, that business opportunities are necessary to promote agricultural development, reduce poverty and promote the empowerment of men and women in rural areas. These insights are in line with the findings of previous reports on CD in agriculture in less developed countries and confirm the call of the interagency report of the G20 for the creation of an enabling environment for agricultural innovation at the national, the regional and the global level [29].

5. Conclusions

Three major groups of constraints were identified in all three regional assessments on CD for agricultural innovation in tropical countries, and they are largely in line with the insights from previous research on the subject as well as with the findings of the "State of Food and Agriculture" Report 2014 on Innovation in Family Farming [18].

The first group of constraints refers to *the way that CD is planned*. CD interventions from internal and external actors are not sufficiently targeted to meet the AIS capacity needs of tropical countries. The previous section has shown that both internal and external initiatives to develop agricultural innovation capacities are not perceived to be well-targeted to the needs articulated by actors at the local level including producers, cooperatives, and agribusiness. This poor targeting is partly caused by the absence of specific national, provincial and institutional strategies and plans that could direct such investments, which in turn leads to approaches with too narrow scope or with poor coordination at the local level. Key stakeholder groups such as the private sector are often not involved in the policy and decision-making processes that lead to concrete agricultural investment plans. A specific example of a systemic constraint is the lack of responsiveness of tertiary agricultural education systems in LDCs to the needs of the production sector, which is manifested in outdated curricula for degrees and postgraduate courses, as well as technical and vocational education and training that do not impart the

skills required for professional development. In addition, CD interventions often use poor methodological approaches to the assessment of needs that reduce the likelihood of sustainability and impact.

The second group of constraints refers to *the way that CD is implemented*. CD interventions are frequently implemented independently from each other and are often too small in scale, narrow in scope, and neglecting institutional and organizational capacity dimensions. The regional reports highlighted the large number and variable composition of CD interventions from international, regional and national CD providers, and the reports noted that these were not linked or coordinated when they might easily have been. Especially in Africa, there was a significant risk that unconnected engagements with separate external investors and actors absorb significant amounts of local resources and time, which could prevent country officials from convening the relevant domestic actors in the AIS to facilitate collective streamlined action for CD of AIS. The lack of collaboration between external actors is especially pointed out in the regional needs assessment conducted by CIAT; in its regional report it makes the following observation which also relates to the first group of constraints: “International cooperation, especially in the form of regional and national projects is widespread. It has been helpful in improving the capacity of personnel, facilitating mechanisms for interaction and contributing to the quality of research, but there is not yet a strategy, nor is there evidence of having improved the capacity of public and private sector institutions”.

In addition, all three regional reports stated that many donor-led initiatives focused on individual CD through training and capacity building programs, while in fact the major obstacles that prevent effective AIS in the LDCs are related to weak institutional/organizational capacities. Domestic AIS institutions, especially those with weak institutional capacity, often do not receive the support they require to improve the enabling environment for investment in AIS and CD in agriculture as a whole. In fact, there are too few mechanisms at the country level that would improve the coordination between locally and internationally-driven investments. Moreover, the mechanisms that exist are often inappropriate to ensure that CD interventions are properly structured and in line with established good practice.

The third group of constraints relates to *the way CD interventions in support of AIS are governed*, which has several dimensions. There is first of all a lack of high-level political and operational mechanisms to better coordinate interventions for capacity development in tropical AIS and thus ensuring the desired improvement of institutional capacity development for agricultural innovation. Governments in the LDCs, especially in Africa, are not benefiting sufficiently from the important lessons learned by the principal emerging economies such as Brazil and China on institutional capacity development to enable innovation and sustainable development in agriculture.

There are however efforts to address these constraints. There has been a shift toward more diversified approaches to CD in agricultural innovation. Previously, CD initiatives in AIS were predominantly public-sector driven with an emphasis on theoretical approaches and social planning approaches. Today, there is a noticeable trend towards more experimental forms of PPPs and South–South collaboration to enhance CD of AIS with the aim of enabling farmers to integrate into global value chains. In view of similar environmental and socio-economic challenges, the sharing of mutual experience is useful and widespread in South–South collaboration [30]. The mutual understanding also provides a strong push for more inclusive partnerships among participating countries; and the scarcity of public resources makes the financial sustainability of CD initiatives in agriculture a focal point. In this context, progressive governments in developing economies are committed to being facilitators of agricultural change

encouraging farmers' and producers' organizations to be entrepreneurial and innovative with the prospect of enhancing and diversifying their income. Governments thus assume tasks that the private sector would not be able to afford or would be too risky (investing in R&D is expensive and always very uncertain in terms of commercial success). If these facilitating policies are in line with the needs articulated by the local farmers, farm cooperatives and agribusiness, they foster demand-oriented CD in agricultural innovation which can be further strengthened through the fostering of institutional capacity development and the creation of an appropriate enabling environment [23,31].

Set in this complex and dynamic environment, the strategic goal of TAP aims at addressing the various constraints identified in the regional needs assessments that hamper effective AIS in tropical countries. TAP will contribute to the development of national capacities for agricultural innovation in the tropics. As a multilateral dynamic facilitation mechanism it aims to enhance coherence and strengthen responsive partnerships designed to improve the quality and impact of CD in innovation systems.

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Author Contributions

Philipp Aerni authored the synthesis report of the three needs assessments for the TAP. Karin Nichterlein and Stephen Rudgard guided the design of the surveys methods for three Needs Assessments and coordinated the overall project. Andrea Sonnino was the FAO supervisor in charge of the project and provided valuable guidance in the different stages of implementation. All authors contributed to the analysis and interpretation of the results. They were also all involved in the preparation and have approved the submitted manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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