# Tertiary Sector Perspectives on Agricultural Innovation Systems (AIS) for Sustainable Development in Asia-Pacific Tropics

A Preliminary Desk Review and Discussion Paper[1] by
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[1] This paper is an independent review of selected academic and agency literatures or project documents. It focuses on highlighting a few important, but arguably somewhat neglected, AIS issues and themes pertaining to the tertiary sector and sustainable development. The analysis and recommendations are the author's alone meant for discussion purposes only. They do not represent official views or policies of the Food and Agriculture Organization of the United Nations (FAO), the Asia-Pacific Association of Agricultural Research Institution (APAARI), the Tropical Agriculture Platform (TAP) or any of their donors or partners.

## Abstract

This paper is a brief reflection on tertiary sector perspectives concerning Agricultural Innovation Systems (AIS) for the FAO-led Tropical Agriculture Platform (TAP) and its Common Framework on Capacity Development for Agricultural Innovation Systems (CDAIS). It reviews global contexts, academic literatures, and technical reports pertaining to sustainable development in the tropical Asia-Pacific region and the challenge of addressing hunger, poverty and environmental degradation especially in low-income countries and rural areas. The paper discusses how Asia-Pacific tertiary institutions can be central actors in learning from strengthening, improving and implementing CDAIS concepts and practice through a more strategic focus on education, research and extension while also helping achieve UN agreed Sustainable Development Goals (SDGs), 2015-2030. The SDGs launched in 2015 are now the main global guiding framework of governments, international agencies and donors, for at least the next decade. As such this paper makes recommendations on refining the *TAP Action Plan 2018-2021* to strengthen the partners' alignment with SDGs. To strengthen the TAP's relevance, it needs to integrate SDG monitoring, reporting, evaluation, analysis and strategic planning for AIS with Higher Education Institutions (HEIs). Moreover, the paper argues that TAP-CDAIS policies and investments should better support a broad, holistic and comprehensive sustainability transition, particularly by utilizing an agro-ecology scaling-up initiative and allied approaches in partnership with FAO and HEIs. The paper introduces a generic model of a Tertiary Agri-Food Innovation System (TAFIS) to illustrate how different types of processes, functions and components in a typical university can either serve as enabling environments (or hinder) impact pathways toward agri-food system sustainability. Finally, it suggests that universities especially can be important incubators, engines and drivers for sustainable agriculture or food system innovations particularly if they are better understood and provided suitable enabling environments and resources. In sum the paper shows how future HEI analysis, policies and reforms can broaden and strengthen FAO-TAP-AIS work with HEIs and SDGs together. It recommends some areas of work to consider for future action.

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**Abbreviations**

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| AET | Agriculture education and training |
| AIS | Agricultural Innovation Systems |
| AKIS | Agricultural Knowledge and Information Systems |
| APAARI | Asia-Pacific Association of Agricultural Research Institutions |
| AAACU | Asian Association of Agricultural Colleges and Universities |
| BIC | Business Innovation Center |
| CASCADE | Central Asia and South Caucuses Agricultural University Consortium for Development |
| CATAS | Chinese Academy of Tropical Agricultural Sciences |
| CDAIS | Capacity Development for Agricultural Innovation Systems |
| COE | Center of Excellence |
| COP | Community of Practice |
| CTA | Technical Centre for Agricultural and Rural Cooperation |
| CURAD | Consortium for Enhancing University Responsiveness to Agribusiness Development, Chinese Association of Agricultural Science Societies |
| FAO | Food and Agriculture Organization of the United Nations |
| GCHERA | Global Confederation of Higher Education Associations for Agricultural and Life Sciences |
| GUPES | Global Universities Partnership on Environment and Sustainability |
| HEIs | Higher Education Institutions |
| IFOAM | International Federation of Organic Agriculture Movements/Organics International |
| IAUA | Indian Agricultural Universities Association |
| IPB | Bogor Agricultural University |
| LDCs | Least developed countries |
| MACS | Meeting of Agriculture Chief Scientists of the G20 |
| M&E | Monitoring and Evaluation |
| MRI | Multidisciplinary Research Institute |
| NAIS | National Agricultural Innovation Systems |
| NARO | National Agricultural Research Organization |
| NARS | National Agricultural Research Systems |
| SDGs | Sustainable Development Goals |
| SEAMEO SEARCA | Southeast Asian Ministers of Education Organization, Southeast Asian Regional Center for Graduate Study and Research in Agriculture |
| TAFIS | Tertiary Agri-Food Innovation System |
| TAP | Tropical Agriculture Platform |
| TIPI | Technology Innovation Platform of IFOAM |
| TNAU | Tamil Nadu Agricultural University |
| TOT | Transfer of Technology |
| UNEP | United Nations Environment Programme |
| YPARD | Young Professionals for Agricultural Development |

**Global Contexts/Imperatives for Sustainable Agri-Food Innovations in Higher Education**

The global agri-food system is one of the world's greatest contributors to environmental damage, including agrochemical pollution, desertification, deforestation, drought, depleting aquifers, water diversion, biodiversity loss, land degradation and climate change. Moreover, almost 821 million people were undernourished or food insecure in 2017 with 515 million, over half, in Asia, with poor rural farmers and communities often among the most vulnerable, malnourished and hungry (FAO, IFAD, UNICEF, WFP and WHO, 2018, pp. 3, 6). The challenges are urgent, serious and complex. Future agri-food innovations and systems, including those conceived, nurtured in or implemented by Higher Education Institutions (HEIs) in partnership with others must respond to a multitude of interrelated environmental, socioeconomic, and food security challenges to be relevant in the 21st Century. Moreover, HEIs cannot be innovators or analysts in a vacuum. They must work in partnership with farmers and other stakeholders to study, debate, teach, co-learn, and enhance new knowledge and skills while being innovation incubators which can ground truth, field test and scale-up viable alternatives to the unsustainable agri-food system.

The general direction that society must arguably move to achieve substantive and measurable progress has been echoed by many experts and agencies. One UN report called for "a fundamental transformation of agriculture" with a "need for a two-track approach that drastically reduces the impact of conventional agriculture, on the one hand, and broadens the scope for agro-ecological production methods on the other…" (UNCTAD, 2013, p. i). Another study urged wide-scale action including more agroecology research and education for a genuinely sustainable agri-food system (IPES-Food, 2016). The agroecology innovation imperative, with other appropriate sustainability models and effective transition pathways in combination, is a useful way to frame the challenge (e.g. Castella and Kibler, June 2015; Lamine, Claire, 2011; DeLonge, Miles and Carlisle, 2016; FAO 2018, pp. 2-3). Others may suggest different actions or strategies, especially in light of how best to achieve UN agreed Sustainable Development Goals (SDGs) arguing simply that a fundamental transition towards sustainable agriculture (SA) and food systems is essential. However, since SDGs did not define SA or sustainable agri-food system (SAFS) universities and colleges can and should play a central role in helping to debate some core conceptual and practical challenges about agri-food system sustainability transitions while stimulating, designing and testing appropriate innovations with partners.

The basic and broad question guiding the present paper is "*How can HEIs as key actors in Agricultural Innovation Systems (AIS) facilitate a transition toward sustainable agri-food innovations and systems while building or strengthening research, education, and public service capacities to meet global SDGs*? The paper does not provide definitive or detailed answers. It reviews relevant academic and agency literatures, notes some case examples to illustrate models or best practices, and proposes future work about/with HEIs in the Asia-Pacific region to address global and regional challenges emphasizing agro-ecological perspectives.

**Introduction to TAP, AIS and CDAIS**

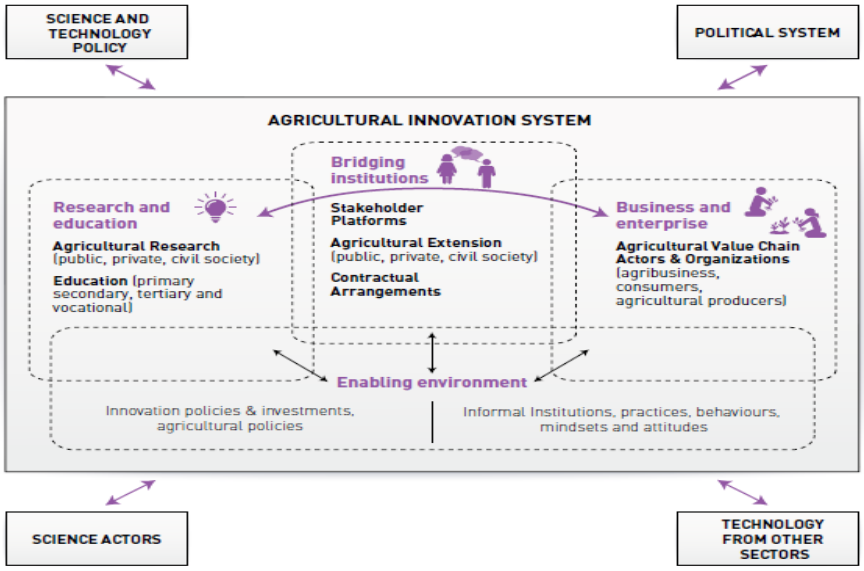
The FAO-led Tropical Agriculture Platform (TAP) is a global initiative launched in 2012 in Mexico in conjunction with the first G20-led Meeting of Agriculture Chief Scientists (MACS). The TAP (hosted by FAO) launched in 2012 with 40 main partners (global, regional and national) including agricultural research institutions, regional and global fora and donor organizations. By 2018 there were 46 partners. Initially a few single HEIs or associations of HEIs in professional networks including The Global Confederation of Higher Education Associations for Agricultural and Life Sciences (GCHERA) were TAP-HEI partners. Most were represented indirectly as institutional member networks of GCHERA amounting to at least several hundred individual HEIs under the GCHERA umbrella in the Asia-Pacific region.[2]

The TAP was designed to improve coherence and coordination of Capacity Development (CD) for agricultural innovation in the tropics. It aims to address perceived gaps in previous CD approaches to agricultural innovation, particularly the Agricultural Knowledge and Information Systems (AKIS) perspective sometimes viewed as a rather limited linear approach where the formal research system (mainly government experts or agencies) was the only (or principal) supplier (in a linear, top-down, one-way) of agricultural innovation knowledge or technologies to farmers. Another concern leading to the TAP was that National Agricultural Innovation Systems (NAIS) in most low-income tropical countries were not adequately connected to the local agricultural sector or economy. NAIS research priorities, and associated education and training or extension services, also appeared to lack alignment with priorities of farmers, farm cooperatives and agribusiness (Aerni, Nichterlein, Rudgard and Sonnino, 2015, pp. 831, 834-5).

The TAP *Common Framework on Capacity Development for Agricultural Innovation Systems: Synthesis Document* conceptualized CD for AIS with multiple actors. The AIS includes: a) Macro-level or overarching influences such as science and technology policy and the political system or more specific enabling environments just as agriculture or innovation policies, or institutions and practices that influence mind-sets; and b) the AIS itself comprised of different actors or stakeholders including: 1) **research and education institutions**; 2) bridging institutions such as extension providers; and 3) business and enterprise, agribusiness and consumers among them as the borrowed conceptual diagram below suggests (TAP, 2016, p.2).

[2] **GCHERA Asia members** are: Asian Association of Agricultural Colleges and Universities (AAACU): Asia Pacific Association of Agricultural Research Institutions (APAARI) with has some HEI members among others; Central Asia and South Caucuses Agricultural University Consortium for Development (CASCADE): Education Professional Committee of the Chinese Association of Agricultural Science Societies (EPC of CAASS); Indian Agricultural Universities Association (IAUA) and Society of Arab Colleges of Agriculture (SACA). **GCHERA's Pacific region** includes on HEI network member: the Australian Council of Deans of Agriculture (ACDA). The only other individual TAP-HEI members in Asia were: Chinese Academy of Agricultural Sciences (CAAS) and Chinese Academy of Tropical Agricultural Sciences (CATAS).

Figure 1 | **Conceptual diagram of an Agricultural Innovation Systems**




*Source:* adapted from Aerni *et al.*, 2015.

TAP paints a picture of a complex Agricultural Innovation System (AIS) with many dynamics or relationships described in Figure 1 above. The TAP advocates a systems approach to capacity development and agricultural innovation in cooperation with small farmers, farm cooperatives and agribusiness as end-users of agricultural research products or services as well as co-innovators, potentially linking all parts of the agri-food system value chain. The TAP Common Framework also recognizes three interdependent dimensions - Individuals, Organizations and the Enabling Environment - and the need to understand relationships among them as a way to strengthen system-wide capacity (TAP, 2016, p. 5). Moreover, the framework suggests five key capacities are required: 1. "Capacity to Navigate Complexity" involving a shift in mindsets, attitudes and behavior to comprehend the larger system away from a reductionist thinking only; 2. "Capacity to Collaborate" among different enabling actors with different perspectives to managing conflicts and managing diversity while combining individual skills and knowledge to build synergetic partnerships and networks; 3. "Capacity to Reflect and Learn" bringing stakeholders together, designing and leading critical reflection and collaborative learning leading to action and change; 4. "Capacity to Engage in Strategic and Political Processes" for transformational change; and 5: "Capacity to Adapt and Respond in order to Realize the Potential of Innovation." The TAP framework views these five capacities as essential to shift focus away from reactive problem solving to co-creating a better future (TAP, 2016, pp. 5-6).

AIS also operate amid different types of "enabling environments" (policies, investments, attitudes, institutions, etc.) as well as individual functional and technical capacities or skills. The converse (an important challenge for TAP) is to understand inhibiting factors or "disabling" constraints with capacity needs or gaps to AIS. One TAP assumption has been that improved or alternative approaches to agricultural innovation in low-income tropical countries can contribute to more effective and sustainable use of natural resources while reducing hunger and poverty

through economic development in rural areas. The TAP suggests increased capacities are needed especially to enable small-scale farmers to collectively act, innovate and broaden or up-scale their innovations for wider development impacts, particularly in low-income tropical Asian countries where poverty is most pervasive. One example of a constraint in HEIs among least developed countries' (LDCs') tertiary agricultural education systems was their poor response to production needs reflected in outdated curricula for degrees or postgraduate courses, as well as technical and vocational education and training that do not provide adequate skills for professional development (Aerni, Nichterlein, Rudgard and Sonnino, 2015, pp. 831, 834-5).

The TAP concept in Figure 1 above clearly acknowledges the importance of **education** (primary secondary, tertiary and vocational) as a critical element of AIS (Aerni, Nichterlein, Rudgard and Sonnino, 2015, p. 834; and TAP, 2016, p. 2). TAP also underscores the vital importance of agricultural innovation **knowledge** (complementing, or a product of, education systems or personal and institutional learning processes) to address practical problems facing farmers, communities and the planet from climate change to population impacts on environment and food security with a need to sustainably manage natural resources ensuring more reliable crop yields. The TAP has also suggested a Monitoring and Evaluation (M&E) framework integrated with needs assessments, and performance reviews around the five key capacities proposed above (TAP, 2016, pp. 13-14). But so far the TAP has not elaborated well implications of its CDAIS conceptualization or M&E framework for the HEI sector. Moreover, and problematically, even the new *TAP Action Plan 2018-2021,* which importantly recognized the higher education sector as a future work area that needs more attention, does not refer at all to SDGs. This needs to be rectified.

**TAP alignment with HEIs and SDGs**

GCHERA has been the main HEI network actor in the TAP aiming to address innovation challenges in the tertiary sector through a multi-disciplinary approach and capacity development in collaboration with its members and other partners. GCHERA's current action plan is committed to curriculum review and innovation to advance science (both natural or life and social sciences) including collaboration to develop or strengthen interdisciplinary degree programmes. GCHERA also aims to encourage and facilitate entrepreneurial skills and competencies for agriculture graduates in universities that promote environmentally sustainable and ethical values (GCHERA, 28 March 2016, pp. 5-7, 9).

GCHERA and APAARI recently collaborated in online learning activities such as a 2017 "Webinar with Universities on Capacity Development for Agricultural Innovation. " Their report noted, for example, GCHERA's beginning of a pilot project, focused on curricula reform and pedagogy, to better prepare graduates to be leaders in tackling global challenges, such as poverty reduction, food and nutritional security and environmental sustainability through improving "soft skills" incorporating key elements of the EARTH University (Costa Rica) model founded on four pillars: (i) technical and scientific knowledge; (ii) ethical entrepreneurship; (iii) personal development, attitude, and values; and (iv) social and environmental awareness and commitment. The teaching and learning process is based on experiential learning and student-centred learning (APAARI, 2017, p. 5). Students or youth are

of course vital sub-actors in HEIs. What and how they learn about agriculture, agrifood systems and innovation is critical to a sustainable future for them and the planet. So in addition to GHERA another important TAP member is the Young Professionals for Agricultural Development (YPARD) network. HEIs, students and youth should all be seen more broadly as important and in many respects **essential** TAP and CD actors influencing many others in the context of innovative knowledge, practices, partnerships, learning processes, products and outcomes that can be studied and applied contributing to achieve various global SDGs by 2030.

Problematically, however, none of the SDGs defined sustainable agriculture (SA) or sustainable agri-food systems (SAFS) concepts or practices or provided a clear mandate or guidance for HEIs. **SDG 2** itself is a noble goal: "***End hunger, achieve food security and improved nutrition and promote sustainable agriculture.*** " But SDGs champion innovation mainly in the context of SDG 8 (for job creation, entrepreneurship and employment) and SDG 9 (scientific research for new technologies amid industrialization). Innovation itself was not indicated as a direct priority in either SDG 2 or in SDG 4 (quality education including the tertiary sector implicating HEIs directly). Moreover, since SDG 2 has not explicitly defined SA (in principle or even operationally well) there is still a glaring need for clearer targets and measurable indicators to guide HEI teaching, research and extension services programmes in ways that can help evaluate, measure, adapt or replicate agricultural and agri-food systems sustainability outcomes while encouraging and assessing innovations. But a broader critique of innovation in the SDGs is that it defaults largely to technology centric or dominant approaches, without adequately addressing multi-disciplinary, social, educational, personal or other "soft" dimensions of the innovation process or non-technical actors. Nonetheless, governments and the UN committed to facilitate a "multi-stakeholder forum on science, technology and innovation" in the SDGs.

In view of the above, the TAP Action Plan 2018-2021 importantly includes reference to HEIs. However, it does not refer to SDGs or how HEIs could contribute to SDG monitoring, reporting and evaluation. An update or amendment to the TAP Action Plan could include SDG-related work building on useful analysis initially done in early TAP needs assessments including surveys and consultations for the Asia Pacific region. Future TAP work could better link SDG monitoring, reporting and evaluation in partnership with HEIs to strengthen multi-disciplinary scientific knowledge and practical learning for sustainable agriculture and food systems innovations.

**Summary Findings for Asian HEIs from First TAP-AIS Needs Assessment**

FAO-TAP commissioned the Southeast Asian Ministers of Education Organization (SEAMEO) Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) to conduct the first Asian assessment. SEARCA is a regional intergovernmental treaty organization with agriculture education, research and capacity building part of its core mandate. The first SEARCA-commissioned TAP study of Asia was limited to a regional survey focused on just five low-income LDCs in the South/Southeast Asia tropics, predominantly agriculture-based economies (i.e. Cambodia, Laos, Myanmar, Timor-Leste and Bangladesh). The first survey generated, a total of 71 respondents from Cambodia (11), Lao PDR (5), Myanmar (25), Bangladesh (13) and Timor-Leste (17) which participated using an instrument developed by

FAO-TAP. Among the respondents were 23 universities or 32% of the sample. Results were validated through focus group discussions in a 2013 regional consultation led by SEARCA.

Some core challenges for HEIs identified in the first TAP Asia survey were "Lack of responsiveness to farmer needs" and "low rates of technology/knowledge exchange between universities and practitioners." The SEARCA survey identified a "limited number of academic courses/degrees promoting innovation in agriculture" as a significant concern. The study also noted (among many other issues) knowledge and capacity gaps for innovation to address environmental challenges through, for example, agro-ecological techniques, biotechnology and solar technology. The SEARCA-TAP study also highlighted a "disconnect between research and extension systems as well as between researchers and policy makers." But detailed implications for HEIs in particular were not discussed or how higher learning or research can better be conducted with or applied to farmers.

SEARCA's main conclusions and recommendations implicating HEIs from this first TAP Asia assessment were that CD for agricultural innovation among the LDCs needs to especially better include a focus on curriculum for agricultural/vocational and extension education. Finally, the SEARCA study noted that "Higher education institutions seem to have not achieved a visible level of influence in the NAIS of each country." One key recommendation was the need for a "More responsive agriculture education curriculum" among HEIs suggesting that this work should be included in future TAP Policy Dialogue/TAPipedia (Cardenas and Bellin, October 2013; pp. 5, 15, 27, 51, 69, 71). But in sum with respect to HEIs the main (seemingly pessimistic) conclusion of the first Asian TAP assessment was that "there were generally very low expectations regarding the contribution of universities to AIS" (Aerni, Nichterlein, Rudgard and Sonnino, 2015, p. 842; reporting results from Cardenas and Bellin, October 2013).

At the same time, the present paper importantly suggests that very low expectations of universities (perceived among survey respondents) do not imply that HEI capacities for AIS in low-income countries should not be strengthened. In fact the implication is just the opposite. There is a need for better understanding HEIs in LDCs with multiple CDAIS issues while providing more support and technical cooperation (South-South, Triangular and other modes) for HEIs while assisting in reform of universities and agriculture curricula.

The above summary of HEI themes in the first TAP Asia needs assessment (particularly identification of weak HEI capacities for agricultural innovation, research and curricula especially in LDCs) barely scratches the surface of key policy issues, academic reform needs and practical challenges requiring closer study and focus for future TAP-CD project planning in partnership with universities and colleges. Since the first Asian TAP assessment did not focus specifically on HEIs (except for including them among other stakeholders) one key question arising and needing further attention, is how best to do improve the TAP to better incorporate HEIs as key actors in future AIS work with FAO, TAP and APAARI, as well as especially GCHERA and YPARD as charter TAP members. Engaging GCHERA especially would be helpful in such future work given several hundred individual HEIs in its Asia-Pacific network.

**Agricultural Innovation Systems (AIS) Concepts/Literatures Implicating HEIs**

The present paper focuses on understanding AIS concepts and issues most relevant for HEIs as sub-components with varied scientist views from different disciplines, fields, and paradigms, ideas or approaches for realistic, appropriate agricultural innovation goals or pathways toward economic, social or environmental sustainability. HEIs should be viewed as key and unique AIS **actors**. Innovation **activities**, processes or subsystems may also be distinct from or include HEIs reflected in various forms of agriculture education and training, learning, research and capacity development or types of institutions with some overlapping issues in farmer extension. For example, the World Bank defined an innovation system as:

> …as a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance. *The innovation systems concept embraces not only the science suppliers but the totality and interaction of actors involved in innovation.* It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways (World Bank, 2006, pp.vi-vii).

With respect to HEI related innovation systems perspectives and challenges various case studies the Bank noted with concern that often "university curricula have failed to keep up with the needs of a thriving agroindustrial sector. " Local agricultural universities in some cases have also been sources for common information about agricultural production costs (and other data) while more access to and coordination and sharing of such knowledge among actors could be improved. One intervention principle proposed by the Bank was to focus on selecting clusters of activities that could receive support for further innovation to satisfy both economic and social goals. One potential HEI "innovation cluster" implied the need for reforming university curricula while involving the private sector more in university governance and establishing internship and exchange programs between industry, universities, and others. The study also suggested enhancing university participation in National Agricultural Research Systems (NARS) while establish training and research facilities jointly sponsored and governed by the public and private sector, including postgraduate programs (World Bank, 2006, pp. 44, 80, 86-87, 105).

Later the Bank elaborated the scope and types of agriculture education and training currently extant or requiring strategic or increased investment to support universities (both specialized agriculture HEIs and comprehensive, multipurpose HEIs) as core actors in AIS. One rationale was that agricultural education and training had already been a significant creator of capacity and supplier of human resources that populate key segments of AIS and enable the system to function effectively, but that past neglect and low levels of investment in agricultural education and training prevented equipped graduates to meet the needs of modern agriculture and contribute to AIS. One concern was not only inadequate technical knowledge, but graduates lacking tools or "soft" skills to recognize and apply innovative ideas and technology, promote useable knowledge, catalyze AIS actor communication, and provide intelligent feedback to researchers and investors. Other priorities included the need to reform curricula and teaching

methods; build capacity and stakeholder partnerships for technical education and training; and developing effective in-service and life-long learning capacity among public workers to facilitate ICTs, learning, research, and networking for agricultural education and training with knowledge content that better meets stakeholders' needs. Moreover, the Bank noted specific areas needing improvement, such as deteriorating physical infrastructure, overcrowded classrooms and residential accommodations, exodus of teaching staff, outdated curricula, inadequate teaching and learning materials, and graduates' limited skills for employment options, as well as low education levels in rural areas (World Bank, 2012, pp. 107-178, passim).

Another lens though which the challenge is whether agricultural education and training or AIS investments are "pro-poor" or small farmer first, or if they strengthen women's and rural education as a means to improve innovation learning and research partnerships, ensure quality and broaden opportunities especially among the marginalized (note e.g. Berdegue, 2005; Atchoarena and Holmes, 2004). But even just ensuring rural peoples and areas are better integrated with urban centers or have access to university education to reduce inequality or raise incomes is not enough without addressing concerns such as food insecurity, natural resource degradation and climate change (Brooks and Loevinsohn, 2011). Some green revolution technologies from the 1960s on led by international organizations in partnership with universities included agricultural innovations that saved millions of lives but had some problematic environmental, health and social effects (Nelles, Aug 2011). Others have argued elsewhere that "green revolutions are not necessarily pro-poor or environmentally benign… achieving favorable outcomes requires appropriate and supporting government policies" (Hazell, November 2009). Sometimes development and adoption of new "technology" has also been (with little critical analysis) equated with diffusion of promising innovations, but their actual value and relevance should be assessed with respect to changes on farm and real impacts on productivity, sustainability and poverty reduction (Röling, 2009, p.84). Deciding on what types of agri-food innovation are most effective or useful, through what means or sustainability goals, or targets and measurement tools is important.

For example, one promising approach is the Technology Innovation Platform (TIPI) of the International Federation of Organic Agriculture Movements (IFOAM), now called "Organics International," which has collaborated with universities and others to build a global platform for organic farming research, innovation and technology transfer. Members of TIPI-IFOAM include university departments or faculties, which conduct research on organic food and farming systems.[3] TIPI has already documented examples of many universities world-wide, including in Asia, that conduct organic agriculture research and innovation (Niggli, Willer and Baker, 10 Feb 2016). TIPI members' research includes study of different pathways needed to develop new technologies compatible with organic farming principles to increase crop yields for food security or enhance health and improve farmer incomes while protecting environments (Niggli, Andres, Willer and Baker, September 2017). A similar, complementary perspective from FAO also argued that:

[3] Although The Research Institute of Organic Agriculture (FiBL) is not a university itself, it is a leader in TIPI-IFOAM facilitating academic research partnerships. FIBL is also a TAP member.

> (FAO's initiative for) Scaling up agroecology matches the transformative ambitions of the 2030 Agenda and will support countries to meet their commitments. ***Transitions require innovations*** in policies, rural institutions and partnerships, as well as in the production, processing, marketing and consumption of nutritious food, leading to sustainability and equity throughout the entire food and agricultural system. ***Scaling up agroecology requires overcoming key challenges while harnessing emerging opportunities***…(FAO. 2018, p. 2).

Other definitions and analyses have importantly underscored that agricultural innovation is not value free, or proceeds in a straightforward linear path (Klerkx, van Mierlo, and Leeuwis. 2012). In sum there is no one size fits all approach to stimulating agri-food innovation or strengthening AIS, with universities or other stakeholders. There are many players, potential innovation drivers, and pathway options. Moreover, there are different agriculture innovation paradigms and assumptions sometimes conflicting. The TAP perspective appears largely complementary to a variety of conceptualizations from the World Bank, EU, and some academic studies over the past decade or so. One common theme seems to be broad agreement that AIS needs to move away from a linear top-down, one-way approach relying only on knowledge or innovation produced or promoted by scientists, governments and other "experts." Instead AIS should better engage farmers and other stakeholder in two way learning and dialogue (e.g. farmers-scientists) which can lead to sustainable, affordable and realistic innovations benefiting a wider number of rural communities, the environment and farmers long term.

FAO's strategy on strengthening AIS complements the TAP-CDAIS approach. FAO (which also hosts TAP) suggests key areas of intervention for innovation needed cut across multiple areas of work (e.g. research and extension, agroecology, biotechnology, green jobs, resourcing, etc.) to achieve sustainable rural development while promoting an enabling environment for agricultural innovation among other means (COA, July 2016). Agro-ecological approaches in particular implicate key actors or stakeholders such as the tertiary sector which (with others) can promote social innovation and participatory research, as well as various types of knowledge and education on agroecology through research, teaching and curricula, with diverse approaches to learning, development and extension services. But whether agroecology and biotechnology are compatible or complementary innovation strategies is contentious. Such issues and concerns can't be easily reviewed in this short paper. However, one critical role for HEIs is to provide objective intellectual, evidence-based study and diverse learning platforms to debate, teach about and evaluate the most appropriate data, models and tools for AIS knowledge, policies and applications. Academia can also assist policy makers and farmers to understand circumstances which best facilitate agri-food system sustainability and assess impacts of agri-food innovations.

**Selected Models and Best Practices for Agrifood Innovation Systems in HEIs**

Universities have often not well enough understood, documented or analyzed actors in agricultural innovation. A few examples examining European universities, for example, were addressing a fragmented AIS by Latvia's University of Agriculture, seeking closer cooperation and farmers' organizations, cooperatives, professional associations and the commercial sector in knowledge exchange, training and advice with new models of cooperation emerging to bridge

the gap between the demand for and the supply of knowledge. Among various points of observation and concern were noting universities as catalysts for agricultural innovation, but that the issue seemed to be poorly documented, understood or analyzed. Initial recommendations or opportunities identified through brainstorming for the European context were, for example:

- Novelties can emerge in areas where research has not yet been active. Researchers can collaborate with innovators within a **participative framework**. New outcomes can be combined with existing know-how.

- **Strengthen and study links** between regional universities, research centres, extension organizations, farmers' organizations, municipalities, market actors and other stakeholders.

- Profiling of university expertise in agriculture, food and rural development.

- Stimuli to offer research expertise in **user-friendly ways** (research briefs, summaries of findings, consultations, idea *shops*, seminars, *grey* literature etc.)
(Dockès, Tisenkopfs and Bock, April, 2011, p. 38**).**

Elsewhere, others have documented how universities were central to development and implementation of several among the top 20 innovations world-wide identified by the Technical Centre for Agricultural and Rural Cooperation (CTA)[4] which clearly benefitted smallholder farmers. University influencers among those types of innovations were, for example:

- Studies and new knowledge with research team from Sotuba Regional Agricultural Research Centre, Institut d'Economie Rurale, Mali and University of Liège, Belgium led to production of a new and highly effective bio-herbicide alternative to dangerous agrochemicals harming fisheries and plants to tackle to water hyacinth.

- A lecturer and a research scientist at the Department of Animal Science, University of Cape Coast, Ghana, capitalised on the genetic characteristics of local chicken breeds to give them a greater tolerance to heat, making them productive in a hot, humid, climate.

- Haiti's Ministry of Agriculture, the Christian University of Northern Haiti and several international partners including the University of Georgia, Cornell University, and the University of Florida contributed to developing and supporting fortified peanut butter with an effective strategy for controlling aflatoxin contamination in ground nuts saving the lives of over 120,000 children.

- Kenya Methodist University, Kenya And Egerton University, Kenya were among others from the East and Central Africa Bean Research Network (ECABREN) to use Farmer-guided selection to understand which beans were most suitable for which areas, and also

[4] The Technical Centre for Agricultural and Rural Cooperation (CTA) is a founding TAP member.

to scale up the cultivation of the improved bean varieties suitable for a wide range of farming conditions and locations in East and Central Africa (ECA) were developed by breeders and agronomists.

- The Consortium for enhancing University Responsiveness to Agribusiness Development (CURAD), a public-private partnership initiative to attract young agribusiness entrepreneurs is involved in implementation of the National Coffee Policy to empower over one million coffee farming families in Uganda over the next decade. Investment is to increase Uganda's domestic coffee consumption while reducing the sector's dependence on export markets and will promote a Farmer Ownership Model adopted for agribusiness development in other sectors besides coffee.

- Fourah Bay College, University of Sierra Leone researchers helped develop a steam dryer to enable smallholders in sub-Saharan Africa to increase their production of cassava flour, access higher-value markets and improve incomes showing how steam can be solution to currently inadequate solar-drying methods in some cases.

- University of Nairobi researchers developed a fodder production and supply service based on a hydroponics system involving sprouting seeds in mineral-rich solution rather than soil, leading to greater production with less water and area, an innovation already been adopted by around 200 Kenyan dairy farmers.

The above were university-led innovations. There were 251 examples in total of different kinds submitted to CTA from 49 countries. Four 'types of innovation' were identified/categorized: university-led (17% of all cases); technological (53%), process (24%) and social (4%) that benefit smallholder farmers in Africa, Caribbean and Pacific regions (ACP) countries where CTA operates (CTA, 2015, pp. 28-29, 36, 44, 46, 53, 57, 61, 67 passim). The above Top 20 selected by CTA were all from Africa. No such reviews have been done for Asia. But there are likely thousands of possible examples that one could document and assess of university agri-food innovation actors. One academic study, for example, noted an "Innovation Community" platform launched in 2015 at Indonesia's Bogor Agricultural University (IPB) with hundreds of innovative products or other outputs in the 2008-2015 period generated by a Business Innovation Center (BIC) and researchers (Nur, Nayyarah, Fauzi and Sukoco, 2017, pp. 13,16).

Other international agencies selectively reviewed Education for Sustainable Development (ESD) innovations in universities albeit with limited mention of agricultural research and education innovations and little documentation of Asia. Nonetheless, one example (again from Africa) is an innovative ESD process being handled within the framework of the Interdisciplinary Climate Change Laboratory of the University of Buea in Cameroon. It was designed to elaborate adequate scientific studies of trends and impacts from which adaptation strategies can be conceived and incorporated with indigenous adaptation approaches with knowledge incorporated into a compulsory course on Civics and Ethics. Agriculture and food knowledge were included as part of a curriculum innovation to transmit knowledge on how more resilient crops and animals are taking over vulnerable species amid climate change and how to transmit adaptation and resilience knowledge to future generations (GUPES-UNEP, October 2011, p. 10). Some students in Cameroon (a

country in 2017 with some 14 % GDP reliance on agriculture) likely came from agricultural families and were able to share academic knowledge with communities. These publically documented cases are from The United Nations Environment Programme (UNEP)-launched Global Universities Partnership on Environment and Sustainability (GUPES).

The TAP itself has facilitated a "stories of change" publication through its CDAIS project. A few Asia-Pacific region stories mention HEI roles in CD and innovation processes. In Bangladesh, the CDAIS project conducted a capacity need assessment workshop. The Bangladesh Agricultural University in partnership with non-governmental organisations among others established Trishal Fish Innovation Platform and collaborated to build new skills and business opportunities that helped diversify from crops to fish products and broader markets. In Laos an expert from Rajabhat University in Thailand assisted CDAIS work in Laos on improving pig production with a study tour of Thailand. Outside Asia, the National Autonomous University of Honduras (UNAH) with various stakeholders was involved in facilitating a cacao innovation partnership in collaboration with CDAIS that led to specialized training, curricula and a diploma about cacao that has improved skills and knowledge for cacao production and marketing for innovative organic fertilizers and cacao products (Pasiecznik, 2018, pp. 39-44; 139, 144, 156).

In collaboration with FAO-TAP APAARI has also been exploring ways higher education can be integral to AIS as a knowledge and information hub, a source of future human capital, a neutral body to provide evidence-based solutions for decision making, a source of up-to-date information to stakeholders, and facilitator of multi-stakeholder platforms and linkages between knowledge and practice for scaling up innovations. For example, APAARI held training workshops on knowledge management and capacity development in Laos and India. Tamil Nadu Agricultural University (TNAU) is now an APAARI pilot site to study AIS challenges, train teachers in India, and assess lessons for others. Expected outcomes from the TNAU workshop and pilot are the beginnings of a policy dialogue process that will create an enabling environment leading to improved agricultural education quality more relevant to changing contexts of agri-food systems today. It is hoped that improved education policies will enhance the employability of graduates, enable youth to create decent, green agricultural jobs and strengthen AIS long-term (APAARI, 2019, passim).

The above examples show how some universities have contributed to CDAIS-TAP work and already are part of enabling environments or have assisted in building individual or institutional capacities with reforms that have enhanced specific knowledge and skills for particular types of agricultural innovations – from fisheries, to pork, to cacao. However, little work yet has attempted to document, synthesize wider implications or impacts of such university contributions or analyze broader HEI roles in a multitude of other types of innovations or how universities contribute to many dimensions of AIS as a whole. A further study is needed.

**University Enabling (or Constraining) Environments for Tertiary Agri-Food Innovation System**

The TAP-CDAIS concept and broader capacity development framework illustrates a complex environment with multiple actors and processes, including education stakeholders as well as political, socioeconomic, environmental and cultural drivers affecting agricultural innovation applications and impacts already demonstrated above. Within AIS generally as noted in Figure 1 some linkages may work well along clear pathways while others are disconnected, weak, dysfunctional or just more aspirational. The same is true within HEIs which themselves are also complex social, political and intellectual environments with multiple actors and processes of many types, with diverse disciplines and departments often working in silos and sometimes with conflicting perspectives or research outcomes.

All topics may not be taught or studied in every HEI, or have innovation outputs, pathways, uptakes or impacts. But some could be typical or relevant to various types of **Specialized Agriculture Colleges and Universities** or post-secondary training institutions historically founded in various Asia Pacific countries to mainly serve national agricultural development and food security, some at times when rural populations outnumbered those in urban centers. Some agricultural HEIs were founded in the national interest given large tracts of land to use as research and teaching farms including mandates to serve local farmers, rural communities and national agriculture development. Some have already been incubators for different kinds of innovations yet to be well documented or analyzed. **General or Comprehensive Multi-purpose Universities** have often been established in urban centers (but some with rural campuses or programs) and may offer agriculture or food systems courses or rural studies. These HEIs can include agriculture or food studies among broader teaching or research topics and service activities. They may or may not have teaching or research farms or provide rural advisory services or farmer extension (note Nelles, 2017, for illustration).

It is not possible to review here the diversity and numbers of HEI actors potentially involved in multiple pathways, enabling factors or constraints implicating AIS. To begin this paper just reflects generally on how TAP and AIS agricultural innovation and sustainability themes can be better understood amid common university governance structures and processes, principal academic mandates and goals, and sometimes conflicting or competing expectations from its core stakeholders or "clients," mainly but not exclusively youth and students seeking degrees, and mostly not related to agriculture or innovation. The proposed Tertiary Agri-Food Innovation System (TAFIS) model in Figure 2 below (which needs correcting or adapting to specific HEIs) presented is of the types of dynamics enabling environments and processes within, across a typical modern public university to achieve SDGs and how this could advance the TAP-AIS agenda. The model illustrates key elements, processes and potential impacts in a typical multi-purpose publicly-founded university which could also apply to many specialized, but degree granting agriculture colleges and universities, especially mandated to work for or with farmers and rural communities. Some features may also apply to private universities or colleges.

***HEI Governance and Influence.*** Most universities are guided as well as funded by national or local state policies and budgets or private interests, but have increasingly been influenced by industry demands for workers in jobs that create profit and growth for corporations. Some are agri-food businesses which provide research grants to academics serving private needs or which may influence faculty or student views in the curriculum or the types of jobs they have access to or can do after graduation. That supply-demand issue, and the many ethical and practical concerns arising, is yet to be well documented or analyzed including what types of agricultural or agri-food innovations universities have already facilitated or their actual impacts on farmers, rural sustainability, youth-student career choice and more. Understanding drivers and constraints, as well as core elements or components of university governance with different types of HEI influences on AIS or implications and impacts on small farmers, rural communities, youth futures or environments is not simple. New research (beyond this paper) is needed.

There are various ways to begin documenting university governance and analyzing how it impacts or impedes agricultural and agri-food innovation pathways and achievement of SDGs. To begin there are at least five main generic (names and combinations differing in each country) groups of guiding Government Ministries and Policy environments relevant to our present discussion: 1) Education; 2) Science and Technology; 3) Industry and Commerce 4) Agriculture, Forestry, Fisheries, and Environment; 5) Labour and Employment. There could be many more if separate, distinct or combined differently. Other relevant Ministries or Departments may also influence university professional schools such as Medicine (e.g. research on pesticides on community health or farmers) or Law Faculties which may affect how some types of agri-food innovation policies or legal instruments are drafted, adopted, promoted or protected (e.g. patent law for new seed or plant varieties) and whether such forms of (biological or legal) innovation may benefit small farmers and families or not, or how they advance and inhibit SDGs.

Moreover, universities and other HEIs often have competing governance visions affected by different political decisions, budget approvals, academic policies, disciplines, or programmes across the core missions of the university. Many large universities usually (with some variation) will have a President and various vice-Presidents, a Board or Governing Council, a Senate, Curriculum Committees, a Research Office, an Industry Liaison office, numerous Department Deans, Strategic Planning processes or documents, Student Affairs liaison, an International Office and also have various Faculty Evaluation mechanisms, Key Performance Indicators affecting international rankings by external reviewers, etc. All of these (and many more) component parts or decision-making processes within a typical HEI can affect AIS and sustainability in different ways. At the same time (with respect to the agriculture sector specifically) typical private agri-food industry goals and labour market demands (with profit and growth objectives to generate new products, services, patents, markets and profits) may have more influence on universities than average citizens, students or farmers. Some private agribusiness corporations have institutionalized lobbying power affecting relevant Ministries, university governance, research, curriculum and Faculty member salaries and incentives.

***HEI Core Missions and Mandates Enhanced***. Most modern universities have three classic core missions: education and teaching, scientific research and public service (Scott, 2006). However, these missions are situated in a much broader academic governance, delivery and evaluation

system amid diverse constituencies and stakeholder demands. For example, the **educational or teaching mission** must be supported by a wide spectrum of administrative and pedagogical and budgetary mechanisms or tools. These include policies, goals, products and practices in HEIs of different types led by different fields or disciplines or departments and governance structures for everything from curriculum approvals to staff recruitment implicating program or course development. Different learning styles and delivery methods affect class-room teaching or online courses and interactive workshops for technical training for recognized credentials in different professional fields. Similarly the **research mission** must be supported by adequate budgets and mandates from the university and national or state governments, donors and others. In many cases there are research offices in universities which support Faculty to conduct studies, collect and analyze data, and publish results (usually important for promotion, tenure, performance indicators and government funding allocations). A Vice-President for Research may oversee this office. Research is important for generating new agricultural knowledge and innovations to improve crop productivity, farmer incomes and health or well-being while at the same time reducing the environmental impacts of agriculture. Finally, the **extension (service) mission** ideally brings educational or teaching resources with research expertise, results or products from universities to serve society at large and communities where they are located. Teaching Faculty are often expected to do research and community work but may not receive credit for their community activities when evaluated for promotions while typical university rankings ignore community service values and sustainable agriculture or food impacts.

Examples of how AIS can be strengthened or applied in **university research** could be, for example through (among many others):

- Data Collection/Documentation and Analysis of Sustainable Agriculture Innovations
- Basic or applied Multidisciplinary Studies of AIS (in/beyond HEIs)
- Laboratory studies of new plant and seed varieties, or production of bio-pesticides and bio-fungicide alternatives to synthetic agrochemicals
- Applied Research (and Teaching) on Campus Farms or rural campuses to test new ideas, innovative products and service approaches or activities
- Scientist farmer partnerships to study Agri-Food Innovations, Applications and Impacts at national, community, ecosystem, watershed or farm levels
- Policy analysis (of Agri-food system innovations, gaps/needs)
- A Center of Excellence (COE) or Multidisciplinary Research Institute (MRI) on campus utilizing various approaches and disciplines to different types of Sustainable Agri-food innovations for specific commodities, technologies, communities, biopesticides, systems, etc. COEs can generate or strengthen ideas, research, outputs, strategies and partnerships

AIS can be strengthened or applied (or adversely affected) in **education** or **teaching** by:

- Understanding, addressing, or reconciling external demands (political, corporate) in tension with pedagogical, learning or agri-food sustainability goals which influence professors or students to study certain topics (unpacked by sociology of higher education)

- New knowledge generated/debated about agri-food systems innovations (but if new knowledge is patented for everything from harvesting technologies to new plant or seed varieties what implications for small farmer affordability or effects on environments?)
- Interdisciplinary teams and evidence-based teaching can provide integrated knowledge and learning about agri-food systems and AIS, discovered with/transferred to farmers
- Curriculum innovations supported by adequate academic policies and reforms could better teach about agri-food systems and types of innovations needed for rural sustainability, improved incomes, and environmental protection
- Encouraging student questions, debate and practical insights for future AIS research designs, evaluation and applied service (with academic credit) in class study, presentations, field projects and exams which can benefit students and farmers together as well as local communities, the wider society and the environment
- Graduate student learning through unique research projects and theses can be strategically focused to help understand agri-food innovation challenges/responses specific to local, environmental, farmer and community circumstances
- Students trained for national agriculture research organizations (NAROs) staffing

AIS can be strengthened or applied through improved **university public service**, particularly with farmers and in rural communities including:

- Improved or new university-based farmer extension offices or services that can facilitate AIS learning and applications in the field
- Continuing or adult education programmes about Agri-Food Innovations (Products, Technologies, farming systems) especially in or targeting rural communities
- HEI Innovations developed in universities, by Faculty and students in partnership with Farmers can be field tested with all partners together to assess long-term impacts and design new research questions and studies from results
- AIS research/teaching converted to useable public goods (open-source, non-patented) knowledge free to all (conflicts/tensions may need reconciliation with private sector)
- Academic expertise in participatory learning methods applied with farmers to improve support systems and enabling environments for AIS
- Innovative (Green) Agri-food jobs or student internships, work training and youth apprenticeships (post-graduation) developed with/co-financed by businesses and donors
- Evidence based (from multi-disciplinary sciences) ***Policy Briefs*** on AIS to inform or lobby university administrations and governments (national, state, municipal)
- Graduate studies/student theses to understand and provide insights for resolving agri-food innovation challenges (crop productivity, income generation, inequality, ecological protection, soil fertility, etc.)
- Students trained in universities to understand AIS and sustainability concerns for careers in NAROs and agri-food jobs generally
- Faculty evaluated for promotion with credit/increased salaries provided for rural community service – scientists working with farmers to co-innovate

Universities can also enable many types of agri-food related innovations in the following sectors, disciplines or activities: Agronomic; Bio-technological; Business Models; Community Development; Conflict Resolution; Curriculum Reform; Democratic- Peer Learning; Farming Systems; Farmer-Scientist Partnerships; Genetic innovations (New plant/seed varieties); Green Campus Food Systems; Green Governance Models; Leadership Collaboration; New Educational/Learning or Teaching Models; New planting or harvesting technologies; Patents/Intellectual Property; Policy Dialogue Platforms with Enabling Policies or governance structures; Social Development innovations (e.g. farmer cooperatives); Teaching/Learning Style alternatives; Tech Knowledge Applied, etc. These and many more areas could be studies, strengthened or enabled in academic environments with adequate capacity development, technical cooperation, policies or administrative support. Agricultural innovations stimulated by the intellectual and sociocultural climate of the university can facilitate uptake or adoption of new approaches and products with potentially positive impacts on agricultural development, food security or safety, health and security of local communities and nation-building as a whole.

However, innovation itself is not a de facto good. Some innovations may work at cross-purposes or contribute to conflict and unwanted consequences. For example, new harvesting technologies developed in HEIs partnering with industry could (if not properly designed or be affordable) lead to worsened environmental degradation or agriculture job losses that favour large agribusiness over small farmers. One could cite many problematic examples. So universities and academic experts, should not just facilitate any innovations, but especially assist multi-disciplinary and cross-sectoral planning and assessments of agri-food innovations in consultation with small hold farmers and rural communities. Such work could be designed with unique targets and indicators (note Spielman and Birner, 2008, e.g. for discussion).

There is a separate but related genre of literature about HEI monitoring, evaluation and sustainability reporting that has emerged over the last decade or so (Adams, 2013; Lozano, 2011). Analysts have not yet paid much attention to agri-food systems learning or research impacts across HEIs or with rural communities or farmers. However, new work on sustainability mainstreaming and reporting in academia could and should be linked to SDGs (see SDSN Australia/Pacific. 2017; and Vaughter, 2018 for analysis of general trends and guidance).

Figure 2 on the next page provides a model to show key elements in a Tertiary Agri-Food Innovation System (TAFIS) illustrating dynamics of a somewhat idealized but typical university (multipurpose or agricultural) in the context of processes and actions implicating achievement of SDGs.

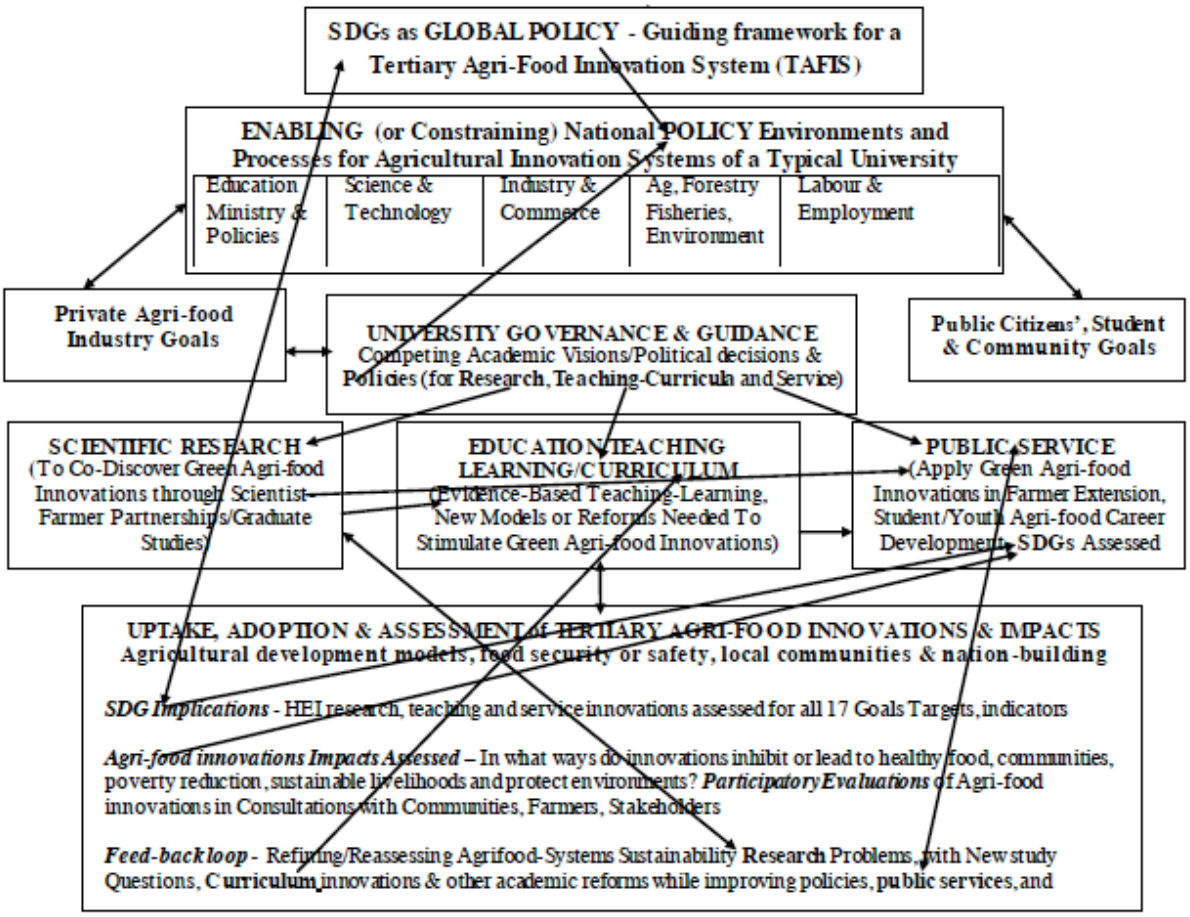



Figure 2: Simple Model of Tertiary Agri-Food Innovation System (TAFIS) dynamics illustrating enabling environments and processes within/across a typical Modern Public University to achieve SDGs (Nelles, Feb 2019)

Universities are complex and unique organizations. The above diagram is simple and generic. Institution-specific elements, detailed components, sub-systems, nuances, and impact pathways would need to be documented and assessed in each HEI as well as for particular SDGs, targets indicators, and impact types. Most of the 17 SDGs are potentially implicated or affected in some way by agri-food innovations (helping to reduce poverty and hunger and inequality while improving health, better water management, protecting environments, mitigating climate impacts and more) through multiple disciplines/fields. Future TAP-AIS studies, could examine a multitude of agri-food system education, research and extension pathways and challenges for HEIs with linkages among the SDGs. New research could compare different national, political, ecological and historical contexts. Studies could collect and categorize various HEI data types (from curricula to research projects to policies) assist priority setting, budgeting and decision-making for agri-food systems innovations among academic administrators and policy-makers.

In sum, universities to strengthen AIS can facilitate better understanding of:

- ***SDG Implications*** - need to analyze HEI research, teaching and service innovations in agriculture or food systems impacts against all 17 Goals, relevant targets and indicators

- ***Agricultural and Agri-food innovations*** – Do they lead to healthy food, communities, poverty reduction, sustainable livelihoods and protect environments, in what ways? - How should this be measured or assessed through what kinds of tools or indicators?

- ***Participatory Planning and Evaluations*** (aligned with SDG monitoring and reporting of agri-food innovations through farmer-scientist partnerships and consultations with rural communities and other stakeholders

- ***New Policies*** **(**analysis of current policy frameworks and drafting of new material based on multi-disciplinary approaches and evidence) to better enable sustainable agri-food innovation adopted by governments and reform HEIs

**Conclusions and Recommendations for Further Study and Actions**

This paper has reviewed some AIS trends and literatures implicating HEIs globally and in the Asia-Pacific region while reflecting on how HEIs can be strengthened to better serve small-hold farmers and rural communities to achieve SDGs. It is intended only as an introduction to some key issues and challenges. It suggests that TAP: (i) works with academia and other partners to take next steps in identifying further research and project development priorities; (ii) gives more systematic attention to HEI roles documenting or strengthening agriculture and agri-food innovation systems; and (iii) gives more attention to SDGs in implementation, monitoring and evaluation.

In closing, the paper has one central message for FAO-TAP, its key partners and stakeholders. Future TAP-AIS planning, projects or programmes should pay much greater attention to HEIs as core agri-food systems actors. The TAP should better recognize universities especially as important incubators, engines and drivers for agricultural innovation, which can address economic, social and environmental sustainability together if provided suitable enabling environments. A variety of new HEI-focused activities of different types should be commissioned to assess and demonstrate HEI roles in achieving SDGs, especially in partnership with small-holder farmers, youth and rural communities. The World Bank in particular could support new work building on previous foundations. APAARI could co-facilitate new Asia-Pacific work in collaboration with FAO, GCHERA and its members, YPARD and other key TAP partners. Subject to available resources, follow-up actions could be as follows:

***New TAP-AIS Project Framing with SDGs***

1. Align future TAP policies and investments in partnership with HEIs or HEI networks to: better support a broader sustainability transition through agro-ecological and allied approaches to achieve SDGs, and amend/revise the *TAP Action Plan 2018-2021* accordingly.
2. Complement TAP activities by and strengthen synergies with FAO's *Scaling-up Agroecology Initiative* and other activities.

***Research-Documentation & Analysis***

3. Conduct new research to document AIS and TAFIS actors, issues, bottlenecks, processes and drivers within/across individual universities or colleges and countries. Produce case studies illustrating how HEI networks contribute to innovation and SDGs with NARS.

4. Utilize the enabling framework in Figure 2 above as a preliminary template for project development and elaborate/adapt or revise it as needed for institutional, national or regional comparative analyses, to conduct case studies and do other related research.

5. Bring data and analysis from HEI and TAFIS mapping (this itself is a basic research project) to assist in priority setting to inform future research, education and extension investments in colleges and universities while improving innovation options and impacts.

6. Invite TAP members and HEI partners to submit examples of models or best practices in AIS and TAFIS. Set up an online registry to share data and resources about academic agrifood innovations and partnerships to encouraging learning exchanges, cross-national multi-institutional research cooperation and academic mobility to stimulate innovation.

***Capacity and Needs Assessments***

7. Conduct in-depth capacity and needs assessments of HEIs with a TAFIS framework through national, sub-regional or Asia-Pacific regional consultations. These could be complemented by online surveys, interviews and small focus-groups to systematically assess and compare existing capacities (Research, curricula, teaching and extension) and identify priority needs to improve HEI science, teaching and field applications or partnerships for agri-food innovations with farmers, youth and other stakeholders.

***Education – Teaching, Learning and Curriculum***

8. Conduct an Asia-Pacific regional mapping of HEI curricula and research projects about agri-food innovation, or for their values in stimulating innovations of different types (technological, social, economic, etc.). Establish an online platform to share syllabi, other learning resources, project documents and research outputs.

9. Encourage and facilitate broader cross-sectoral, interdisciplinary and cross-national collaboration to exchange knowledge and practical examples of best practices in AIS teaching and applied learning (update and impacts) across the Asia-Pacific region.

10. Facilitate policy dialogues (national and regional) on the quality and relevance of current agriculture and agri-food system innovations in education, research, curricula and university-based extension services in Asia-Pacific countries using results to conceptualize necessary reforms and donor support (building on recommendations from the 2013 SEARCA-led TAP study).

***Networking and Partnerships***

11. Establish a Subcommittee or Working Group of TAP (with core members such as GCHERA, YPARD, APAARI and others) to frame a new strategy for HEI engagement, innovation research and capacity-development to design new projects (with suitable donors), document and assess AIS models and best practices in the higher education sector, with special attention to youth, students and rural communities. The Asia-Pacific region could pilot new studies and partnerships aligned by SDG reporting.

12. Facilitate establishment of a Community of Practice (COP) on TAFIS with HEIs leading but as a multi-stakeholder COP with farmers, universities, individual scientists, NGOs, youth and students, and small-business private sector to discuss and share agri-food innovation ideas and strategies for HEIs to help achieve SDGs.

***Reframing Donor Priorities and Investments for TAFIS***

13. Strengthen Donor Collaboration and Investments in TAFIS related work to improve HEI research, education and extension capacities for agri-food system innovation to meet SDGs. The World Bank (as TAP founding member) especially could support new work in collaboration with key donors and HEI partners in the Asia-Pacific tropics. The European Union (EU), Asian Development Bank (ADB) and others could be engaged in future project development.

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