Research Application Summary

NARI-University collaboration for development impact

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Abstract

The primary aim of current improvements in agriculture in Uganda, and indeed the whole of Eastern Africa region, is to ensure food and income security for improved livelihoods of the people. Unfortunately, key factors that have often been over-looked have limited this potential. One such factor is the lack of appropriate demand driven technologies, knowledge and skills from national, regional and international research and training institutions because of the limited linkages and synergies required for effective engagement of the research and training institutions in addressing developmental needs within the agricultural sector. While the desire for partnership exists between national research institutes and universities, policy and resource constraints has limited effective collaboration to sporadic and short-term events which often leave little impact on livelihoods of the poor in developing countries. The temporal and spatial scope of inter-institutional collaboration often fails to nurture the relevant ingredients for fostering sustainable partnerships for development. The *status quo* has persisted in spite of the global recognition of partnership as a premise for harnessing intellectual, physical and financial resources and creating synergies of actions for development. Equally important is the extension of partnership beyond intellectual boundaries, which has eluded the national agricultural research systems (NARS) including universities and public research institutes (PARIs) for a long time. Delinking research and training from the people who are (*de facto)* the markets for technologies, skills and knowledge, is the core problem that undermines the undisputable relevance of research and training in responding to the Millennium Development Goals on food security, poverty reduction, sustainable natural resource management and economic growth. The key challenge has been: how to forge effective innovation platforms complementary interests, resources, and opportunities in order to maximise the strengths and minimize real or perceived threats that tend to linger within and create artificial borders between otherwise compatible institutions. Sporadic media reports suggests that both national

research institutes (NARIs) share challenges of relevance to emerging demands in the technologies, skills and knowledge markets; indicating the need to re-brand and identify with development processes under circumstances of declining material and financial resource base. Yet both NARIs and universities must exist if sustainable growth and prosperity of nations has to the guaranteed from generation to generation. Resource constraints and balance of complementarities dictate that partnership encampassing inclusive business models under the emerging development paradigms is the most viable option for re-branding and re-invigorating the corporate images of NARIs and universities in the national agricultural research systems.

Key words: Agriculture, NARIs, partnerships, research, Universities

Résumé

L'objectif principal de l'amélioration courante dans l'agriculture en Ouganda, et même dans l'ensemble de la région d'Afrique de l'Est, est d'assurer la sécurité alimentaire et des revenus pour des meilleures conditions de vie des populations. Malheureusement, les facteurs clés qui ont souvent été négligés ont limité cette possibilité. Un tel facteur est le manque de technologies appropriées axées sur la demande, de connaissances et de compétences pouvant provenir de la recherche nationale, régionale et internationale et les institutions de formation à cause des liens et des synergies limités nécessaires pour une participation effective des institutions de recherche et de formation pour répondre aux besoins de développement dans le secteur agricole . Bien que la volonté de partenariat existe entre les instituts nationaux de recherche et les universités, les contraintes politiques et celles de ressources ont limité la collaboration efficace à des événements sporadiques et à court terme qui laissent souvent peu d'impact sur les moyens de subsistance des pauvres dans les pays en développement. La portée temporelle et spatiale de la collaboration entre les institutions échoue souvent à alimenter les composants importants pour encourager des partenariats durables pour le développement. Le *statu quo* a persisté en dépit de la reconnaissance mondiale de partenariat comme une prémisse pour exploiter les ressources intellectuelles, matérielles et financières et créer des synergies d'actions pour le développement. Tout aussi importante est l'extension du partenariat au-delà des limites intellectuelles, qui a échappé aux systèmes nationaux de recherche agricole (NARS), incluant

les universités et les instituts de recherche publics (PARIs) pour une longue période. Dissocier la recherche et la formation des personnes qui sont (*de facto)* les marchés des technologies, des compétences et des connaissances, est le problème fondamental qui mine la pertinence incontestable de la recherche et de la formation pour répondre aux objectifs du Millénaire pour le développement sur la sécurité alimentaire, la réduction de la pauvreté, la gestion durable des ressources naturelles et la croissance économique. La principale difficulté a été: comment forger des intérêts complémentaires des plates-formes d'innovation efficaces, des ressources et des opportunités afin de maximiser les points forts et minimiser les menaces réelles ou supposées qui ont tendance à s'attarder à l'intérieur et créer des frontières artificielles entre les institutions par ailleurs compatibles. Les rapports sporadiques des médias suggèrent que tous les instituts nationaux de recherche (NARIs) partagent les défis de pertinence par rapport aux besoins émergents dans les marchés de technologies, de compétences et des connaissances; indiquant la nécessité de remarquer et d'identifier les processus de développement, dans des circonstances de la baisse de la base de ressources financières et matérielles. Toutefois, ensemble les NARIs et les universités doivent exister si la croissance durable et la prospérité des nations ont la garantie de génération en génération. Les contraintes de ressources et l'équilibre des complémentarités dictent que le partenariat incluant les modèles d'entreprenariat dans le cadre des paradigmes émergents de développement est l'option la plus viable pour remarquer et redynamiser les images d'entreprise de NARIs et des universités dans les systèmes nationaux de recherche agricole.

Mots clés: Agriculture, NARIs, partenariats, recherche, Universités

Background

The agricultural sector dominates the economies of the majority of the countries in Eastern Africa region, and yet it remains a vulnerable sector. Agriculture is considered as one of the boosters of economic development and an important vehicle in meeting key aims of the Millennium development goals (MDGs). Developments in the agricultural sector are key to food security and the livelihood for the majority of the population. It provides income, foreign exchange earnings, savings, and gainful employment. Many factors have contributed to holding back agricultural development in African countries but especially in the Eastern African region where agricultural potential is rather

high. According to FAO, slow agricultural growth, especially since food production increases more slowly than population growth, is a root cause of the economic and food deficits. With this realization a number of interventions have been initiated at both country and regional level that range from breeding approaches for improved crop productivity in addition to harvest and post-harvest technologies for improved storage and increased income. Unfortunately the agricultural sector continues to lag behind and research efforts are yet to yield the expected results. Many innovative technologies have largely remained on the shelf and not benefited the end users.

The question is how to enhance the research capabilities of the NARS by repositioning them towards producing the most relevant end user required technologies. Enhancing the research capacities of NARS requires integrated and sustained engagement of all the key institutions involved in agricultural research for development. Strong and effective NARs require sustained political will, support and commitment, linked with appropriate policies and research management, together with defined priorities, coherent objectives, qualified and motivated research scientists, trained technical support staff, adequate research facilities, sustained adequate funding, effective coordination and intensified on-farm involvement. Almost all NARIs in the region fail to satisfy these essential requirements. They all require, to varying degrees, research capacity building and capacity improvement, particularly in human resources development, and the assessment of performance and impact as an ongoing requirement for institutional development. Most of these requirements bring into light the role of academia in strengthening and guiding research. Their involvement would be important in imparting trainee scientist with the required skills that would propel agriculture to another level.

Collaborative research activities between Universities and the NARIs have existed with the two institutions mostly concentrating on their own key mandate areas. Worldwide universities are recognized for their role in human resources development, but little recognition is given for the role they could play in agricultural research as part of national agricultural research systems (NARS). In fact most universities have for long been involved in agricultural research as a side event. Most of their research is basic in nature with little anticipation for end user (farmer) products but rather mostly marketable products. However, universities in many developing countries have

mandates and resources for research and can make significant contributions to agricultural and economic development. Indeed universities have sizeable well trained human resource that is rarely fully utilized for development-oriented research. This has not only left a lot of gaps due to limited human resource within the NARIs but also contributed significantly to the lack of end user impacts. Organized and targeted collaboration between universities and national agricultural research institutes (NARIs) can increase scope and improve research capacities. It can benefit the universities in both undergraduate and post-graduate training.

Higher agricultural education institutions and NARIs were established based on the conviction that both are vital for agricultural research. While the sole mandate of academic institutions is to train, it is embedded in most of their research agendas that the training received should be able to meet the needs of the farmers. In fact for most of these Universities research that contributes to national development is part of their vision and mandate, therefore collaborations of such institutions of Academia and NARIs is not divorceable, being necessary in all if not most of the aspects of their research agenda. The combined effort of both will strengthen the combined capacities of NARS. Thus such strong linkage ought to lead to formation of improved, effective and sustainable linkages between universities and NARIs that will help agriculture realize its potential.

The state of NARI-University collaboration

An FAO Expert Consultation (FAO, 1991) underlined the important role of universities in NARS, and considered them vital components of these systems. The consultation called for establishing and strengthening institutional and functional linkages and procedures for coordination, cooperation and collaboration between universities and NARIs, which would enable universities to become effective partners in agricultural research and thereby contributes to improved capacity of NARS. The consultation recommended that FAO assist member states of the region in devising appropriate and durable mechanisms for the creation of the required linkages, according to the specific needs of research for sustainable agricultural growth in each country.

According to FARA (2006), establishing research collaboration is important in ensuring optimum use of available resources for different partners and strengthening them. In this study, it was

found that a number of NARIs have formal research linkages with local universities (58%) although most of these linkages were weak (34%). This was observed in the low number of projects shared between the two in addition to different research agendas. In Uganda, NARS linkages with clients and stakeholders include a broad range of mechanisms for consultation, collaboration and interactions with policy makers, extension agents, and farmers. Linkages to farmers are through participation in priority setting, research planning and execution of adaptive research activities. However, the level of client participation, the nature of participants, sources of information, the extent of collaboration and impact is uneven and varied, and largely depending on the level of resources available. In broad terms, clients do not have effective control of the research agenda of the major NARS institutions (Bashaasha *et al.*, 2011). The main public sector institutions have direct linkage to political leadership in the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF – in the case of National Agricultural Research Organisation (NARO) and National Agricultural Advisory Services (NAADS)) and the Ministry of Education and Sports (MoES – in the case of Universities). The MoES (and training institutions in general) have no or limited mandate for and little interest in promoting agricultural technology development, a factor that has greatly accounted for the limited linkage of University research into overall national research plans (Lukwago, 2010).

In the few countries studied by FAO, a number of findings were established which still define the situation today. For example, in Egypt it was realized that a number of universities and faculties of agriculture (FOAs), are all engaged in one way or another in agricultural research. The primary function of the academic staff was to teach and post-graduate training, and most research was done as part of post-graduate study programs. It was also noted that no efforts have been made to involve university staff in national research programs through allocation of funds from nationally financed, university linkage programs. Except for a few successful examples of linkages supported by externally funded programs, there were no official functional linkages between universities and NARIs. Linkages supported by external funds were found not sustainable as they weaken following termination of the projects they are related to. The situation in Morocco was almost the same but better with academic staff from universities spending 40% of their time on research and 30% on teaching. This research was

mainly conducted within the research institutes. In Sudan it was found out that most of the research in the universities was being carried out by the graduate students and the research linkages between NARIs and the academic institutions were generally poor, except for cooperation in the post-graduate studies programs. In Tunisia, much as academic staff would be involved in research, this research was not supervised or monitored with most of the research being carried out for promotion purposes, where scientific papers published in recognized journals were required, and it is also required for the graduation of the students. Research linkages for collaborative programs were lacking. Very limited examples of successful collaboration between research institutions and universities had occurred in the past (FAO, 1996).

All the above examples depict the situation in Uganda with minor differences in researcher's perceptions regarding their roles. For example, in a recent presentation by the Principal of the College of Agriculture and Environmental Sciences, Makerere University, it was clearly pointed out that the linkages between the college and NARIs barely existed much as they were brought together by a number of donor funded initiatives. In addition, given the different mandates, it is recognised that fitting an academic institutions agenda into a NARI/NARS agenda is challenging given the different time frames to the accomplishment of tasks in both systems. This poses problems to the collaboration and hence weakens it strongly.

In addition, one of the outstanding situations in Uganda is that researchers on both sides are usually reluctant to approach one another to formulate long standing research agendas and sustainable collaborations. While researchers in universities would opt for short term information generating research options, NARIs opt for long term and product delivery research agendas which require committed human resource that cannot be availed by the academic institutions. This is due to the use of graduate and undergraduate students as research assistants and aides by the academic institutions of which their time span in the research agenda is less and hence cannot be easily accommodated by the NARI system.

The major limitations to university involvement in research included incoherent national research strategies and policies, in addition to poor priority setting, programming, monitoring and evaluation, which fail to provide guidance to universities,

absence of university research strategies and policies, and demoralised research environments, absence or weakness of research management structures, inadequate and declining research funding, heavy teaching loads and lack of recognition of downstream research in promotions, poor linkages with NARIs, extension, farmers and development agencies, paucity of well-trained research staff and technicians, and insufficient research support staff, deficient physical research infrastructure and lack of maintenance of buildings and equipment, and shortages of consumable research materials, limited contact with external research agencies.

NARI systems are better suited for research given the fact that research policies and priority programming in NARIs are better articulated than in universities, NARIs' linkages with extension services and the farmer community exist in most cases much as they need strengthening. Levels of research funding, particularly for operational and maintenance budgets, are generally insufficient in both research and academic institutions. Funds for salaries of academic and research staff, although low, are generally timely maintained. Physical resources in most cases are deficient, and in some cases inappropriate and not well maintained.

National and university policies to initiate and guide collaborative agricultural research are generally inadequate. Some limited linkage mechanisms of an informal nature occur between universities and NARIs. Formal institutional linkages are lacking or ineffective, and generally not sustainable. Weak institutional linkages are primarily due to failure on the part of the institutions concerned to recognize the mutual benefits that can be gained by linking institutions of higher agricultural education into the work of the NARIs, given their great concentration of highly qualified scientists. Other factors contributing to the problem include disparities in the policies and practices that influence the professional and career environment. For example, while salary structures in universities and NARIs are now comparable, the criteria for promotion and other career incentives of staff motivation are better in universities than in NARIs. Staff retention in NARIs is also poor.

Post-graduate study programs for MSc degrees are available in most universities in the country. In most cases, post-graduate research is not necessarily linked to stated national research priorities. The involvement of the staff of the NARIs in

supervising graduate students jointly with university academic staff, though increasing, remains limited with frustrations on policy and implementation level. Provision for reciprocal representation of academic and NARI staff on the governing bodies of each other's institutions is limited and ineffective which makes it difficult for the stakeholders on both sides to share knowledge and skills. Exchange of staff or sharing of research facilities among the research and academic institutions is limited to a few personal cases.

Breaking through the odds: The case of NARI-Makerere Regional Graduate Training Programme

Desirous of a local training program of international quality in 2008 Makerere University approved the PhD Program in Plant Breeding and Biotechnology and MSc Program in Plant Breeding and Seed Systems. Sixteen (16) MSc students (1st cohort) began their studies in October, 2008 and completed their program in good time. The first cohort of 22 PhD students (1st cohort) began in December 2008. Most are nearing completion. Subsequently, 19 MSc students (2nd cohort) commenced training in February, 2011. Coursework has been completed and most expect to submit their thesis by December, 2012. Also, 6 PhD students (2nd cohort) started their training in November, 2011; coursework is in progress, and research has begun. Recently, 20 MSc students (3rd cohort) started training in August, 2012.

For both the PhD and MSc training, dynamic cooperation involving student's research has been established with the Ugandan National Agricultural Research Organization, and with other national agricultural research institutions in Uganda, Rwanda, Kenya, Tanzania, and Ethiopia, and with several CGIAR and other regional and international agricultural research organizations. PhD and MSc students have been successfully embedded in ongoing breeding programs during the research phase of their degree training. Several of the NARI, and other national, and international staff have been mobilised to strengthen the training and students research projects including attachment to private seed companies.

Features of the Makerere Regional Graduate Programmes in Plant Breeding

a. Students represent many countries from Southern, Central and Eastern Africa — Uganda, Rwanda, Kenya, Zimbabwe, South Sudan, Sudan, Burundi, Zambia, Malawi, Ethiopia, Tanzania, Mozambique (listed in order of the number of students from each)
b. Advanced-level coursework is provided at both MSc and PhD levels. The coursework required for PhD is in contrast

to the typical research-only PhD degree training usually provided by African Universities.

c. Students take an internship with private seed companies and national plant breeding programs
d. A purposely structured program encourages productivity, timeliness, and quality.
e. Parallel operation of the MSc and PhD regional programs is synergistic.
f. Makerere University expertise is supplemented by visiting lecturers and research supervisors from other countries.
g. Thesis projects focus on critical crop improvement needs in the region. Many are especially related to specific issues in the student's country of origin, and many involve cutting-edge research.
h. All students are embedded in ongoing breeding programs, whether locally or in other countries.
i. Students conduct their research in cooperation with research institutions in Uganda and internationally. Students' projects involve a wide variety of crops, which presently includes maize, rice, wheat, sorghum, finger millet, barley, beans, soybeans, pigeon peas, mung beans, groundnuts, sweet potatoes, potatoes, cassava, hot peppers, bananas, and elephant grass.
j. Topics they research include resistance to diseases, insects, and Striga, tolerance to abiotic stresses of drought, low nitrogen and phosphorus, aluminium toxicity, nutritional quality, and adaptation of varieties to climate change. Several projects involve molecular breeding and molecular plant pathology and physiology.
k. The location also enhances close ties between the students and the mutual help systems they have developed. Strong bonds of friendship and professional cooperation have formed across nationalities, providing an unusually strong network of cooperating scientists for the future.

Bridged gaps, advantages and opportunities for NARI-MAK regional graduate training programme of international quality

Gaps

a. Broad, practical training beyond a limited MSc research project, in addition to adequate theoretical trainin. This will require strengthening the current internship program where students are attached to plant breeding programs and seed companies
b. Priority of focus on practical problems of regional significance as opposed to whatever small project happened to have research funding within the university at the time

Advantages

a. Three to five students can be trained locally for the same cost as training one student in the US or Europe.
b. Coursework and research, while fully up to date, are purposely relevant to the constraints and needs of the region.
c. The student research projects provide excellent breeding material for the region and their own countries
d. Retention of scientists within their countries of origin, and workplace, especially as RUFORUM, AGRA, International Foundation for Science, and other institutions provide grants to recent graduates to help them establish a productive research program and career.
e. Building a network of scientists within the African region.
f. Family ties are maintained more easily, the student retains his/her place in the family and can respond to crises.

Opportunities

a. Convergence of RUFORUM & AGRA initiatives starting at the same time.
b. Visionary leadership by Prof. Adipala Ekwamu, the RUFORUM Network, and their NARI partners in structure of programs and curriculum content
c. Strongly committed involvement of program coordinators, Prof. Okori and Richard Edema
d. Availability of an experienced, "retired" breeder to anchor the program as primary instructor and full-time mentor
e. Fortuitous circumstances that necessitated students being housed and taught as a group at Kabanyolo (research institute) contributed greatly to a group cohesion. The location away from Kampala, with screenhouse and field facilities, and that is also close to Namulonge, made it easy to coordinate teaching and research activities.

Key results and impacts accruing from the NARI-Makerere collaboration

a. Effective cooperation among NARI-Makerere staff and programs, generating outputs of value in national agricultural development.
b. Breeding material and information of real, practical value generated by student research projects
c. Students provide highly skilled manpower to conduct research projects as needed by the NARI projects
d. Since students are trained in the context of ongoing, major programs, they are embedded for 18 - 24 months in a

program in which they get much broader experience and exposure than a typical university-based research project.

e. Students more readied for program management. In addition to technical courses, students undergo leadership, management and business skill enhancement training.
f. International networking among current and former students of the program (88 students from 12 countries, so far)
g. Strengthened cooperation with International Agricultural Research Organizations
h. Publications (about 30 in peer-reviewed journals, so far, from the plant breeding training program that began in 2008. Most have both NARI and Mak co-authors. Some in prestigious journals. Many more publications in the pipeline).
i. Enhanced scientific focus among NARI staff.
j. Instilling a strong work-attitude in students — in contrast to other graduate students who experienced a rather relaxed academic program, but upon completion entered demanding positions without the benefit of having developed disciplined work habits.
k. NARI as intellectual resource offered unlimited opportunities for student attachments to enhance their learning process.
l. Collaborations have also in one way or another helped in the institutionalization of the role of public universities in national agricultural development agenda. This has allowed their participation in a number of research initiatives that meet the national agricultural research targets while contributing to national agricultural development
m. Fostered linkages for experiential training and skills development at undergraduate and postgraduate levels. This window has been exploited through a student-scientist pairing system to increase on contact hours between the student and the supervisor, tap coaching, and sharpen student interpretive power. This has improved on the quality of the graduates.

Drivers for success of the NARI – Makerere Initiative

a. Personal cooperation among university staff and NARI staff who saw the need for such joint training.
b. Heavily involved, experienced core staff providing extensive individual student guidance, liaised with research supervisors.
c. Academic objectives required for the degree harmonized with the scientific objectives of the more immediate practical goals of the cooperating breeding program.
d. Supervision was compensated by a modest payment. Initially, this was critical in obtaining supervisors for the

students. By now, recognized benefits to the research programs might make it possible to continue even if funds are not available to compensate supervisors.

e. Some very modest operational support from outside the NARI-Makerere system from RUFORUM and AGRA was essential in the beginning to get the program started, but is still critical due to lack of the program's access to the legally-contracted percentage of tuition money intended to support basic operations.

f. Formulating research objectives early has allowed students to develop excellent projects, usually involving crossings to create new populations, and evaluation of the offspring from those varieties crossed.

Lessons for the Future

a. Forging the initial cooperation depends on personal friendships, and individual initiative of the program organizers.

b. It is extremely valuable to have experienced scientists in the core staffing who can devote considerable time to mentoring students, thereby making effective use of the limited time that designated supervisors can spare for guiding the students.

c. Both sides must commit resources in order to obtain the benefits of the cooperative training. Research programs must provide the necessary research support for the student, whose individual research budget is small, and whose research has been requested by the program.

d. Course and program curriculums need to be both practical and solid in the theoretical base, structured to produce "fit-for-task" graduates who can function in key positions immediately after completion, and yet have sufficient theoretical background to continue learning and growing with increased responsibilities and new scientific developments. Inflexible curriculum structures, and excessively cumbersome curriculum revision procedures, can interfere with this process.

e. Inclusion of "soft-skills," such as personnel and project management, social research methods, and personal development are important components of training for researchers to be able to identify and address the necessary development priorities and operate programs effectively.

f. Imparting a serious and enthusiastic attitude toward learning and work is key to the students' future success.

g. Cooperation between universities and NARI's is looked upon favourably by grant agencies, which fact can be helpful in motivating projects to cooperate.
h. In-country or regional training at the MSc and Ph D level can be as effective as, or even more effective than training abroad, with lower costs and fewer issues of retention and re-integration.
i. PhD training that includes coursework provides a much better and broader theoretical grounding than research-only programs. While PhD training locally cannot match internationally renowned universities for facilities, breadth of expertise, and breadth and depth of coursework, local PhD training can contribute greatly to the scientific capacity of the region, while avoiding the cost and various difficulties involved in training abroad.
j. All involved parties should receive adequate credit for their contribution. Such programs depend on multi-party financial and technical support, and all should be gratefully acknowledged.
k. Starting with a number of students that exceeds the funding, facilities, instructional capacity, and the number of supervisors available (or accepting them later) seriously compromises program quality and even sustainability.
l. Detailed planning is needed to effectively integrate the material from different courses, and to manage the implementation of the research when required equipment and consumables are not already available.
m. The most effective promotion of the program is by the graduates of the program and their administrative superiors.
n. Graduates of the two programs have witnessed a very positive interaction of NARI-university cooperation, and so they eagerly participate in and promote such cooperation in their professional roles, in either a university or a NARI. Therefore, the ripple effect across countries and institutions is very positive over time.
o. A set of guiding principles is required in order to improve and sustain the collaborations. Laws and guidelines should be formulated to give relevancy to establishment of such linkages and in addition promote the much required cohesion between the collaborating parties.
p. Data integrity should be highly upheld. The type and quality of data to be generated should be discussed earlier within the collaboration life time. In particular the use of data by both partners should be defined. In most cases, the data generated should be confidential to all parties involved in

the collaboration rather than censored where one party may not have or is denied free access to the data resources generated.

q. Classification of collaborations is important and can be the main source of information in guiding their establishment. Short term and long term collaborations have different intended uses and so from the start, the type and form of collaboration should be understood. Instead of planning for short term collaborations that will not yield the intended results, long term collaborations can be initiated allowing both parties to exercise their full potential in meeting the goals of the collaboration.

r. In cases where collaborations involve short term tasks and accomplishments, there is a need for constant renewal and a search for ways of fostering and upholding forward looking partnerships. These can be done in light with the results of earlier collaborations which in addition gives value to any future linkages and guides the whole purpose of the partnership. However if the goals of the partnership have not been met, then it is important that the collaboration is revisited and new ideas are brought into it. In any case, failures within the partnership are most likely going to result into the severing of the collaboration

Challenges encountered while implementing the NARI-Makerere Initiative

a. Procedures for the disbursement of research funds are still challenging. Administrative structures are cumbersome and time-consuming. Funds transferred to research institutions to support an individual student's project often disappear into the general pool. Funds dispersed direct to the student may be misused by the student, despite strict accountability procedures.

b. Research projects tend to view the training project as having lots of resources available, and vice-versa. The reality is that both types of projects are trying to do much with limited funds, and both must strategically use those funds to maximum benefit. Recognition of the genuine limitations of both NARI projects and university funding must be acknowledged by both parties. The requirements of the student's proposed project must be realistically compared with the available resources, and decisions made in a cooperative spirit concerning what is feasible and what costs will be borne by each participating party.

c. Student numbers have been extremely large for the available staffing. It has been very difficult for core staff to find

adequate time to guide, mentor, review, and edit student work in addition to a heavy teaching load.

d. In a few cases, cooperation has been hindered by personal or professional rivalries between research supervisors and other individuals involved with the students.

e. Interaction of students in the regional program with students in regular departmental programs has been inadequate, due partly to the fact that students in the two programs are based at Kabanyolo away from the main campus.

g. Administrative integration of the program into departmental procedures has been difficult, mostly due to departmental and university procedures that interfere with effective administration of the programs.

Similarities between NARI-Makerere initiative and others elsewhere in the world

a. The US land grant university system that combines research, education (BSc, MSc, PhD) and extension has produced an extremely effective integrated training encompassing excellent academic training combined with research embedded in ongoing, major projects. The key to this system is that all 3 branches are administratively under the Dean of the College of Agriculture, whose main job is to see that the 3 branches are effectively integrated in that state. (History of this arrangement dates back to 1863).

b. Attempts to copy the US system have typically not worked, because the organizational structures and historical influences are very different. There is often too much competition between organizations, with rivalry and overlap complicating their efforts.

c. The majority of effective efforts have been based on individual visionaries who have built their success on voluntary cooperation.

Strategies for scaling out

a. Such programs depend on the voluntary cooperation among individuals who see the benefits and potentials.

b. While the level of cooperation needed for such programs cannot be institutionally mandated, it can be administratively encouraged by extolling the benefits, reducing administrative hurdles to cooperation, implementing credit and reward structures that give appropriate credit to joint publications (eg. not limited to the 1st and corresponding authors), giving appropriate credit in performance reviews and promotion decisions for successful joint projects that involve individuals not listed as co-PIs who truly contribute.

c. Establishment of such programs needs to be evaluated for feasibility compared to available staffing, research

supervisors, facilities and funding. Programs should be initiated with student numbers large enough to justify the program, but with small enough to be easily managed and to allow for a period (of several years) in which to learn how to operate effectively. Therefore, expansion to a larger number of programs per university, and to larger numbers of students per program, should be implemented only over a time frame of several years.

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