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Improving the capacity of Agricultural Higher Education Institutions to contribute to food security: the iAGRI experience and lessons learned

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ABSTRACT

The Innovative Agricultural Research Initiative (iAGRI) is a long-term investment in agricultural higher education and research capacity in Tanzania funded by U.S. Agency for International Development (USAID) and led by The Ohio State University in conjunction with five other U.S. land grant universities and the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM). Although University contributions to sustainable agricultural development in sub-Saharan Africa have been well documented, for the past several decades, donors and national governments have neglected agricultural higher education institutions. The main goal of the iAGRI project is to improve food security and agricultural productivity in Tanzania by strengthening the training and collaborative research capacities of Sokoine University of Agriculture (SUA) and the Ministry of Agriculture, Livestock and Fisheries (MALF) and has four major objectives: 1) implementing a program of collaborative agriculture research with SUA and MALF; 2) providing advanced degree training in agriculture for Tanzanian graduate students; 3) strengthening the capacity of SUA to develop and implement instructional, research and outreach programs; and 4) promoting cooperation between SUA, U.S. universities, and global south universities. The paper summarizes outcomes of the degree training, collaborative research and institutional strengthening efforts and innovative approaches to institutional capacity development (ICD). iAGRI granted scholarships to 139 Tanzanians to pursue graduate degrees in the agricultural sciences, with half studying at U.S. universities and half studying at RUFORUM affiliated universities in Africa and India. Nearly half of the candidates were women. Although human capacity development (HCD) is important, it is not a substitute for ICD. Approaches used to promote ICD are discussed including improved planning processes, organizational experiments, and promotion of innovations and linkages to the private sector.

Key words: Feed the Future, iAGRI, Tanzania, USAID

RÉSUMÉ

L'Initiative de Recherche Agricole Innovante (iAGRI) est un investissement à long terme dans renforcement des capacités d'enseignement supérieur agricole et de recherche en Tanzanie. Le projet est financé par l'Agence Américaine pour le Développement International (USAID) et est dirigé par l'Ohio State University en collaboration avec cinq autres universités américaines à vocation agricole, et le Forum Régional des Universités pour le Renforcement des Capacités en Agriculture (RUFORUM). Bien que des contributions universitaires au développement agricole durable en Afrique sub-saharienne, ont été bien documentées, depuis plusieurs décennies, les bailleurs de fonds et les gouvernements nationaux ont négligé les établissements d'enseignement supérieur agricole. L'objectif principal du projet iAGRI est d'améliorer la sécurité alimentaire et la productivité agricole en Tanzanie, en renforçant les capacités d'enseignement et de recherche collaborative de l'Université d'Agriculture de Sokoine (SUA) et le Ministère de l'Agriculture, de l'Élevage et de la Pêche (MALF), et a quatre objectifs spécifiques: 1) mettre en œuvre un programme de recherche collaborative sur l'agriculture avec SUA et MALF 2) offrir une formation d'études de troisième cycle en agriculture aux diplômés Tanzaniens; 3) renforcer

la capacité de SUA à développer et à mettre en œuvre des programmes d'enseignement, de recherche, et de sensibilisation; et 4) promouvoir la coopération entre SUA, les universités américaines, et les universités des pays du Sud en développement. Le document résume les résultats de la formation du cycle supérieur, la recherche collaborative et les efforts de renforcement des institutions, et des approches novatrices pour le développement des capacités institutionnelles (ICD). iAGRI a accordé des bourses à 139 Tanzaniens pour poursuivre des études supérieures dans les sciences agricoles, avec la moitié des études se faisant dans les universités américaines et la moitié des études se faisant dans les universités Africaines affiliées à RUFORUM et en Inde. Près de la moitié des candidats étaient des femmes. Bien que le développement des capacités humaines (HCD) soit important, il n'est pas un substitut à l'ICD. Les méthodes utilisées pour promouvoir l'ICD sont discutées, y compris un meilleur processus de planification, des expériences organisationnelles, et la promotion des innovations et des liens avec le secteur privé.

Mot Clés : Feed the Future, iAGRI, Tanzanie, USAID

INTRODUCTION

The Innovative Agricultural Research Initiative (iAGRI) is a long-term investment in agricultural higher education and research capacity in Tanzania funded by U.S. Agency for International Development (USAID) under the Feed the Future initiative. The iAGRI is led by The Ohio State University in conjunction with five other U.S. land grant universities and the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM). The aim of iAGRI is to assist Sokoine University of Agriculture (SUA) and the research institutes of the Tanzania Ministry of Agriculture, Livestock, and Fisheries (MALF) to advance their capacity to respond to client needs in the rapidly expanding agricultural markets, in order to ultimately improve food security and agricultural productivity in Tanzania and the greater East African region.

Agricultural development is fundamental to economic growth and poverty alleviation in Sub-Saharan Africa (SSA). In these largely agrarian nations, the food and agriculture sector serves as the primary source of livelihood for 65% of the population, contributes 30 to 40% of GDP and accounts for almost 60% of export income on average across the region. Yet in many of these countries, low agricultural productivity, low incomes, malnutrition, and food insecurity persist. University contributions to sustainable agricultural development in sub-Saharan Africa have been documented (Eicher, 2004; Bloom, 2005; World Bank, 2007; Montenegro and Patrinos, 2013), but many examples are unreported because of weak information systems and communication channels. In the knowledge-based

global economy of today, any country that does not produce well-educated people will find it increasingly difficult to take advantage of emerging technologies such as biotechnology and genomics and to integrate and use science as a development tool. Strong agricultural higher education institutions (AHEIs) can address development challenges through new technology generation and innovation, by training the next generation of scientists, educators and leaders, and by transforming universities to be responsive to the emerging needs of the economy. Investments in human and institutional capacity provide the foundation necessary to sustain agricultural growth and transformation (Ojijo *et al.*, 2016).

For the past several decades, donors and national governments neglected AHEIs in SSA and their contributions to agricultural growth and national development (World Bank, 2007; Lindow, 2009). Many factors have contributed to this neglect including the perception among donors that investments in primary and secondary education contributed more than tertiary education to economic growth and poverty reduction, shifting donor priorities (e.g., more emphasis on health improvement and poverty alleviation), and donor disillusionment with the non-sustainability and limited development impact of previous long-term degree training and institution building programs (Bloom *et al.*, 2005). Faced with stagnant or declining national investments for higher education and burgeoning undergraduate enrollments, African AHEIs were left with overcrowded and deteriorating facilities, depleted faculty numbers, and diminished instructional and

research capabilities. As a result, public concerns mounted about the ability of universities in general and AHEIs in particular to meet the emerging needs of society and contribute to economic growth (World Bank, 2007).

More recently, there has been a resurgence of interest among donors to revitalize AHEIs. There is broad-based recognition that these institutions require support to replenish dwindling human resources and to adjust training, research and outreach programs to address changing demographic, food production and consumption trends and an emergent market-driven agriculture (World Bank, 2007). Changes in the agricultural production landscape are impacting and being impacted by these trends resulting in changing labor market needs, market organization and production patterns including an increasingly important role for the private sector in the provision of improved technologies, innovation and the organization of input and output markets. These emerging value chains, which link producers with end-use markets, provide the infrastructure for an agricultural transformation in SSA, to which AHEI's must respond and contribute to in order to remain relevant and attract new sources of revenue.

The iAGRI is the joint response of the governments of Tanzania and the United States to Tanzania's low-level of productivity in agriculture, high dependence on agriculture for employment, and rapidly growing population. The main goal of the iAGRI project is to improve food security and agricultural productivity in Tanzania by strengthening the training and collaborative research capacities of Sokoine University of Agriculture (SUA) and the Ministry of Agriculture, Livestock and Fisheries (MALF). The project has four major objectives: 1) to implement a program of collaborative agriculture research with SUA and MALF; 2) to provide advanced degree training in agriculture for Tanzanian graduate students; 3) to strengthen the capacity of SUA to develop and implement instructional, research and outreach programs in agriculture; and 4) to promote cooperation between SUA, U.S. universities, and global south universities.

It is the goal of iAGRI to strengthen SUA's linkages with the private sector, government, civil society, and other stakeholders in Tanzania. A focus on external linkages was established during the first year of the project in a thorough stakeholder assessment of training and research needs. Through this assessment, the project management identified eight themes for collaborative research and eight areas of study for degree training.

Training

iAGRI has granted scholarships to 139 Tanzanians, comprised of 71 females and 68 males, to pursue graduate degrees in the agricultural sciences, with approximately half studying at U.S. universities and half studying at RUFORUM affiliated universities in Africa and India. Out of this total, 21 were placed in PhD programs and 118 in MSc programs. In addition to funding for coursework and research, students are provided with dual advisors, one from their host university and one from Tanzania, leadership training, and specialized seminars and laboratory opportunities. Examples of research by students include the identification of maize varieties resistant to maize lethal necrosis, development of micro-nutrient fortified common bean varieties for vulnerable segments of the population, and low-cost pest management and postharvest technologies. The students' research covers a wide range of food system problems involving the disciplines of agricultural economics, agronomy, soil science, plant protection, engineering, nutrition, and extension education. Responding to increasing youth unemployment, iAGRI has initiated activities to strengthen entrepreneurship skills and practical training in agricultural mechanization, and a technology development program for young innovators.

Women's empowerment in leadership and research is a major area of emphasis in the training and institutional capacity building components of iAGRI. This includes leadership training and a mentoring and sensitization program aimed at increasing the acceptance of women in management positions and senior roles. In an effort to increase women's involvement in agricultural and nutrition sciences and in food-

system leadership in Tanzania in the future, iAGRI awarded 51% of its long-term training scholarships to women. As shown in Table 2 below, this proportion of females stands in sharp contrast to the current norm in Tanzania. At Sokoine University of Agriculture, just 20% of the faculty and 30% of the students are female. Among all agricultural researchers in Tanzania, just 25% are female, according to the Agricultural Science and Technology Indicators database (ASTI, 2016).

Training individuals is important but it is not enough if training is intended to be transformative. Building capacity of the institutions in which the trainees will work when they graduate is also important. Poorly functioning universities, research institutes, government ministries, and companies are unable to harness much of the talent of returning Masters and PhD graduates. Thus, the iAGRI was designed to respond to some of these challenges.

Table 1: iAGRI Degree Training Placements and Graduates

Location of Study	Placed in Degree Program			Graduated as of August 2016		
	MSc	PhD	Total	MSc	PhD	Total
United States ¹	55	15	70	52	9	61
Africa Outside Tanzania ²	27	5	32	8	1	9
Tanzania ³	30	1	31	12	0	12
India ⁴	6	0	6	5	0	5
Total	118	21	139	77	10	87

¹Ohio State University (lead), Iowa State University, Michigan State University, Tuskegee University, University of Florida, Virginia Tech. Together, they constitute the Ohio State University Consortium providing technical assistance through iAGRI.

²RUFORUM-member universities: Egerton University (Kenya), Jomo Kenyatta University of Agriculture and Technology (Kenya), Kenyatta University (Kenya), Lilongwe University of Agriculture and Natural Resources (Malawi), Makerere University (Uganda), Stellenbosch University (South Africa), University of Nairobi (Kenya), University of Zambia, (Zambia)

University of Zimbabwe (Zimbabwe)

³Sokoine University of Agriculture, also a member of RUFORUM.

⁴Punjab Agricultural University

Table 2: Female and male percentages in iAGRI scholarship pool compared to current Norm in Tanzania

	Female (%)	Male (%)
Faculty of Sokoine University of Agriculture	20	80
Student Body of Sokoine University of Agriculture	30	70
Agricultural Researchers in Tanzania ¹	25	75
iAGRI Students and Graduates	51	49

¹ Data from Agricultural Science and Technology Indicators (ASTI).

Institutional Transformation

iAGRI is partnering with SUA in a major transformation of the University. The goal of the transformation is for the institution to realign itself internally so it can better respond to the needs of external stakeholders and students. In the past, SUA produced graduates mainly to serve as government research scientists and extension agents. Today, the University's mission has

shifted towards meeting the skill, technology, and information needs of the commercial agricultural and agribusiness sectors.

iAGRI's approach to institutional transformation involves change at multiple levels. The highest level focuses on the strategic direction of the University but change at that level is only a paper exercise unless trust and enthusiasm have been

built throughout the institution. To promote a climate of change that would ultimately facilitate changes in the overall strategy of the University, iAGRI worked with leaders at multiple levels to engage internal stakeholders in the design and implementation of organizational experiments following a three-stage process. The final stage aims to achieve sustainable changes in the formal systems of the University. As such iAGRI supports various units at SUA to develop institutional capacities in the areas of leadership, demand-driven services for students and faculty, improvement of processes and administrative practices, and technologies and information for external clients. The result of the many organizational experiments undertaken throughout the University with iAGRI's assistance is an improvement in support systems and facilities, greater organizational efficiency, improved quality of teaching and research, and a change in mindsets and institutional culture that facilitates sustainable change.

The Sokoine National Agricultural Library (SNAL) at SUA is one of the units that has been transformed. iAGRI has supported SNAL in the modernization of academic information services for SUA students, researchers, and external agricultural scientists. iAGRI supports the training of students in the use of electronic resources for research, adding to the quality and vigor of scholarship. Similarly, the University, with iAGRI's assistance, initiated the Sokoine University of Agriculture Laboratory for Interdisciplinary Statistical Analysis (SUALISA) to provide technical consultation to students and faculty on the use of statistical tools and methodologies. In the Department of Soil Science, iAGRI has assisted the University to establish a new laboratory for analyzing soil samples and initiated an accompanying business model to sustain the provision of fertilizer recommendations to farmers. iAGRI has also helped the University create a Monthly Leadership Forum to develop visionary leadership.

Through the Innovation Portfolio, iAGRI is working with SUA to strengthen linkages with the private sector by packaging iAGRI post-graduate student theses and innovations

developed by SUA students as an "investment portfolio" to be marketed to food system firms, brokering public-private partnerships between SUA and agribusiness firms, and providing technical assistance to the horticulture industry in Tanzania. For example, together with John Deere, iAGRI has assisted the University in launching a Tractor Training and Research Program on the SUA campus to provide an on-going series of short training courses on tractor operation, tractor maintenance and repair, and tractor business management for farmers, faculty, and students. To strengthen this further SUA, iAGRI, and two other USAID projects have teamed up to launch a financially self-sustaining horticulture farm for demonstrating best practices to farmers and students. With assistance from iAGRI, SUA has also launched a University-owned private company to engage in joint ventures with private investors and to manage the University's farm and other income-generating assets.

The success of the organizational experiments has created a positive climate of change at all levels at SUA and this has resulted in high-level changes in institutional strategy and structure. Two examples are cited here. First, in the course of conducting the experiment on "Strengthening Capacity to Generate Income", the top management of the University saw the need to dramatically revamp the University's entire strategic plan and to tie it into the budgetary process and annual work plans. Previous strategic plans at SUA had no organic connection to the budget or to annual evaluation processes. The second example involves organizational restructuring. SUA had attempted for six years without success to develop a restructuring plan. With iAGRI's assistance over an 18 month period, the University was able to develop and obtain agreement among internal units for a major restructuring that transforms faculties into colleges and decentralizes responsibilities and resources from central administration to the colleges (and a school). In the process of developing the strategic plan and the restructuring plan, iAGRI assisted the University to conduct a series of stakeholder workshops to ensure that linkages with stakeholders are strengthened.

Figure 1: iAGRI’s Organizational change experiments

Category	Name of Organizational Experiment
Teaching	Strengthening Capacity to Manage Classroom Facilities Strengthening Capacity of the English Language Program Strengthening Capacity to Utilize Teaching Assistants
Leadership	Strengthening Capacity for Mentorship Strengthening Capacity for Leadership Development
Research	Strengthening Capacity of the Library to Provide Access to Digital Resources Strengthening Capacity to Provide Statistical Advisory Services
Private Sector Linkage	Strengthening Capacity for Entrepreneurship Programming Strengthening Capacity for Horticultural Teaching and Outreach Strengthening Capacity to Provide Commercial Soil Laboratory Services Strengthening Capacity for Poultry Industry Outreach Strengthening Capacity for Farm Mechanization Outreach
Revenue Enhancement	Strengthening Capacity to Generate Income Strengthening Capacity of the Alumni Association
Administration	Strengthening Capacity for Efficient Document Handling

RESEARCH

Problem-driven research by collaborative teams of Tanzanian and U.S. research scientists is a major component of iAGRI. Ten research teams have focused on issues crucial for improving food security, including crop improvement, value chain management, climate change, gender and agricultural productivity, water resource management, agricultural policy, agricultural and nutrition extension, and nutrition and food science. The collaborative research projects are designed to engage researchers working in interdisciplinary teams. The teams are comprised of researchers from Sokoine University of Agriculture, the Tanzanian Ministry of Agriculture, Livestock and Fisheries, and the six U.S. universities in the Ohio State University Consortium. One of the teams used an integrated approach to the management of irrigation schemes, resulting in large yield increases on damaged and abandoned salt-affected soils. New varieties of rice and tomatoes have been introduced and adopted by farmers through collaborative research projects. Farmers have been trained in land management techniques such as the System of Rice Intensification (SRI), horticultural techniques such as tomato grafting,

and improved pest management aimed at increasing yields and incomes of smallholder farmers. Conservation agriculture and irrigation techniques have been tested, locally adapted, and introduced to farmers to address the effects of climate change. Farmers, extension agents, and students have been trained as a result of the research projects supported by iAGRI. The research has also led to publications and policy-relevant findings on climate change mitigation and adaptation for small-scale farmers.

Building Capacity: Challenges encountered and lessons learned

Institutional Capacity Development is the goal: We learned early in the iAGRI project that Human Capacity Development (HCD) is important, but undertaken alone it is insufficient in making strong contributions to Institutional Capacity Development (ICD). Many African scientists, teachers, and managers work in organizations which are not change-oriented; are unable to harness the talent, skill, and creative energy of current and newly trained staff members; and are not demand-driven because of limited linkages with the external environment. Newly

trained scientists return to universities or other home-country organizations where bureaucratic inefficiencies frustrate their attempts to “make a difference.” The structure and performance of AHEIs need to be improved so that creative, professional/scientific talents and energies of well-trained nationals can be harnessed by the organizations in which they work. Strengthened institutional capacity raises the return on investments made in HCD. Overall, ICD needs to be a goal to which HCD contributes.

Building AHEI partnerships is a long-term process. Effective partnerships take time to evolve because they are based on trust, which itself takes time to develop. Two mechanisms contributed to building trust under iAGRI: 1) the prime contractor (OSU) has its own faculty on the ground in the host country on a resident basis, and 2) the prime contractor is a university handling both the academic and management aspects of the project. This parallelism in the university-to-university relationship facilitates building trust, which is created through shared values and experiences.

Needs assessments are critical to project design. A critical feature of the iAGRI model was conducting a needs assessment of the Tanzanian food system early in the project. This assessment identified future trends, constraints and knowledge gaps and helped ensure that project inputs were demand driven, addressed key priorities, took advantage of complementary assets and would lead to outcomes that would achieve project goals. It allowed partners to participate in the design of the project and ensure that the project would be partner led.

Formal administrative systems tend to resist innovation and engagement with external stakeholders. Formal systems are, by their nature, intended to create standardization and stability but often stand in the way of needed change. The organizational experiments co-sponsored by SUA and iAGRI operate, by design, in the “informal system” of the University, meaning that they do not depend on the existing hierarchy, reporting arrangements, or resource base. In the informal system, as long as the

organizational experiments are blessed by top administration, members of the University community are free to experiment with activities and processes that are not “business as usual”. This inspires innovation and harnesses the energies of champions of change within the University.

Organizational experiments must be translated into improvements in the formal system in order for them to have a lasting impact. A ‘learning and revising’ exercise must be an integral part of the design of an organizational experiment or it will not create sustainable change. This requires time and takes resources but it ultimately pays large dividends.

Planting many small changes at multiple levels and identifying champions of change at each level creates a climate that facilitates bigger changes, such as changes in the strategy and structure of the institution. Mindset change is essential but does not happen through top-down directives. Rather, it happens through diverse individuals and groups observing and becoming part of the change and experiencing the benefits of change. When this happens, trust is built and motivation multiplies.

External linkages with the private sector and other external stakeholders are essential for transforming a university internally. Linkages to the private sector help a university understand the training needs of current and future employers, can provide revenue, and nurture public voices of support for AHEIs. With iAGRI support, SUA has taken important steps forward to do this through needs assessments and strategic planning done with private sector and external stakeholder participation.

o *Strengthening programmatic linkages with the private sector:* As Tanzania has liberalized its economy, the private-sector agribusinesses have become major contributors to agricultural growth and important employers of agricultural graduates. The importance of agribusiness driving the transition to more commercial and productive agriculture has been incorporated into Tanzanian and donor agricultural development strategies. SUA must respond to the emerging

private sector-led economy by reorienting curriculum, research, and outreach programs, and building the institutional capacity to service and work with private sector agribusiness.

o Improving University outreach programming: Given the limited evidence of outscaling and upscaling of best practices and proven technologies to farmers, communities, and businesses, SUA needs to develop university outreach programming. A vibrant outreach strategy ensures that SUA is relevant and respondent to changing needs and interests, and that external clients in turn value the university as a key resource. SUA cannot achieve this alone but is doing this in partnership with governmental, non-governmental, donor, and private-sector organizations.

o Building the capacity of Tanzanian public-sector organizations: iAGRI has placed emphasis on developing the capacity of Tanzanian public-sector organizations to create and sustain public-private partnerships. This is being done by training individuals, promoting success-models of private-sector linkages creation, and helping organizations to put structures and processes in place to build vibrant public-private partnerships. The goal is for public-sector organizations (i.e., universities, research organizations, and government ministries) to become more attuned to the needs of commercial agriculture, especially small and medium-sized farms.

Remaining Challenges for SUA

Agricultural knowledge systems (AKS) in Tanzania are not connected: Integrating and building synergies among national and regional knowledge system actors is a critical need in many countries in sub-Saharan Africa. SUA, as Tanzania's only comprehensive AHEI, should seek to serve as a leader and convener of national agricultural knowledge systems to better address complex and multi-disciplinary challenges like climate change and food security.

Providing quality programming: In response to the increased demand for higher education in Tanzania and the region, the number of higher

education institutions - both public and private - have increased, as have their enrollments. For SUA to excel in this increasingly competitive national and global higher education environment, it will need to emphasize and incentivize the provision of quality training, research and outreach programs.

Developing alternative sources of revenue: The Government of Tanzania funding to SUA is declining as the number of universities in the country grows and other sources of revenue must be found so it can attract and retain high quality staff and maintain high quality teaching, research, and outreach programs. SUA has potential to greatly increase revenue from grants, contracts, and sale of agricultural and intellectual products and services. To realize this potential, the University must strengthen its grant-seeking and project management capacity and its financial management system. This would assist in attracting revenue from donors and the private sector and would aid staff in competing for competitive funding. SUA has taken steps in this direction through several initiatives supported by iAGRI, including creation of an innovation portfolio, an income generation coordination unit, a Directorate of intellectual property and linkages, and a private company to manage the University farm and other large income-generating activities.

Best Practices in Degree Training

The following are best practices that the iAGRI project has found to be valuable, specifically in the area of degree training:

Training needs assessment: Conducting a training needs assessment early in the project informed and oriented the students' thesis and dissertation research to address key food security constraints in Tanzania.

Development of problem-oriented student research proposals: In most cases, students conducted their research in conjunction with producer groups and local communities, thereby addressing targeted needs and promoting the visibility of SUA among national constituencies.

Dual advisor model: Assigning graduate students

an advisor at their host university, as well as one from in Tanzania from SUA or MALF, has proven beneficial in that it provides a practical platform for Tanzania and host-country advisors to collaborate and ensures that the students' research is addressing Tanzania's agricultural production challenges.

Student and advisor selection: The two most important ingredients that contribute to successful degree training programs are to select students who have a high probability of succeeding, and advisors who have a strong interest in seeing that the student succeeds as well as interest in the student's area of research. The merit-based process used to select degree candidates based on personal interviews, as well as English language proficiency and GRE test results, must be a part of any future degree training program. Proof that this selection process worked was the excellent academic performance by the majority of trainees in USA and in the region. Lastly, ensuring that students are matched with effective advisors requires someone who knows faculty interests at the host universities and who will invest the time to contact, discuss and select motivated advisors. This was facilitated by the iAGRI training team, which included local staff at the Project Management Unit (PMU) at SUA and the Management Entity Training Coordinator at OSU. The latter individual helped facilitate placement and monitor process at the consortium universities in the U.S. RUFORUM played a similar role for placement of students in African universities and regularly interacted with PMU at SUA and the Management Unit at OSU.

Importance of Information Technology (IT): Early in the project, enhanced IT capacity was developed at the PMU headquarters on the SUA campus. This allowed iAGRI students to use videoconferencing for "virtual advising" with their U.S. advisors after they returned to Tanzania to conduct their field research. It also allowed returned students to take their final oral examination (thesis defense) in Tanzania by videoconferencing. This avoided the cost of a return trip to the U.S. merely for the examination. The use of IT also made it possible to offer leadership webinars to the students either while

they were studying at their host universities in the U.S., Africa, and India or while they were conducting their field research in Tanzania.

Leadership training for graduates: Two leadership webinars based on well-known leadership books developed trainees' personal and professional leadership skills through instructional webinars with Ohio State faculty and the staff of the PMU. This program complements the technical training they receive through their degree program, and strengthens leadership and communication skills necessary for assuming positions of higher management in their home institutions.

Gender: iAGRI designed its training program so that the pool of funded graduate degree students was at least 50% female. This has resulted in the training of approximately 71 women who will contribute significantly to improving Tanzania's food and agricultural systems at SUA, MALF, and in the private sector, as well as facilitating the acceptance of women in positions of leadership in those respective institutions.

Working with a consortium of US universities and a local partner RUFORUM: This has been quite useful for providing diverse degree training placements and opportunities, and availed resources and specialists in these schools, further building their training capacities.

CONCLUSIONS

The iAGRI comprehensive approach to ICD has strengthened the capacities of SUA and MALF to adjust and respond to demographic and economic challenges and to contribute to sustainable agricultural growth and food security in Tanzania. ICD in knowledge generating and disseminating institutions is essential for transforming agriculture and creating food security. For SUA to thrive and contribute to food security and economic growth it must have an institutional infrastructure that is robust, engaging and dynamic in order to attract and retain the best and brightest agricultural scientific talent, who can then produce high impact and societally relevant research and high quality training programs for the rising generation. To this end,

iAGRI helped SUA strengthen its linkages with the private sector and other external stakeholders enhancing its relevance to society and economy.

As of 2016, 92% of iAGRI graduates are employed, the majority in the agricultural ministry and public universities. They are assuming leadership roles in agricultural research projects, serving as university or institute lecturers in the agricultural and nutrition sciences, working as technicians, and serving as advisors. These graduates are now leaders in their respective fields and are able to more effectively contribute to the improvement of the agricultural sector in Tanzania. Graduates supported by iAGRI form a unique community of scholars, each equipped with a multi-faceted, well-rounded skillset in the agricultural sciences. Their technical knowledge and leadership skills will help them prosper as individuals while helping the country transform its agricultural and food systems. For many years to come, they will contribute to creating food security interventions and achieving nutrition outcomes in Tanzania and beyond.

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STATEMENT OF NO CONFLICT OF INTEREST

We the authors of this paper hereby declare that there are no competing interests in this publication.

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