Research Report 26

University-based Agricultural Research: A Comparative Study in Sub-Saharan Africa

Heike Michelsen
Frank Hartwich

International Service for National Agricultural Research

isnar

International Service for National Agricultural Research (ISNAR)

Until March 2004, ISNAR was one of the 16 Future Harvest Centers supported by the Consultative Group on International Agricultural Research (CGIAR). At its 2003 Annual General Meeting, the CGIAR approved the recommendations of a team that was charged with restructuring ISNAR. One of the recommendations called for ISNAR to cease operating as an independent center of the CGIAR. The Annual General Meeting requested that the Boards of ISNAR and the International Food Policy Research Institute (IFPRI) carry out a transfer of governance and relocation of ISNAR's programs to IFPRI. On April 1, 2004, the new ISNAR Program was established as a division within IFPRI and began work from a base on the ILRI campus in Addis Ababa, Ethiopia.

Relocating the new ISNAR Program in sub-Saharan Africa brings it into closer contact with its main target region. The new Program aims to work in partnership with national and regional organizations and the CGIAR Centers. The primary theme of the Program will be to produce new knowledge on institutional change that enhances the impact of agricultural research. The secondary theme will be to enhance the performance of agricultural research institutions by strengthening their organization and management. A Program Advisory Committee, established by the IFPRI Board and consisting of NARS leaders and specialists on the main themes, will help guide these activities.

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About the authors

Heike Michelsen is a Senior Research Officer at ISNAR. Since 1996 she has been leader of ISNAR's University in NARS study and has worked with a group of scientists on linking research organizations and stakeholders in a changing environment. In 2002 she was a visiting scientist at Cornell University, College of Agriculture and Life Science, working on institutional partnerships and collaboration. She has an MSc and a PhD in Economics from the University of Hohenheim, Germany. Before joining ISNAR in 1993, she worked for 5 years as a research associate at the Institute for Agricultural Economics and Social Sciences in the Tropics and Subtropics at Hohenheim. **Frank Hartwich** has been a Research Associate at ISNAR and at the University of Hohenheim, Germany since 2001. His current research focuses on public–private partnerships for agricultural research. He also is involved in research on evaluation of agricultural research and has worked with theories and methods for institutional innovation in agricultural innovation systems. Between 1996 and 1998 he was the Research Assistant for the University in NARS study, before completing his PhD in Germany and working as a consultant. Frank has an MSc in Agricultural Science from the University of Bonn, an MSc (French DAA) in Agricultural Management from ENSA Toulouse, and a PhD in Agricultural Economics from the University of Hohenheim, Stuttgart.

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This research report is one of the outcomes of ISNAR's project on strengthening the role of universities in national agricultural research systems (NARS) in sub-Saharan Africa: the "University in NARS study". This was an action-oriented, multi-year project involving six countries in SSA: Benin, Burkina Faso, Côte d'Ivoire, Nigeria, Uganda, and Zimbabwe. In addition, using the same framework, special research studies were conducted in Cameroon and Tanzania as part of a PhD study. A wide range of professionals from local, national, regional, and international institutions contributed in one way or another to the report's development.

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Abstract

Universities in sub-Saharan Africa, given their considerable resources both in terms of human resources and scientific infrastructure, are often criticized for not contributing enough to national agricultural research and development (R&D) and for having an "ivory tower" mentality. However, documented evidence is rare. This report presents analytical results of data collected from over 980 scientists and over 2300 research projects in eight countries in sub-Saharan Africa, namely, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Nigeria, Uganda, Tanzania, and Zimbabwe. It shows that university scientists often performed equally to scientists with an official mandate for conducting agricultural research, i.e. those in the national agricultural research organizations. It also shows that scientists in Anglophone universities often have a better research performance than scientists in Francophone universities, and there is a high research potential in the latter that remains untapped. This study identifies several factors that can explain a scientist's research performance. These are related to the university research mandate, objectives, and policies; the organization and structure of research and research linkages; the human, financial, and physical resources available; and the research program and how it is planned and managed. Based on these findings, several recommendations are made to policymakers and university managers to improve current research performance at universities. They are urged to define the specific constraints facing their country and find the appropriate mix of strategies to address them. While some remedial actions can be implemented at low cost, some will require long-term and costly interventions. Long-term and coordinated support from the international donor community to strengthen the higher education capacity in sub-Saharan Africa remains a necessary, and potentially high pay-off, investment.

Executive Summary

Agricultural research and development (R&D) is urgently needed in sub-Saharan Africa (SSA) and it is often argued that universities in this region, with their considerable potential in human resources and scientific infrastructure, should contribute to this area. Universities in the region are also often criticized for concentrating solely on education, and for maintaining an "ivory tower" mentality, and not participating actively in national agricultural R&D. However, to date, there has been hardly any documented evidence about the contribution of the region's universities to national agricultural R&D in SSA to confirm or refute this criticism.

This report addresses this gap by presenting analytical results of data collected from over 980 scientists and over 2300 research projects in eight countries in SSA, namely, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Nigeria, Uganda, Tanzania, and Zimbabwe. These countries were selected because of their varied cultural and historical backgrounds and the size of their research systems. The study includes analysis of variances between groups of scientists as well as partial correlation and multiple regression analysis to identify relationships between indicators.

This study employs a conceptual framework for analyzing the contributions of universities to national agricultural research. First, it acknowledges that universities are part of both the education and research systems. This systems perspective allows university research performance to be analyzed in relation to the performance of the national agricultural research system (NARS) and other NARS institutions, such as national agricultural research organizations (NAROs). Second, it provides a research performance assessment model that includes various factors to explain organizational performance. The performance criteria used are effectiveness, efficiency, and sustainability. Factors influencing the research performance of universities are grouped into four categories, known as the MORP factors, which characterize an organization:

- Mandate, objectives, and policies;
- Organization, structure, and linkages;
- Resources and information; and
- Program planning and management.

This study was designed to analyze the performance of universities in agricultural research in SSA and to test three key hypotheses:

1. Research performance at universities in SSA is lower than at NAROs.
2. Research performance at universities in SSA is influenced by the historical and cultural development of the country in which they are based.
3. Research performance at universities in SSA is determined by a set of institutional factors related to the dimensions of their mandate, the structure and organization of their research, their resources, and programming and management of their research.

Based on the comparative analysis of this study, the following conclusions can be drawn about these hypotheses.

University scientists in SSA often perform at similar levels to their counterparts in organizations with an official mandate for agricultural research, i.e. NAROs. Factors that contribute to this finding include the following. Some universities have an explicit mandate for development-oriented research and some are recognized as a NARS component and actively contribute to the development of a national strategic plan for agricultural research. Universities also have more highly qualified human

resources than NAROs and a diversified infrastructure, both of which can be used for research. University scientists spent about 30% of their time on research. Universities, particularly those that offer PhD and MSc degrees, also benefit from the availability of students. They provide the critical mass for scientific discourse, carry out adaptive research, and provide inexpensive labor for assistance and fieldwork. University scientists have more incentives than NARO scientists to conduct research as it determines their career and promotion opportunities. University scientists have greater academic freedom than those in other research institutions. Finally, university staff also have a wide range of research linkages with the international science and donor community. It can be concluded that many universities already significantly contribute to national agricultural research. But, there is a high potential that remains untapped; in some universities more than others.

This study also shows that scientists in Anglophone universities often have a better research performance than scientists in Francophone universities. Factors that contribute to this finding include the following. The higher education system in Francophone countries focuses less on research and development and more on teaching and thesis supervision and Anglophone university scientists have much closer links to national research organizations and technology users than Francophone university scientists. Only some of the Anglophone universities and none of the Francophone universities had an explicit mandate for development-oriented research. The average time spent on research is comparable but Francophone university scientists use more of this time to supervise student theses than Anglophone university scientists. Francophone universities offer less PhD and Masters courses so they have less students available to assist in research. Anglophone universities, by nature of their language, have better access to the international science network, which is predominantly characterized by the use of English. Finally, more Anglophone than Francophone university scientists were promoted because of their research performance. It can be concluded that universities in Francophone countries in particular could make a significantly stronger contribution to national agricultural research. However, in order to do so, many institutional problems would need to be addressed.

Performance in research at universities in the country studies can be explained by a set of institutional factors. Factors influencing the research performance are related to the four MORP categories that characterize an organization. Based on the analysis, eight key factors seem to have particularly strong influences on the research performance of university-based scientists:

- *Active participation in defining national agricultural research strategies:* Official policies need to reflect the research potential of universities and identify universities as a component of the NARS.
- *Linkages with NARO scientists:* Stronger linkages with NARO scientists (particularly for Francophone university scientists) are important to avoid duplication of effort, and for ensuring a critical mass of expertise and resources is maintained, and closing existing gaps in the national research agenda.
- *Linkages with technology users:* Increased linkages with technology users (particularly for Francophone university scientists) are important for improving the relevance of the research, developing a common understanding of the problem, and improving the impact of research.
- *Linkages with donor agencies:* Increased linkages with international donors are important for obtaining additional funding for conducting research. Donors are also very output- and impact-oriented.
- *Participation in international conferences:* More opportunities for attending international conferences are important because they create opportunities for presenting research results and seeking additional resources, and provide access to new knowledge.
- *Academic qualifications:* Scientists with a PhD have more scientific skills and expertise in conducting research and in publishing the results than those with an MSc qualification.
- *Teaching loads:* A reduced teaching load (particularly for Anglophone university scientists) increases the ability of staff to conduct research.
- *Incentives for conducting research:* More incentives for conducting research (particularly for

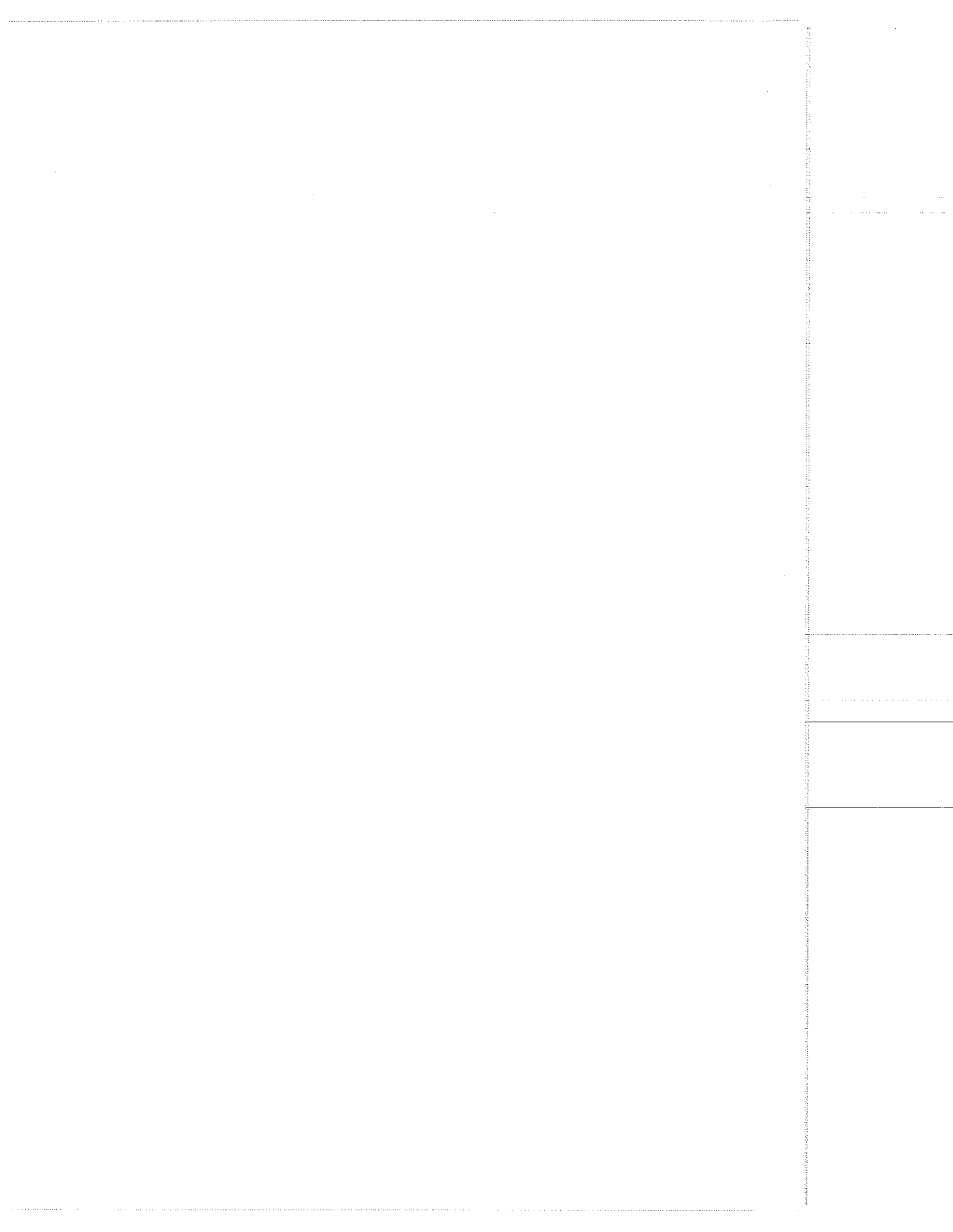
Francophone university scientists) are important. If research performance becomes an important criterion for promotion, scientists are motivated to conduct quality research.

Finally, the report presents recommendations that are addressed to national policymakers and university managers, and to the international donor and science community.

There is no blueprint or model for a new research-based university that can address the specific constraints that universities face. Policymakers, NARSs, and university managers have to take the specific circumstances of the country into account when selecting the appropriate mix of strategies for addressing the specific constraints in the country. As part of the University in NARS study, ISNAR developed a research management guideline document that assists countries in undertaking such a review-and-change process. There are a number of potential strategies and actions supported by the findings of this study, some of which can be implemented in the short-term and at low cost, while others require long-term and costly investments: (1) involve the university in the NARS; (2) establish or strengthen formal linkages with the NARO and other research institutions, particularly in Francophone countries; (3) establish or strengthen linkages with technology users, particularly in Francophone countries; (4) strengthen relationships with international donors to secure additional funding for agricultural research; (5) improve university human resource capacity and incentives for research; and (6) improve funding for agricultural research at universities. A prerequisite for any decision-making on the appropriate strategy mix is reliable information about the NARS.

For the agricultural research capacity at universities in SSA to be strengthened, policymakers and NARS managers will need long-term and coordinated support from the international donor community. International investments in strengthening higher education capacity remain necessary and have a potentially high pay-off. The complementary nature of research, education, and extension dictates not only closer ties among these activities and the various institutions that participate in pluralistic national technology systems, but also a more balanced development of these institutions. Most developing countries supported by external donors have, over time, focused their efforts either on the development of higher education or extension services or research institutes. This has clearly limited sustainable national institutional development. Donor organizations might need to rethink their own structure (usually different departments are responsible for higher education and agriculture) to be able to provide more balanced support. International development agencies are also encouraged to collect and provide reliable and current cross-country data on higher education to help rationalize perceptions and decision-making.

There is a need for further research concerning (1) more appropriate indicators for measuring and explaining research performance, particularly for countries in SSA where the statistical database is very weak, and (2) the use of multivariate techniques, such as canonical analysis, for institutional performance assessment that can take into account the complexity of the interactions occurring between performance indicators and performance predictors.



Acronyms

AAU	Association of African Universities
ABU	Ahmadu Bello University, Nigeria
ADEA	Association for Development of Education in Africa
AEATRI	Agricultural Engineering and Appropriate Technology Research Institute, Uganda
AGRITEX	Department of Agricultural and Technical Extension, Ministry of Agriculture, Zimbabwe
AISA	Association Ivoirienne des Sciences Agronomiques, Côte d'Ivoire
AKIS	Agricultural knowledge and information system
AU	African University, Zimbabwe
BMZ	Federal Ministry for Economic Cooperation and Development (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung), Germany
BUNASOL	Bureau National des Sols, Burkina Faso
CIREJ	Centre Ivoirien d'Etudes et de Recherches Juridiques, Côte d'Ivoire
CIRES	Centre Ivoirien de Recherches Economiques et Sociales, Côte d'Ivoire
CIRT	Centre Ivoirien de Recherches Technologiques, Côte d'Ivoire
CNF	Centre National de Floristique, Côte d'Ivoire
CNRST	National Center of Scientific and Technology Research, Burkina Faso
CNSF	Centre National des Semences Forestières, Burkina Faso
COREC	Coffee Research Centre, Uganda
CPU	Collège Polytechnique Universitaire, Benin
CRO	Centre de Recherches Océanologiques, Côte d'Ivoire
CSER	Center for Social and Economic Research, Nigeria
CTA	ACP–EU Technical Centre for Agricultural and Rural Cooperation (Centre technique de coopération agricole et rurale), The Netherlands
DNPWM	Department of National Parks and Wildlife Management, Zimbabwe
DNR	Department of Natural Resources, Zimbabwe
DR&SS	Department of Research and Specialized Services, Ministry of Agriculture, Zimbabwe
DRD	Department of Research and Development, Tanzania
DSE	German Foundation for International Development (Deutsche Stiftung für Internationale Entwicklung). Germany
DVA	Direction de la Vulgarisation Agricole, Burkina Faso
DVS	Department of Veterinary Services, Ministry of Agriculture, Zimbabwe
ENSA	Ecole Nationale Supérieure Agronomique, Côte d'Ivoire
FAF	Faculty of Agriculture and Forestry
FAO	Food and Agriculture Organization of the United Nations
FASEG	Faculté des Sciences Economiques et de Gestion
FAST	Faculté des Sciences et Techniques
FENG	Faculty of Engineering
FIRI	Fisheries Research Institute, Uganda
FLASH	Faculté des Lettres, Arts et Sciences Humaines
FLASHS	Faculté des Langues des Arts des Sciences Economiques et Sociales
FOA	Faculty of Agriculture
FOANR	Faculty of Agriculture and Natural Resources
FORI	Forestry Research Institute, Uganda

FOSRI	Food Science and Technology Research Institute, Uganda
FSC	Faculty of Science
FSS	Faculty of Social Science
FTE	full time equivalent
FVM	Faculty of Veterinary Medicine
FVS	Faculty of Veterinary Sciences
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit, Germany
IAD	Ingenieur Agronome Diplome
IAR	Institute for Agricultural Research, Nigeria
IDEFOR	Institut des Forêts, Côte d'Ivoire
IDESSA	Institut des Savanes, Côte d'Ivoire
IDR	Institut de Développement Rural, Burkina Faso
IET	Institut d'Ecologie Tropicale, Côte d'Ivoire
IMPM	Institut de Recherches Médicales et d'Etudes des Plantes Médicinales, Cameroon
INE	Institut National d'Economie, Benin
INERA	Institut de l'Environnement et de Recherches Agricoles, Burkina Faso
INRAB	Institut National de Recherches Agricoles du Bénin, Benin
INSS	Institut National de Sciences Sociales, Burkina Faso
ISNAR	International Service for National Agricultural Research
IRAD	Institut de la Recherche Agronomique pour le Développement, Cameroon
IREN	Institut de Recherche en Energies Nouvelles, Côte d'Ivoire
IRSAT	Institut de Recherche en Sciences Appliquées et de Technologie, Burkina Faso
IRSS	Institut de Recherche en Sciences Sociales, Burkina Faso
KARI	Kawanda Agricultural Research Institute, Uganda
LIRI	Livestock Health Research Institute, Uganda
LNE	Laboratoire National de l'Elevage, Burkina Faso
MORP	Mandate, objectives, and policies; Organization, structure, and linkages; Resources (human, financial, and physical) and information; Program planning and management
MU	Makerere University, Uganda
MUARIK	Makerere University Research Institute, Kabanyoro, Uganda
NAARI	Namulonge Agricultural and Animal Research Institute, Uganda
NAERLS	National Agricultural Extension and Research Liaison Service, Nigeria
NAPRI	National Animal Production Research Institute, Nigeria
NARO	National agricultural research organization
NARS	National agricultural research system
PM&E	Planning, monitoring and evaluation
R&D	Research and development
SAARI	Serere Agricultural and Animal Research Institute, Uganda
SSA	Sub-Saharan Africa
TAFORI	Tanzania Forestry Research Institute, Tanzania
UNB	Université national du Bénin, Benin
UNCE	Université nationale de Côte d'Ivoire, Côte d'Ivoire
UNESCO	United Nations Educational, Scientific and Cultural Organization
UO	Université de Ouagadougou, Burkina Faso
USAID	United States Agency for International Development
UZ	University of Zimbabwe, Zimbabwe

Introduction

Over the past four decades, the number of universities in sub-Saharan Africa (SSA) has grown significantly. In 1960, there were only six universities or university colleges in the region (Goma 1989) but since then, almost all sub-Saharan African countries have set up universities, and by 1999 there were more than 200 universities and institutes of higher education in SSA, covering a wide range of disciplines. Among these there are currently 87 involved in agriculture and its related fields (Beintema et al. 1998; ISNAR 2001).

Agricultural research and development (R&D) is urgently needed in SSA and it is often argued that universities in this region, with their considerable potential in human resources and scientific infrastructure, should contribute to this area. Universities in the region are also often criticized for concentrating solely on education, and for maintaining an "ivory tower" mentality, and not participating actively in national agricultural R&D. However, to date, there has been hardly any documented evidence about the contribution of the region's universities to national agricultural R&D in SSA to confirm or refute this criticism, and even less on how this contribution could be improved.

In order to address these issues and to foster a more active integration of universities in national agricultural research in SSA, the International Service for National Agricultural Research (ISNAR) launched a project with the aim of "Strengthening the Role of Universities in National Agricultural Research Systems in Sub-Saharan Africa". It was implemented in collaboration with a number of African universities and the University of Hohenheim, and was supported by the German Federal Ministry for Economic Cooperation and Development Cooperation (BMZ), ACP–EU Technical Centre for Agricultural and Rural Cooperation (CTA), German Foundation for International Development (DSE), and Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ).

Since 1994, agricultural research leaders in Benin, Burkina Faso, Côte d'Ivoire, Nigeria, Uganda, and Zimbabwe have engaged in a far-reaching review-and-change program that looked systematically at factors limiting the research contribution of their universities to national agricultural research. As a result of this process they have designed and implemented action plans to address the constraints identified.[1] In addition, and using the same framework, special research studies were conducted in Cameroon and Tanzania as part of a PhD study.[2]

This research report is based on the analysis of data collected in these eight countries. The database includes over 980 questionnaires completed by scientists, over 2300 completed questionnaires on research activities, as well as over 200 interviews with key actors in the national research systems. Based on the analysis of variances between groups of scientists, as well as partial correlations and multiple regression analyses to identify relationships between indicators, the objective of this report is to analyze the research performance of university scientists and the factors that influence their research performance. In particular, it tests three research hypotheses:

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[1] For each of these countries, analytical reports (Burkina Faso 1997a; Republic of Nigeria 1995a, 1999; Republic of Uganda 1997a; Republic of Zimbabwe 1998; République de Côte d'Ivoire 1998a; République de Bénin 1995a), actions plans (Burkina Faso 1997b; Republic of Nigeria 1995b; Republic of Uganda 1997b; Republic of Zimbabwe 1997; République de Côte d'Ivoire 1998b; République de Bénin 1995b), proceedings of national and two international workshops (Michelsen et al. 1995, Michelsen and Shapiro 1998), as well as an evaluation of the implementation of actions (Michelsen and Petry 2001) are available from ISNAR upon request.

[2] Results of the PhD thesis are published in Hartwich (2000).

1. Research performance at universities in SSA is lower than at NAROs.
2. Research performance at universities in SSA is influenced by the historical and cultural development of the country in which they are based.
3. Research performance at universities in SSA is determined by a set of institutional factors related to the dimensions of their mandate, the structure and organization of their research, their resources, and the programming and management of their research.

The report is structured as follows. Chapter 1 provides background information focusing on the historical development of universities in the field of agricultural research in SSA. Chapter 2 presents conceptual issues. It discusses the role of universities within NARSs and presents an approach for assessing and explaining the research performance of universities. Chapter 3 describes the study design, i.e. the research hypotheses, the selection of countries, data collection, indicators, and data analysis. Chapters 4 and 5 summarize the results of the analysis. Chapter 4 provides an overview of the current status of agricultural research at the universities. It also highlights the role these universities play within the NARSs. Chapter 5 presents and discusses the results of analyzing the universities' research performance and factors that possibly explain this performance. The final section presents conclusions in relation to the research hypotheses, and highlights recommendations for national policymakers, NARSs, university leaders, and the international donor community that can improve agricultural research performance of universities. It also identifies areas for further research.

Chapter 1. Background on Universities in Sub-Saharan Africa

This chapter focuses on the historical background of universities in SSA. Although most universities in the region were established after independence from their former colonial powers, their development, to a large extent, was influenced by the colonial past of the countries and, to a lesser extent, by other external influences. The chapter is therefore divided into two parts, the first describes university models that influenced the development of African universities, and the second details the development phases of African universities since independence.

1.1 University models in sub-Saharan Africa

As most African universities were modeled on European universities it is important to understand the basic characteristics of these models. Here, we present the two most important university models within the study area, namely the Anglophone and Francophone higher education models.[1] International donors have also influenced university development, for example, the creation of large institutions at a wide range of African universities is supported by USAID. Given the importance of US support, we therefore also describe the American university model.

The Anglophone (British) model: The British higher education system includes universities, polytechnics, and colleges. In general, emphasis is placed on education, free from the demands of both research and professional life. Though everybody should have access to education, usually only those who can afford it enter academic institutions. Generalist and humanist training of "good members of society" is the main aim (Hartwich 2000). Education on the graduate level has a rather intellectual character as opposed to a narrowly disciplinary and scientific one. The educational system is built on close informal contacts between students and professors, formalized through tutorial programs. The role of science is limited to its contribution to educational demands. In contrast, most postgraduate studies, which are in general conducted at universities, are characterized by academic research focused on solving concrete problems.

The Francophone (French) model: In the French education system priority is given to elite teaching institutions, the "Grandes Ecoles". Their teaching activities mostly respond to the demands of the private and, especially, public sectors. Though the "Grandes Ecoles" are intellectually and socially selective, they are usually not involved in research. Other non-elite education institutions, including universities, carry out the biggest portion of higher education (Burian 1992). Student access to universities is free, to the degree that the public sector engages in funding university activities. Scientific work is directed to universities but national science policies also delegate much research to national and parastatal research institutions.

The US (American) model: The American university system aims to respond to societal demands both for research for industry and for the education of graduates. This leads to the combined objectives of teaching, research, and outreach. Together with wide funding support from the government, industry, and alumni, this model has led to the creation of the world's biggest and leading academic science industry (Whiston and Geiger 1992). In the so-called "US Land-Grant University"

[1] The following classifications in no way reflect the contemporary British or French higher education system.

model, universities host research, teaching, and extension simultaneously in order to bring about agricultural development in specific regions and states.

In comparing these university models, some broad lines of differentiation can be found that have implications for the policy, organization, and management of universities (1) in the priority placed on the personal development of the human being, (2) in the priority placed on research, (3) in the priority placed on various forms of service to society, (4) in the degree of autonomy from the state, and (5) in the relationships and linkages with other research organizations in the country (Table 1).

Table 1. Characteristics of Different University Models

Model	Development of personality	Priority given to research	Service to society	Autonomy from state	Linkage to research organizations
British	More important	Low	Indirect (personal development)	High	Weak
French	Less important	Low	Direct (skilled manpower)	Low	Strong
American	More important	High	Direct (research and outreach)	High	Built in

Although these are 'historical' models and although many attempts have been made to 'Africanize' universities, it is important to note that many African universities still bear the mark of their European origin (Adams et al. 1991; Mwiria 1992; Assie-Lumumba 1993). Anglophone and Francophone SSA countries, in particular, followed the administrative patterns of Great Britain and France when setting up government institutions and universities (Mattee 1987). We, therefore, argue that the historical and cultural background of these universities had a strong influence on the development of their policies, organization, and management. The first hypothesis to be tested is that the research performance at universities in SSA is influenced by the historical and cultural development of the country in which they are based.

1.2 Phases of university development in sub-Saharan Africa

The development of universities in SSA since the independence of most African states in the early 1960s can be seen as passing through three major phases (Eicher 1990, 1999). After independence, the governments of the young African nations made significant efforts to develop and improve their universities. Many developed countries, development organizations, and donors supported the creation of universities in SSA (World Bank 1994a,b). The primary concern of political leaders at this point was the training of Africans to run the civil services of their newly independent countries. Governments respected universities, provided generous financial support for them, and granted them a huge degree of autonomy. However, higher education usually remained the privilege of the newly established upper classes (Last et al. 1991).

In the 1980s, a significant increase in the quantity of education was accompanied by a decrease in its quality, leading to "mass universities" (Last et al. 1991). Austerity measures and structural adjustment programs hit universities particularly hard, as university funds came almost entirely from the government (Lynam and Blackie 1994). During this period, universities and governments coexisted in an uneasy and frequently conflictual relationship. The major causes of conflict were the inability of governments to meet the financial needs of universities, the increased involvement of

governments in university affairs, and the tendency of sections of the university community to question their governments on matters ranging from corruption to shortcomings in democratic decision-making (Mwiria 1992). Meanwhile, donor preference shifted from higher education to other sectors. Agencies like the World Bank argued that developing countries spent too much on higher education which, it claimed, had lower economic and social returns than elementary and secondary education (Psacharopoulos and Woodhall 1985; World Bank 1994a). Consequently, support from the World Bank and other international donors for agricultural education, including higher education, decreased drastically in the 1980s and 1990s (Willett 1998).

In the 1990s, after some 30 years of experience, it became apparent that university education in SSA no longer met the demands of society. On the one hand, it was found that a large number of graduates remained jobless, either because the public sector was already overstaffed or because the private sector was not able to provide jobs (Court 1991). On the other hand, and despite the fact that an increasing number of universities in SSA were offering degree training, there was a shortage of scientists in disciplines like agriculture and economics, due to the limited opportunities for postgraduate training (Pardey et al. 1997; Fine et al. 1994). The lack of sufficient qualified national scientists meant a continuing reliance on short-term expatriate appointments in many developing country programs (Jones and Blackie 1991). Many African students continued to be trained in universities in the Northern hemisphere.[2] However, this option was becoming less and less feasible as the costs of a MSc or PhD course in the North continued to rise. Moreover, the changing focus of universities in the North made the education they provided less relevant to current African research needs (Lynam and Blackie 1994; World Bank 1999).

African governments facing stringent economic restrictions were barely able to finance their universities at even the most basic levels. The relentless financial crises led to a decline in the universities' intellectual resources, research funding, and teaching facilities. The most serious casualty was staff morale. Faced with "starvation wages," many professors searched for income outside the university, running small businesses or "consulting" for private companies and foreign agencies (Useem 1998). Meanwhile, official organizations and NGOs frequently looked upon universities as distant cousins, which were enjoying a privileged position but returning little to the societies that supported them (Uphoff 1996). As Useem (1998) puts it: "Across Africa, crumbling public universities are barometers of the continent's intellectual malaise."

There seems to be general agreement that African universities are in severe crisis and that new approaches and renewed international and national support are needed to revitalize universities in SSA. However, despite the many reports written on the crisis facing universities in SSA (for example, World Bank 2000), it is rather surprising that data is often missing or relatively old. Most reports rely on qualitative data, as quantitative data on higher education systems, as published by international agencies such as the World Bank, the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the Food and Agriculture Organization of the United Nations (FAO) barely exist for SSA. This absence of data can be also seen as a reflection of the administrative weakness of many countries in the area of science policy (Eisemon and Davis 1991).

This study contributes to the current debate by offering solid information on the current status of African universities regarding their contribution to national agricultural research for development. Based on quantitative data collected in eight countries in SSA, it presents a wide range of indicators from universities and national research organizations related to research.

[2] In the early 1990s, over 88,600 African students were trained abroad (Beintema et al. 1998).

Chapter 2. Conceptual Issues

The conceptual framework of this study acknowledges that universities cannot be studied in isolation, but rather should be considered in a system context. Given their mandate for research and education, they are part of the national education system and the research system. Consequently, a system approach is adopted for analyzing the contributions universities make to agricultural development. The conceptual framework further acknowledges that institutional performance can be measured and explained through institutional policy, organization, and management. An approach for assessing the institutional research performance of universities and determining the factors that influence this performance is presented here.

2.1 Universities within the national agricultural research systems

In today's world, an ever-increasing part of the economy depends on science and its positive effect on productivity and profitability (Dasgupta and David 1994). Knowledge can be defined as the sum of what is known. In an economic sense, knowledge has been created by past investments that depreciate over time, and can be augmented by new investment. As a result of R&D the amount of things known, i.e. the stock of knowledge, can be expanded. "The extent to which the stock of knowledge is utilized – the rate of adoption of research results – depends principally on its applicability, as determined by the expected profitability of using the innovation and the user costs of acquiring the information" (Alston et al. 1994, p.23).

Universities can contribute twofold to an augmentation of the stock of knowledge, through teaching and through R&D. However, in developing countries, universities have been primarily regarded as teaching institutions. There are a number of arguments why universities should be involved in R&D and, indeed, may have a comparative advantage therein (Venezian 1995, cited in Echeverría et al. 1995; Eyzaguirre 1996):

- Local institutions should be involved in locally important R&D. Some local problems cannot be studied elsewhere as it is not possible to respond to local natural and social conditions abroad.
- Universities are usually composed of highly qualified human resources and a diversified infrastructure, both of which can be used for R&D. The existence of a teaching infrastructure may enable universities to carry out R&D even if limited budgets are available specifically for R&D.
- Universities profit from the synergy between teaching and R&D. R&D has a positive effect on the quality of teaching, as the necessary scientific skills are developed. Teaching has a positive effect on R&D as students provide a critical mass for scientific discourse, carrying out adaptive research (e.g. through theses), and provide cheap labor for assistance and fieldwork.
- A large university institution profits from the effects of scale and scope (e.g. existence of research culture, research infrastructure, and critical mass of highly educated scientists), which can be of great benefit for R&D.
- Universities usually have greater academic freedom than other R&D institutions. This may have a positive effect on creative, unplanned, and nonmainstream R&D. The associated scientific climate at universities is beneficial to R&D as well.
- Universities usually have good access to information and, due to advanced means of communication and personal relationships of staff trained abroad, interact well with the international research community.
- University R&D has comparative advantages in particular domains where long-term commitment, freedom of research, and public good character of the research result are relevant,

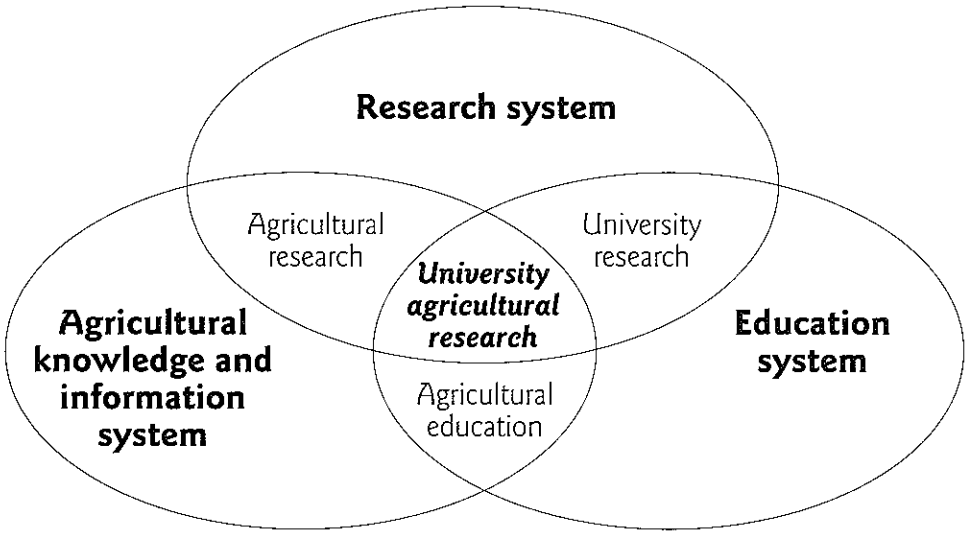
e.g., basic research, social science and economic research, natural resource management research, and others.

There are many arguments that call for investing in agricultural research at universities. However, the question remains of how to "institutionalize" agricultural research within a country, to clearly define the roles of the key players in agricultural research and how they should interact. Often, when dealing with these issues a systems perspective is applied (Wilson 1984; Hartwich and Meijerink 1999). Applying the systems perspective to agricultural research has led to the concept of the national agricultural research system (NARS). ISNAR defines a NARS as comprising all of a country's entities responsible for organizing, coordinating, or executing research that contributes directly or indirectly to the development of its agriculture and the maintenance of its natural resource base. Agriculture is understood to include the production of fish and trees, as well as crops and livestock (ISNAR 1992).

A further development of the NARS concept is the agricultural knowledge (and information) system (AKS or AKIS) concept, based on the work of Röling and Engel (1992). According to Röling (1990, p.1), an AKIS is "a set of agricultural organizations and/or persons and the linkages and interactions between them, engaged in processes such as the generation, transformation, transmission, storage, retrieval, integration, diffusion, and utilization of knowledge and information, with the purpose of working synergistically to support decision making, problem solving and innovation in a given country's agriculture or a domain thereof." AKIS actors include farmers, farmers' organizations, cooperatives, specialized services, universities, groups and study clubs, agro-based industries, public and private sector research, extension, and training institutions, agricultural press and information services, agricultural policy units, and formal and informal networks of many kinds. NARSs can be seen as a part of AKISs. AKISs are concerned with the various actors involved in the knowledge generation and diffusion chain, while taking into account the different feedback mechanisms and dynamics between these actors. Universities, in an AKIS context, contribute to the generation of new knowledge through research, but also through education.

Recently a somewhat different approach has been applied to agricultural research, making use of the "innovation system" perspective. This perspective has been developed in response to the observation that, in the past, innovations were thought to be generated through a (linear) knowledge and technology production process. Instead, innovation systems are now believed to be institutions that, jointly and individually, contribute to the development and diffusion of new technologies and which provide the framework in which governments form and implement policies to influence the innovation process (Mani 2001). In relation to the AKIS perspective, the innovation system perspective places primary importance on the creation of innovations; it sees the (sometimes chaotic) interaction of "players" in innovation as a major source of innovation. The innovation might not necessarily come from research, it can also originate from all those who take an active part in social and economic processes, or can simply be imported.

In any case, the systems approach to agricultural research suggests that there is more than one player that can execute agricultural research. The systems approach implicitly recognizes that universities are part of a larger research system or knowledge and information (innovation) system which is not limited to the NARO (Figure 1). One can assume that three independent systems exist, the research system, the education system, and the AKIS, each of which share some common ground with the activities of the others. These common grounds or overlapping spheres are "agricultural research" (research system and AKIS overlap), "university research" (research system and education system overlap), and "agricultural education" (education system and AKIS overlap). The sphere that is shared by all three systems is "university agricultural research". The implication is that activities within the sphere of university agricultural research can only be interpreted when the multiple relations between the three systems are understood.



Research system	Agricultural knowledge and information system (AKIS)	Education system
• Scientific and research institutions • Universities and colleges • Private-sector research • Science and technology policy units • Scientific press and information services	• Agricultural research institutions • Universities and colleges • Agricultural technical institutes • Extension organizations • Farmers and farmers' organizations • Private agro-based companies • Markets for agricultural inputs and outputs • Agricultural press and information services • Agricultural policy units	• Primary and secondary schools • Technical institutes • Universities and colleges • Training institutions • Adult education institutions • Education policy units

Source: ISNAR (1996a)

Figure 1. Systems context for university participation in national agricultural research

As universities, with their science and education mandates, are part of the NARS and AKIS, it is appropriate to analyze the contributions universities are making to national agricultural research. However, we argue that the role of universities within these systems has not been sufficiently recognized and that the focus of their activities has been on their contributions to the education system. The second hypothesis to be tested is that the research performance of universities in SSA, given their considerable human resources and scientific infrastructure, is relatively low. This will be tested by comparing the research performance of university scientists with the performance of scientists from NAROs.

2.2 Assessing a university's research performance

The literature on criteria for describing and defining organizational research performance is vast and varied (Lusthaus et al. 1997; Peterson 1998; Peterson et al. 2003; Alex 1998; Hartwich 1998; Horton et al. 1993). ISNAR (1992) suggested three performance criteria, i.e. organizational efficiency, effectiveness, and sustainability, to be useful in research performance evaluation:

- Effectiveness is the ability to meet defined objectives. Effectiveness refers to the quality of an organization's research output, the relevance of this output to users, and its ultimate contribution to agricultural development. Effectiveness is assessed by analyzing the defined goals of the national research system and determining whether the achievements of the component institutions correspond to the defined national priorities.
- Efficiency refers to how well resources and knowledge are used in generating research output. It is, therefore, a function of the inputs and the outputs of an activity.
- Sustainability refers to the ability of the organization to maintain performance over time, to continue to be relevant to its stakeholders, and to acquire the financial and other resources needed, indicating the organization's capacity to adapt to changing circumstances.

All these performance criteria were considered in the data collection and attempts were made to develop performance indicators that go beyond publication records. Consequently, performance indicators reflect a wide range of indictors, including (national and international) publications, (national and international) conferences attended, outputs for extension, meetings with technology users, and supervision of theses, thus allowing some conclusions to be drawn on the relevance of the research activities too. However, indicators predominantly address the efficiency criteria as there were clear limitations to identifying meaningful indicators for effectiveness and sustainability criteria.

The literature on management of organizations also offers many models that attempt to explain organizational performance and the criteria described above. One example is factor analysis, which involves describing various factors that contribute to effective organizational performance (Plucknett et al. 1990; Özgediz 1991). In this study the research performance of organizations is of particular concern. The approach used in this study builds on elements of previous models used to review organizational performance (Nestel 1989; Echeverría and Elliott 1990; Özgediz 1991). Our conceptual model has four major components that influence the research performance of agricultural research institutions, which ISNAR has termed the "MORP" categories: mandate, organization, resources, and program planning and management.

Mandate, objectives, and policies. Policymakers define the mandate, objectives, and policies of universities and other institutions of a NARS and, where an agricultural research council or other apex body exists, of the NARS itself. These are the guiding principles for these institutions. For example, government policies on export earnings, food security, and financing research are critical determinants of how, in broad terms, the NARS operates, as well as influencing how the individual institutions function, develop, cooperate, and perform.

Organization, structure, and linkages. The structure and organization of a NARS institution influences the extent of its involvement in development-oriented research and linkages with other institutions. For example, universities are typically oriented along disciplinary lines, while NAROs generally have a commodity-based structure, and this difference might inhibit linkages between the two types of organizations. The external environment and relationships with different stakeholders also influence the operations and performance of the institution. Institutions can bring about some internal changes, particularly in relation to their linkages, but policymakers traditionally play the most important role in determining how an institution is organized.

Resources (human, financial, and physical) and information. Human, financial, and physical resources and information management determine how much an institution can do in the area of agricultural development-oriented research. Thus, they also influence a research institution's performance. These factors are managed at the institutional level, but are influenced, if not determined, by policymakers.

Program and activity planning and management. Actual program planning and management processes, including priority setting and the planning, monitoring, evaluation, and coordination of activities and projects, significantly influence a research institution's performance. Institution

managers can determine many of these management processes, although priority setting is often a national exercise.

Consequently, our organizational model distinguishes between (1) variables that describe performance (i.e. performance criteria), and (2) variables that predict performance (i.e. performance predictors). It is presumed that there is a functional relationship; research performance criteria are the dependent variables, which are influenced by certain research performance predictors, the independent variables.

$$P = f(X) \tag{1}$$

where P is a vector of research performance criteria and X is a vector of research performance predictors.

Given the four categories of performance predictors, the analytical relationship between institutional performance and performance predictors can be defined as:

$$P = f(M,O,R,Pr) \tag{2}$$

where
M = a vector of performance predictors related to mandate objectives and policies at the university or research organization;
O = a vector of performance predictors related to organization, structure, and linkages of the university or research organization;
R = a vector of performance predictors related to resources (human, financial, and physical) and information available to researchers at universities or research organizations to conduct research;
Pr = a vector of performance predictors related to program and activity planning and management at the university or research organization.

Performance predictors that potentially influence the research performance of universities were distilled from a literature review (Hartwich 1997a,b; Michelsen and Hartwich 1997), and experiences relating to capacity development in higher education of the FAO (FAO 1993, 1996), the World Bank (Willett 1998; Alex and Byerlee 1999), and the United States Agency for International Development (USAID) (USAID 1986; Hansen 1989, 1990). Table 2 summarizes the performance predictors in each of the MORP categories.

All these performance predictors were considered in the data collection. However, it was not possible to develop meaningful indicators for all them. Table 2 also shows in parentheses the indicators that were developed from the collected data (see Chapter 3.3). It can be seen that meaningful indicators for physical resources or information availability could not be developed.

Based on our organizational model, this report addresses questions that are related to the research performance of university scientists and to factors that influence their research performance.

Questions related to research performance are: How many publications do universities produce and how many conferences do they attend? Do they regularly meet with technology users? How does the research performance of university scientists compare to other research scientists? Are there major differences in performance between universities? What are the factors that can explain the scientists' research performance? Are they solely related to the qualification levels of staff members or do they also relate to how research is managed and organized at universities?

Questions related to the four categories that characterize an organization are:

- **Mandate, objectives, and policies:** Do universities have a mandate for development-oriented agricultural research and what are the research objectives and policies? Do universities contribute to the development of national strategic plans for research?

Table 2. Performance Predictors that Potentially Influence the Research Performance of Universities

Mandates, objectives, and policies	Organization, structure, and linkages	Resources and information	Program planning and management
• Absence of an explicit mandate for development-oriented research at universities (university mandate) • Lack of university involvement in the NARS (university participation in NARS)	• Organizational structure which does not promote research at universities (degree of interdisciplinarity; technology orientation) • Poor or non-existent linkages with NAROs and other research organizations (NARO–university linkages) • Poor or non-existent linkages with technology users and potential clients of research (user orientation; private sector involvement) • Poor or non-existent linkages with international organizations (time at international conferences; international science linkages; international donor linkages)	• Existing potential of human resources at universities that is not used for research (gender; research time; job experience; academic qualification; teaching time; studying; consultancy) • Low or non-existing funding for university research (research expenditures) • Poor or non-existing physical facilities for research at universities • Missing information on ongoing and proposed research	• Lack of monetary and nonmonetary incentives for university staff to do research (incentives) • Lack of management functions of planning, monitoring, and evaluation (PM&E) for research at universities (degree of self-initiative; PM&E) • Differing management functions in the NARS with regard to PM&E (PM&E) • Absence of national research objectives, policies, and priorities (research priorities)

Source: Adapted from Michelsen and Shapiro (1998)

- **Organization, structure, and linkages:** How is research organized within a university? Who is responsible for agricultural research? How many postgraduate courses in agriculture and related fields are offered? Who do university scientists collaborate with when conducting their research?
- **Resources:** What are the resources that universities have available for conducting research? Are these important within the national context? How do university scientists allocate their professional work time?
- **Program and management:** What kind and type of research do university scientists conduct? Do university scientists get promoted based on their teaching or research performance? Who initiates the research of university scientists? Are there any research priorities at universities? Is there a PM&E system in place at universities?

To summarize, it can be argued that the research performance criteria, as well as research performance predictors, can be measured and that there is a functional relationship between the two groups. The third hypothesis to be tested is that research performance, particularly the efficiency of universities in SSA, can be explained by a set of institutional factors related to the dimensions of their mandate, the structure and organization of their research, their resources, and the programming and management of their research.

Chapter 3. Study Methods

This study analyzes the performance of universities in agricultural research in SSA in relation to (a) other research organizations, in particular NAROs, and (b) a set of institutional and historical/cultural factors which possibly influence research performance. Against these objectives we will test three key hypotheses:

1. Research performance at universities in SSA is lower than at NAROs.
2. Research performance at universities in SSA is influenced by the historical and cultural development of the country in which they are based.
3. Research performance at universities in SSA is determined by a set of institutional factors related to the dimensions of their mandate, the structure and organization of their research, their resources, and the programming and management of their research.

By testing and discussing these hypotheses we aim to improve understanding of if and how universities can be more actively involved in the national research systems in SSA, so that more development-oriented research results can be made available to enable sustainable agricultural development.

Evaluating agricultural research is a particularly difficult undertaking as the research process is complex and very hard to measure, with a high degree of unpredictability of its output. By no means can it be compared to production processes from other industries that can be conveniently analyzed by means of economic, statistical, and management tools. The indicators used in agricultural research (and in this study) should be seen for what they are: mere proxies of determinants of a barely quantifiable process. From the analysis undertaken, it is clear that research performance evaluation is a difficult undertaking, particularly in situations where data is difficult to obtain, incomplete, and not really comparable across institutions and countries. Developing and quantifying appropriate indicators for establishing research performance proved to be challenging. Thus, all results have to be interpreted with caution, as the model applied did not sufficiently take into account all of the inputs which were used to derive research outputs.

However, we are convinced of the value of the available dataset and that some quantification of the research process is necessary and useful to rationalize perceptions on research performance. Rule-of-the-thumb methods and peer views are important for day-to-day decisions in agricultural research management. However, they are weak for management policy formulation. Conventional cost–benefit analysis, using inputs for agricultural research, remain important for overall justification of resource allocation in comparison to other sectors and when comparing large research subsectors (e.g. research on cassava or on maize), but they are not able to provide management advice.

Simple description of isolated indicators of the research process is not appropriate, given the high degree of complexity and the many interactions which occur in the analysis of R&D performance. In fact, the evaluator faces a situation in which a set of research performance determining factors influences a large set of different research output categories. Based on a comparative case study approach, this study used partial correlation analysis and multiple regression models to deal with these interactions.

This chapter describes how the countries were selected, how the data were collected within these countries, how the indicators were developed to describe research performance and performance predictors, and the data analysis.[1]

[1] A more detailed description of the fieldwork approach used, including questionnaires and interview guidelines is presented in ISNAR (1996b).

3.1 Selection of countries

Countries and their NARS were selected to give a representation of the different historical and cultural backgrounds (Anglophone and Francophone). These are linked to the countries' colonial pasts, and expressed in their official languages. Another criterion was a strong national commitment towards improving the agricultural research system and university contributions to development-oriented research. As described in Chapter 1, the historical and cultural background of a country strongly influences the policy, organization, and management of universities and their relationship with other organizations in the NARS.

When selecting countries, the size of their NARS (small, medium, or large)[2] was also taken into account. Previous ISNAR studies have shown that the developing world is not a single, homogenous group with regard to the way they organize agricultural research. Smaller systems often experience special difficulties in meeting the broad range of demands placed on them (Eyzaguirre 1996). This directly influences research strategies, research programs, and the management and organization of resources of both the overall NARS and universities.

The following countries participated in the project: small-sized Benin and Burkina Faso and medium-sized Côte d'Ivoire and Cameroon as Francophone countries; and medium-sized Uganda and Zimbabwe and large-sized Tanzania and Nigeria as Anglophone countries. However, as Nigeria's NARS is so large, only part of the system was studied. The focus being on Ahmadu Bello University (ABU), Zaria, which has three specialized agricultural research institutes, as well as faculties of agriculture and veterinary medicine, in addition to other relevant units and departments across the university.

3.2 Data collection

Secondary data on resources available for research in universities and on the outputs of scientists in each country is very limited. Therefore, most of the data presented in this report is based on primary data. Different modes were used for collecting the data for determining the performance indicators and performance predictors:

- Questionnaires for university and NARO researchers were designed to collect information about the qualifications, time allocation, activities, outputs, and linkages of researchers. In addition, they were asked to complete from one to three questionnaires for each major research activity they were involved with.
- Interviews with key actors from the universities and NAROs were designed to obtain additional information about the universities' actual and potential research activities, as well as a personal assessment of the strengths and weaknesses of the university.

Data was collected by two national consultants in each of the chosen countries. Data collection in Cameroon and Tanzania was carried out separately since it was part of a PhD study analyzing other aspects of research performance as well. Here, the data was collected based only on a sample of research activities, i.e. research on cassava, beef cattle, and agroforestry. As a consequence, not all indicators are comparable between the 8 countries. Therefore, in some cases, correlations were only applied to the 6-country dataset or to a dataset not including all variables. Table 3 summarizes, for each country, the number of questionnaires completed and the number of interviews conducted.

The number of interviews that were conducted by the national consultants varies with the size of the NARS. Furthermore, information from Benin and Nigeria is slightly different from that from

2 For this study, three main NARS sizes were distinguished: small, medium, and large. Operationally, a country with 150 or fewer full time research scientists in its NARS was defined as small, one with 151–350 researchers was defined as medium, and with 351 or more full time research scientists was defined as large.

Burkina Faso, Côte d'Ivoire, Uganda, and Zimbabwe due to an improvement in the fieldwork approach used for data collection in these countries. For example, information on individual staff in Benin and Nigeria is limited to research activities of university staff. Data in Benin and Nigeria were collected in 1995, and in Burkina Faso, Côte d'Ivoire, Uganda, and Zimbabwe in 1997.

Table 3. Number of Staff Members Who Completed the Questionnaire and Number of Key Actors Interviewed by Country

Mode of data collection	BE	BF	CA	CI	NI	TA	UG	ZI	Total
Questionnaires completed by university researchers	67	52	9	38	59	24	66	32	**347**
Questionnaires on university research activities	70	155	55	90	47	69	177	90	**753**
Questionnaires completed by NARO researchers	37	100	43	132	69	48	87	122	**638**
Questionnaires on NARO research activities	–	274	236	315	–	157	317	260	**1559**
Interviews with university key actors	21	17	4	17	19	4	22	8	**112**
Interviews with NARO key actors	14	21	8	15	34	2	33	27	**154**
Total questionnaires completed by researchers	104	152	52	170	128	72	153	154	**985**
Total research activities	70	429	291	405	47	226	494	350	**2312**
Total key actors interviews	35	38	12	32	53	6	55	35	**266**

Return rates of questionnaires ranged from 41% in ABU-Nigeria to 87% in Uganda. The return rate was defined as the number of questionnaires completed by researchers divided by the total number of research staff identified in a country. It was generally much more difficult to obtain data from university staff than from NARO staff. However, the return rate from the university staff was higher than that of the NARO staff in Benin and Burkina Faso.

In total, the analysis presented here is based on 985 questionnaires completed by researchers, 2312 completed questionnaires on research activities, and 266 interviews.

3.3 Indicators

Finding meaningful and reliable indicators that describe and predict research performance is important. As discussed above (Chapter 2.2), it was not possible to develop indicators from the collected data for all performance criteria and MORP predictors that were defined a priori in our organizational model. The list of indicators that were developed from the data collected is summarized in Table 4.

Table 4 also highlights the main characteristics of the indicators. It summarizes the data source, data type, data availability, and the number of observations for each indicator. As the unit of analysis is the individual researcher, it is important to note that not all data was available at the individual level. Indicators for performance predictors in the category "mandate, objectives, and policies" (M1 and M2), "program planning and management" (Pr3, Pr4, Pr5) and "resources" (R2) were not available from questionnaires with individual staff members. Information was gathered through interviews with key actors in the organization, such as department heads and deans of faculty, or in the

Table 4. Variables for Statistical Analysis

Classification	Variable	Indicator	Code	Data source	Data type	Data availability	Number of observations
Category	Type of research organization	University or NARO	Type	–	D	–	892
	Cultural background	Anglophone or Francophone	Culture	–	D	–	892
	Country	Benin, Burkina Faso, Cote d'Ivoire, Cameroon, Nigeria, Tanzania, Uganda, Zimbabwe	Country	–	Discrete	–	892
Performance criteria	Publications	Number of international and national papers, national and international conference papers, and books and book chapters published (over the last 5 years)	P1	Q	C	All countries	890
	International publications	Number of international papers, international conference papers, and books and book chapters published (over the last 5 years)	P1a	Q	C	All countries	890
	Conferences attended	Number of national and international conferences/ workshops/seminars attended (over the last 5 years)	P2	Q	C	Be, Bu, Co, Ni, Ug, Zi	781
	International conferences attended	Number of international conferences/workshops/seminars attended (over the last 5 years)	P2a	Q	C	Be, Bu, Co, Ni, Ta, Ug, Zi	845
	Outputs for extension	Number of outputs for extension, such as production recommendations for farmers, publications, and video tapes (over the last 5 years)	P3	Q	C	Be, Bu, Co, Ni, Ug, Zi	783
	Meetings with users	Number of meetings with farmers and extension services (over the last 5 years)	P4	Q	C	Bu, Co, Ug, Zi	576
	Theses supervised	Number of MSc and PhD theses completed that were supervised (over the last 5 years)	P5	Q	C	Bu, Ca, Co, Ta, Ug, Zi	186
Performance predictors: Mandate	University mandate	University mandate for development oriented research (Y/N)	M1	I	D	All countries	890
	University participation in NARS	University participation in developing national strategic plan for agricultural research (Y/N)	M2	I	D	All countries	890
Performance predictors: Organization	Degree of interdisciplinarity	Share of research time spent on multidisciplinary research projects (during the last year)	O1	Q	C	Bu, Co, Ug, Zi	480
	NARO–university linkages	Share of research time spent on research projects linked between NARO and Universities (during the last year)	O2	Q	C	Bu, Co, Ug, Zi	481
	User orientation	Share of research time spent on research projects which are linked to users (during the last year)	O3	Q	C	Bu, Co, Ug, Zi	479
	Time at international conferences	Share of time spent at international workshops/seminars and conferences (during the last year)	O4	Q	C	Be, Bu, Co, Ni, Ug, Zi	774

Table 4. Variables for Statistical Analysis (continued)

Classification	Variable	Indicator	Code	Data source	Data type	Data availability	Number of observations
	International science linkages	Share of research time spent on research projects which are linked to international universities and international research organizations (during the last year)	O5	Q	C	Bu, Co, Ug, Zi	480
	Private sector involvement	Share of research time spent on research projects which are linked to the private sector (during the last year)	O6	Q	C	Bu, Co, Ug, Zi	480
	International donors linkages	Share of research time spent on research projects which are linked to international donors (during the last year)	O7	Q	C	Bu, Co, Ug, Zi	479
Performance predictors: Resources	Gender	Female or male (data presented shows percentage of female scientists)	R1	Q	D	All countries	892
	Research expenditure	Agricultural research expenditure per researcher in 1991 (in million 1985 PPP$ per country)	R2	ASTI	C	All countries	892
	Research time	Share of time allocated to research (during the last year)	R3	Q	C	All countries	860
	Job experience	Number of years working since highest degree year	R4	Q	C	Be, Bu, Co, Ni, Ta, Ug, Zi	771
	Academic qualifications	Highest degree attained (data presented shows percentage of researchers with PhD)	R5	Q	D	All countries	892
	Teaching time	Share of time allocated to teaching (during the last year)	R6	Q	C	Be, Bu, Co, Ni, Ug, Zi	779
	Studying	Currently studying (Y/N) (data presented shows percentage of researchers currently studying)	R7	Q	D	Be, Bu, Co, Ni, Ug, Zi	778
	Consultancy	Share of time allocated to consultancy (during the last year)	R8	Q	C	Be, Bu, Co, Ni, Ug, Zi	773
Performance predictors: Program	Technology orientation	Share of research time spent on applied and adaptive research projects (during the last year)	Pr1	Q	C	Bu, Co, Ug, Zi	481
	Degree of self-initiative	Share of research time spent on self-initiated research projects (during the last year)	Pr2	Q	C	Bu, Co, Ug, Zi	479
	Incentives	Performance in research is one of the two most important criteria for promotions in the unit (Y/N) (data presented shows percentage of researchers in units with research incentives)	Pr3	I	D	Bu, Co, Ug, Zi	556
	Planning, monitoring, and evaluation	PM&E system exists in the unit (Y/N) (data presented shows percentage of researchers in units with PM&E)	Pr4	I	D	Bu, Co, Ug, Zi	569
	Research priorities	There are formally spelled-out priorities in the unit (Y/N) (data presented shows percentage of researchers in units with research priorities)	Pr5	I	D	Bu, Co, Ug, Zi	576

Notes: Q, questionnaires to individual staff members; I, interviews with key actors of institution; ASTI, ISNAR project on agricultural science and technology indicators; C, continuous data; D, dichotomous data; and Discrete, discrete data

case of research expenditures (R2) from another ISNAR database. As this data lacked variation and was only available at the country rather than at the institutional level it had implications for the data analysis (see Chapter 3.4).

Most of the indicators are continuous or discrete. Discrete variables such as highest degree achieved were re-categorized into a dichotomous variable, also known as dummy variable coding. The advantage of the dummy variable is that a variable with only two points can have a linear relationship with other variables. Consequently, they can be appropriately analyzed by methods using correlation where only linear relationships are analyzed (Tabachnick and Fidell 1996). The only exception is the category 'country' which is categorical.

3.4 Data analysis

The unit of analysis is the individual scientist.[3] Three types of statistical analysis were applied to the dataset:

1. Analysis of variance between independent groups (e.g. between research performance between universities and other research organizations)
2. Analysis of partial relationships between variables (e.g. correlations between research performance indicators and performance predictors)
3. Analysis of multiple relationships between variables (e.g. regression of research performance indicators with institutional factors).

Variations between independent groups: First, a set of group indicators, i.e. the historical background and the type of organization, was tested with regard to their influence on the research performance of the organization. The identified indicators were tested for significance using analysis of variance for comparing dichotomous/discrete with dichotomous/discrete variables (e.g. gender ['female' or 'male'] versus type of institution ['NARO' or 'university']) and analysis of variance for comparing dichotomous/discrete with continuous variables (e.g. gender ['female' or 'male'] versus number of publications). With this procedure it could be determined whether the observed differences in means were significantly different between the two groups.

Relationships between the variables: Then partial correlations between each of the performance criteria and each of the performance predictors were analyzed to answer the following questions:

- Is there are relationship between the performance predictors and the performance criteria? Can one reliably predict performance with this predictor?
- How important is the performance predictor?

Partial correlations have been applied to the whole dataset (all university scientists) and subsets of data (Francophone and Anglophone university scientists).

Multivariate relationships between the variables: Both the analysis of differences between groups and of relationships between the variables are partial and cannot account for multivariate effects. In fact, two types of multivariate effects can be distinguished (1) one performance criteria can be influenced simultaneously by a range of performance predictors, and (2) one performance predictor can simultaneously influence a range of performance criteria. Often, such a problem is solved through aggregation of the dependent variables (performance variables) into a single cumulative indicator. In such a case regression analysis and analysis of variance can be applied for holistic analysis. However, in the case of research outputs aggregation of the different performance variables to a cumulative indicator is a problem. Often it is argued that particular research results (such as, for example, "papers published in journals") cannot possibly be compared with research outputs (such as, for example, "meetings with technology users").

[3] Only scientists with an MSc or PhD or comparable degree were included in the analysis.

Multiple regression analysis was therefore applied in order to avoid the aggregation and the autocorrelation problem of other multivariate methods, but still enabling multivariate effects between variables to be analyzed. With the use of multivariate statistics complex interrelationships among variables are revealed and assessed in statistical inference. The following questions are of particular importance in this study:

- Is there a relationship between the performance predictors, the category, and the performance criteria? Can one reliably predict performance?
- Which performance predictors and categories are important and which ones are not?

Nonlinear regressions were carried out for each of the performance criteria. However, three performance predictors, namely "existence of a mandate for research at the university" (M1), "participation of the university in the national agricultural strategy" (M2), and "research expenditure" (R2) had to be excluded from the multiple regression analysis because the dataset lacked variation and data were only available at a country not an institutional level. Consequently, the category "Mandate, objectives, policies" of our organizational model could not be included in this analysis.

Chapter 4. Study Results: Agricultural Research at Universities

This chapter presents a descriptive analysis of agricultural research at universities in the eight countries studied. First, the contribution of these universities to national agricultural research is highlighted; followed by a comparative analysis of the major institutional characteristics of these universities.

4.1 Contribution to national agricultural research systems

The structure of the NARSs and the role universities play within these systems varies substantially among the country cases. An overview of the main components of the NARS of the eight countries studied is presented in Annex 1.

In two of the Francophone countries, namely Burkina Faso and Côte d'Ivoire, the same ministry supervises both the universities and NAROs. In Benin and Cameroon, the other two Francophone countries studied, they fall under different ministries, as is the case in all four Anglophone countries studied. In Burkina Faso, Cameroon, Tanzania, and Zimbabwe, NAROs belonging to different ministries have been identified as part of the research system. None of the universities studied fall under the jurisdiction of a Ministry of Agriculture.

Public research organizations (NAROs) are the most prominent components of most NARSs and have the central mandate for agricultural research. The number of NAROs in each country differs substantially and is not directly related to the size of the research system. In Benin, Cameroon, and Tanzania several departments, and in Uganda seven institutes, are organized under the umbrella of one major NARO. In Côte d'Ivoire and Zimbabwe there are two major NAROs, compared to four in Burkina Faso, and twelve in Nigeria, three of which have been included in the present study as they are closely linked to ABU.

The academic components of the research system have been defined as all universities, faculties, and departments that are related to agriculture and have the capacity to conduct agricultural research. The number of universities in each of the case studies varies. There is one university in each of Benin, Burkina Faso, and Uganda. Tanzania has two universities, as does Zimbabwe, where a second private university was established four years ago. In Côte d'Ivoire, the academic component of the agricultural research system consists of the Grande Ecole and three universities. Cameroon has six universities of which one is set up as an agricultural college. In Nigeria, ABU is one of 36 universities, of which 23 have a Faculty of Agriculture and 5 have a Faculty of Veterinary Medicine. There are also three agricultural universities.

Human and financial indicators of resources available for agricultural research at the country level are available for 1991 from the dataset of the Agricultural Science and Technology Indicator Project (Table 5).[1] It shows that the number of researchers per million agricultural laborers is highest in Cameroon, Cote d'Ivoire, and Zimbabwe, with over 100 researchers per million agricultural laborers, and is particularly low in Uganda, Burkina Faso, and Nigeria, with less than 40 researchers per million. The research expenditure per researcher also varies substantially. Expenditure per researcher

[1] The focus of the data collection for this project was on national agricultural research institutes. Data represents best estimates. The dataset provides information at the country but not the institutional level within these countries.

Table 5: Human Resources and Research Expenditure of Agricultural Research in Country Studies (1991)

Country/region	FTE researchers	Research expenditure (million 1985 PPP $)	Expenditure/ researcher (million 1985 PPP$)	Agricultural labor (thousands)	Researchers per million agricultural laborers	Agricultural GDP (million 1985 PPP $)	Expenditure as % of agricultural GDP	Total population (thousands)
Benin	90.0	*10.044*	*0.112*	1341	67.1	1713.8	*0.59*	4767
Burkina Faso	142.4	19.130	0.134	4053	35.1	2263.0	0.85	9248
Cameroon	332.0	*37.050*	*0.112*	2704	122.8	3244.0	*1.14*	11857
Côte d'Ivoire	298.0	37.842	0.127	2563	116.3	4701.6	0.80	12436
Nigeria	1012.8	86.902	0.086	27103	37.4	45174.9	0.19	112072
Tanzania	546.0	74.708	0.137	10312	53.0	7625.6	0.98	26898
Uganda	183.0	*20.422*	0.112	6414	28.5	4414.6	*0.46*	18112
Zimbabwe	290.8	43.252	0.149	2723	106.8	2299.9	1.88	10266
Of which:								
Francophone countries			0.121		80.9		0.87	
Anglophone countries			0.111		43.7		0.38	
For comparison total SSA (48 countries)			**0.112**		**63.3**		**0.63**	

Source: ISNAR 2003 (dataset of the Agricultural Science and Technology Indicator Project)

Note: Italicized FTE figures have been estimated on the basis of the average number of researchers per million population. Italicized expenditure figures have been estimated by multiplying the number of FTE researchers with the average expenditure per researcher (0.112 million 1985 PPP$). Italicized agricultural labor figures have been estimated using the regional average share of agricultural labor in total population.

is particularly low in Nigeria at USD 86.00 (1985 PPP$), whilst in Benin, Cameroon, and Uganda it is USD 112.00, which reflects the average of 48 sub-Saharan African countries. The expenditure per researcher is highest in Zimbabwe, followed by Burkina Faso, Tanzania, and Cote d'Ivoire. These expenditure trends are confirmed when research expenditure as a percentage of agricultural GDP is calculated. Only Cameroon has a relatively high percentage of expenditure per agricultural GDP.

Averages of these indicators for different country groupings indicate that agricultural research systems in Francophone countries received greater human and financial resources than research systems in Anglophone countries. On average, Francophone countries had considerably more researchers, with 81 per million agricultural laborers, compared to Anglophone countries, with 44 researchers per million agricultural laborers. The per capita expenditure on Francophone researchers was also higher than that on Anglophone researchers, at USD 121.000 as opposed to USD 111.000. Expenditure as a percent of agricultural GDP was also over double that in Anglophone countries (0.9% compared to 0.4%).

Based on data collected in the country studies, selected information on human and financial resources at institutional level are available and presented in Figure 2. In all the countries studied, universities contribute significantly to the total number of researchers available for agricultural research. The size of the NARSs in human resource terms varied from 173 scientists in Benin to 513 scientists in Tanzania. The total number of scientists has been converted into full time equivalents (FTEs) according to the percentage of time staff use for research. In all of the countries, the number of university FTEs (based on approximately one-third of staff time being spent on research) contributes significantly to the total number of FTEs available for agricultural research, ranging from 16% in Tanzania to 48% in Zimbabwe of all human resources for agricultural research.

When comparing the research funds available to universities and NAROs, only officially budgeted research funds for universities were taken into account. This implies that international donor funds directly or indirectly supporting research activities have not been fully included and, therefore, the research funds available to universities are probably underestimated. Nevertheless, university contributions to the total financial resources available for agricultural research are significantly lower in all countries than their contributions to human resources (Figure 2). They range from zero in Burkina Faso to 16% in Tanzania. The lack of a research budget in some countries might be explained by the fact that many universities fall under the Ministry of Education whereas national research funds are channeled through specialized Ministries, such as the Ministry of Agriculture. Therefore, access to these research funds by universities is limited.

Based on the descriptive comparative analysis above, the following key conclusions can be drawn regarding the contributions of the universities to national agricultural research:

- Universities contribute significantly to the total human resources available for national agricultural research.
- Universities' financial resources for agricultural research are very low compared to NAROs.
- Francophone agricultural research systems have significantly more human and financial resources per farmer available than Anglophone research systems. Research expenditure per researcher is also higher.

4.2 Institutionalization of agricultural research within universities

This section presents a comparative analysis of the major institutional characteristics of the universities in the eight countries. The structure follows our conceptual model on components that influence the research performance of agricultural research institutions: mandate, organization, resources, and program planning and management. Within each component characteristics of the universities are analyzed. Indicators for universities are compared across countries and country groups and the main differences in comparison with NAROs are highlighted.

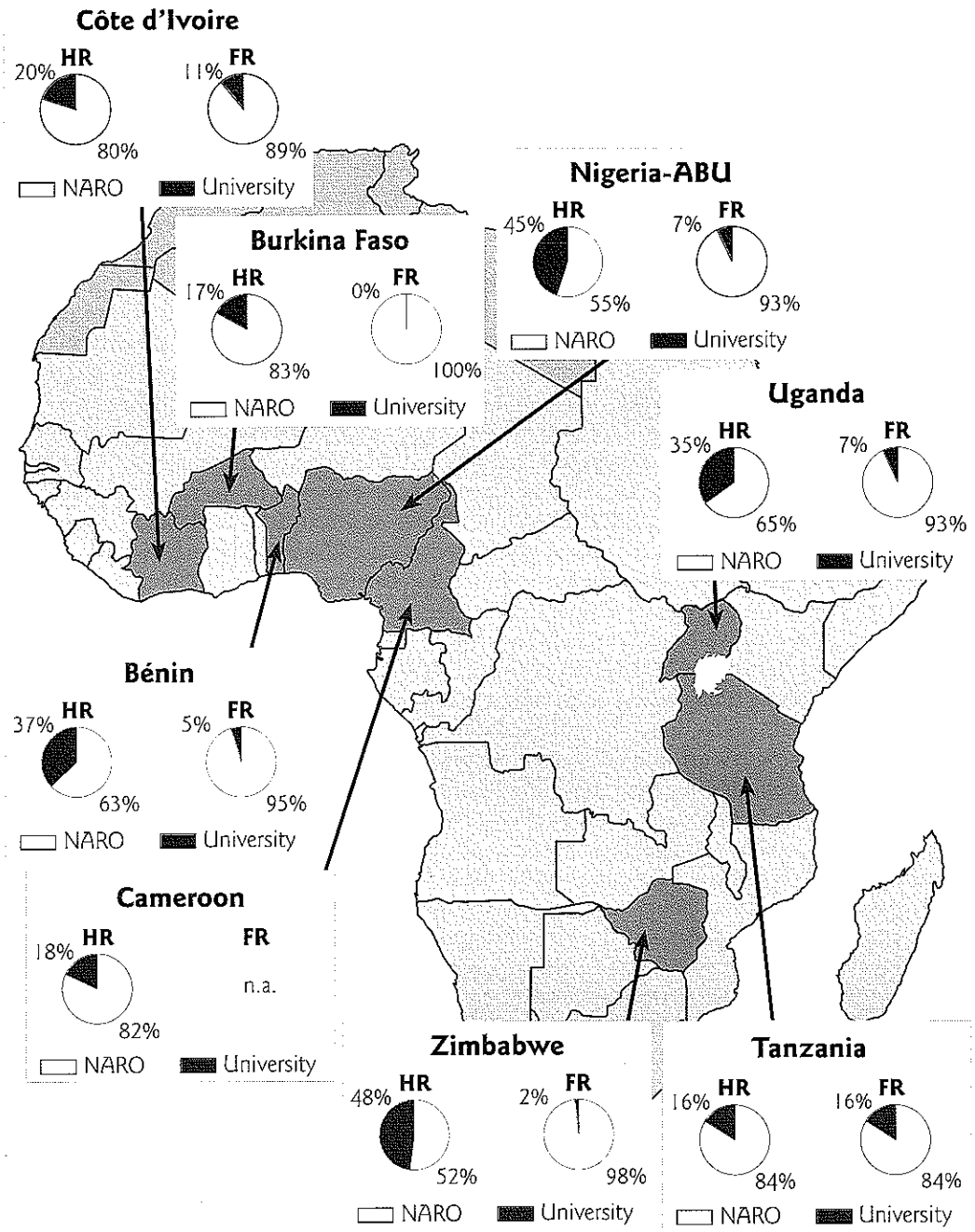


Figure 2. Human and financial resources for agricultural research in universities and NAROs in study countries (1993–1995 in %). HR, human resources; FR, financial resources. *Source:* Table A1.

4.2.1 Mandate, objectives, and policies

Mandate, objectives, and policies provide the foundation of any organization. If research is to be legitimized and encouraged, it is important that universities have a mandate for research and clarify what kinds or types of research are endorsed. Without a mandate for development-oriented research, which is defined as research that contributes to national development objectives, universities can regard themselves as a hired resource to assist public agricultural research organizations.

All universities have a mandate for research and training. However, of the universities reviewed, only two Anglophone universities, ABU in Nigeria and Dar Es Salaam University in Tanzania, have an explicit mandate for development-oriented research (Table 6). These two cases can be explained by the attempts made to establish land-grant type universities in SSA, which were supported by the US Development Corporation. Francophone universities made fewer efforts to integrate the research, teaching, and outreach functions. In general, the Anglophone system strongly recognizes the importance and contributions that universities can make to R&D. The Francophone system regards universities as teaching institutions while research is conducted in specialist NAROs.

If national research policies do not identify universities as part of the NARS, universities and NAROs function independently rather than interdependently. This is a critical factor in determining the university's contribution to national development efforts. An important indicator is, therefore, the university participation in NARS expressed as their contribution to the development of the national strategic plan (Table 6).

Table 6. Performance Predictors Related to the Mandate, Objectives, and Policies in Selected Countries

Country/region	University mandate for development-oriented research	University participation in NARS
Benin	No	Yes
Burkina Faso	No	No
Cameroon	No	No
Côte d'Ivoire	No	No
Nigeria (ABU)	Yes	Yes
Tanzania	Yes	No
Uganda	No	Yes
Zimbabwe	No	–

At the time of data collection, all but one country, namely Zimbabwe, had a national strategic plan for agricultural research or was just developing one, as in the case of Benin (see also Hambly-Odame and Setshwaelo 1997). Benin started the process of developing a new agricultural research policy in 1993 with the participation of key stakeholders such as the University of Benin.[2] Nigeria (in 1989) and Uganda (in 1991) also involved key stakeholder groups in the formulation of their agricultural research policies. In the other countries university staff participated in different ways to its development. Although in two countries, Burkina Faso and Cote d'Ivoire, (a) universities and NAROs are organized under the same Ministry (i.e. the Ministry for Research and Higher Education) and (b) the universities have a clear research mandate, they did not as institutions participate in setting up the national strategy for agricultural research. Instead, individual researchers were asked to contribute as subject matter specialists. In Tanzania and Cameroon, too, universities have not been included in the national planning process, although they have been identified as sources of knowledge that can participate in research conducted by the NARO. Consequently, Benin, Nigeria, and Uganda were the only countries where the universities actively participated as institutions in developing the national strategic plan.

Based on this analysis the following key conclusions can be made regarding the mandate, objectives, and policies of the universities:

- A research mandate exists in all universities. A few Anglophone universities, but none of the Francophone universities, also have an explicit mandate for development-oriented research.

[2] However, for data analysis purposes this indicator was set as 'No' for Benin, as the new strategic plan had not yet been completed when collecting data for this study.

- Universities are becoming more and more recognized as part of NARSs. However, only a few countries' universities actively contributed to the development of a national strategic plan for research as a NARS component institution.
- Anglophone research systems seem to strongly recognize the importance and contributions that universities can make to research and development.

4.2.2 Organization, structure, and linkages

The organization and structure of a university influences the extent of its involvement in development-oriented research and its linkages with other organizations. In the country studies, the organization and structure of universities and agricultural research within universities is very diverse and related very much to the historical and cultural development of the country. Most universities and colleges were founded in the 1960s or 70s, after independence of these countries (Table 7). Only Makerere and Zimbabwe University existed as colleges before this and received university status in the early 70s. Most of the universities have Faculties of Agriculture and Veterinary Medicine/Sciences, while the University of Ouagadougou (Burkina Faso) has an Institute for Rural Development. Most agricultural scientists in Cote d'Ivoire are trained at the National Higher School of Agronomy (ENSA).

Table 7 summarizes how these universities are involved in postgraduate agricultural education. Only three of the Anglophone universities, ABU, Sokoine, and Zimbabwe, offer a PhD in agriculture or veterinary medicine. Other universities offer the possibility for dissertation through their relationships with other faculties and universities. However, it is important to note that at the time of data collection no Francophone university in SSA offered a PhD in agriculture, rural development, or veterinary medicine.

Table 7. Universities and Colleges Involved in Postgraduate Agricultural Education

Country	University	BSc	Master	PhD
Benin	University of Benin: Faculty of Agriculture (1970)	No	Yes	No
Burkina Faso	University of Ouagadougou:			
	Rural Development Institute (1973)	No	Yes	No
Cameroon	University of Dschang (1977, 1993): Faculty of Agriculture	Yes	Yes	No
Cote d'Ivoire	National higher school of agronomy (ENSA) (1965)	No	Yes	No
Nigeria	ABU:			
	Faculty of Agriculture (1962)	Yes	Yes	Yes
	Faculty of Veterinary Medicine (1964)	Yes	Yes	Yes
Tanzania	Sokoine University (1984): Faculty of Agriculture	Yes	Yes	Yes
	Faculty of Veterinary Medicine	Yes	Yes	Yes
Uganda	Makerere University (1922, 1970):			
	Faculty of Agriculture and Forestry	Yes	Yes	No
	Faculty of Veterinary Medicine	Yes	Yes	No
Zimbabwe	University of Zimbabwe (1953, 1970):			
	Faculty of Agriculture	No	Yes	Yes
	Faculty of Veterinary Medicine	Yes	Yes	Yes

Source: ISNAR 2001; Beintema et al. 1998

Notes: Only faculties and institutes that are directly linked to agriculture are listed here. In some cases, e.g. Burkina Faso and Cote d'Ivoire, other faculties of the university such as faculties of sciences are also very relevant for postgraduate agricultural education. The degrees offered in Francophone and Anglophone universities and colleges are not directly comparable. In most cases, the 'Diplômes d' Ingénieur d' Application', 'Licences', and 'Maîtrises' equal a BSc; the 'Diplômes d' Ingénieur' ('Agronome', 'Vétérinaire', etc.) and 'DEA' correspond to a MSc; and the 'Doctorat de IIIème Cycle', 'Doctorat d' Université', and 'Dr d' Etat' to a PhD. Although some faculties do not directly offer a PhD, they still offer the possibility for dissertation through relationships with other faculties and universities.

In general, it is difficult to compare the postgraduate programs across countries as they have very different entry requirements, minimum duration, number and type of courses offered, course content, and mode of examination (Zoungrana and Temu 1996). However, the existence, scope, and size of postgraduate programs are closely related to the universities' contributions to research. Postgraduate programs imply that the university has a well-established research mandate and function. Postgraduate students also increase the availability of human resources and, normally, the amount of funds available for research. Consequently, they influence the research outputs that can be expected.

As a rule, universities are organized along disciplinary lines and departments have considerable autonomy in defining scientific topics. As most agricultural problems have multidisciplinary dimensions it was expected that disciplinary research was limiting the potential contribution of universities to development-oriented research. However, results of our survey showed that most research conducted at universities was multidisciplinary, as scientists spent an average of 65% of their research time on multidisciplinary research (Table A2). This average is only slightly lower than that for scientists in NAROs, who spent an average of 67% of their research time on multidisciplinary research. Given the organizational structure at universities, this difference is smaller than expected. The question is then whether universities have a comparative advantage for conducting multidisciplinary research.

The current administrative structures of African universities still bear the mark of their European origins, although in practice they have often been modified by national political philosophies and associated approaches to development administration (Saint 1992). Typically, their administrative organization is highly centralized, hierarchical, and rigid (Assie-Lumumba 1993). Universities in the case study countries were found to have the following structures:

- A faculty/college director or vice-director for research, who is appointed to organize and administer research activities. In Burkina Faso, each faculty has a vice dean for research and extension as well as a vice dean for academic affairs. At Sokoine University (Tanzania), the Director of Research and Post-Graduate Studies is responsible for coordinating research activities, managing and facilitating the dissemination of research findings and results, maintaining an inventory of research facilities, and soliciting and administering research funds.
- A central research committee within the university and no specific research administration at the faculty level. In Benin, the scientific council is responsible for planning and coordinating research activities. It is organized into six sectoral committees including one for agricultural sciences. In the case of ABU (Nigeria), a university board of research distributes the funds from the university budget assigned for research to the individual research projects in the various departments. In the case of Makerere University (Uganda), the Research Grants Committee within the School of Post-graduate Studies is responsible for coordinating and streamlining research activities within the university. In Zimbabwe, too, one central research board caters for the research needs of many disciplines.
- A special research institute, center, unit, or other distinct entity within the university. Institutes have a separate budget and a core staff. Examples of such units are the Centre Ivoirien de Recherches Economiques et Sociales in Côte d'Ivoire or the Centre d'Etude et de Recherche Economique et Sociale in Burkina Faso. In the case of ABU in Nigeria, five of the six departments of the Faculty of Agriculture are joint departments with the Institute for Agricultural Research.

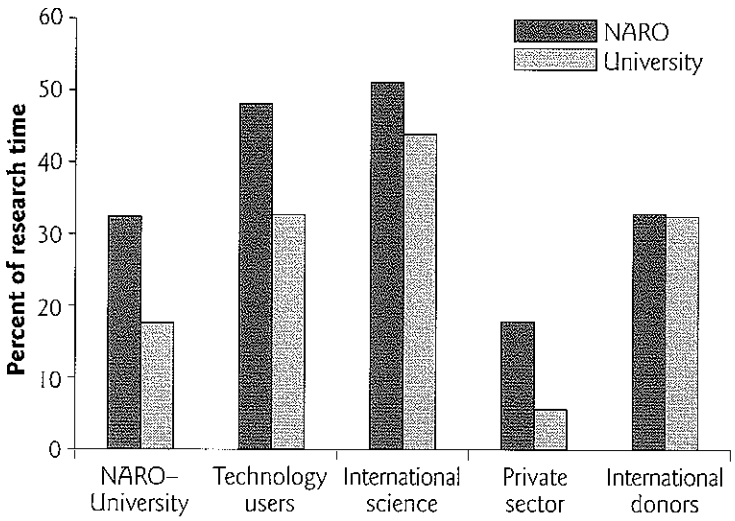
All of the universities studied have some form of formal structure for research at the university or faculty level. However, they often have little impact due to having limited financial resources available for allocation and, therefore, they are not very effective. Structuring a university's agricultural research gives internal and external visibility to the research function, allows for the development of policies supporting research, serves to encourage staff to engage in research activities, and allows for the development and management of important external relationships.

Data collection also focused on the research linkages of the universities. Linkages to other national research institutions are important to avoid duplication of effort, for ensuring a critical mass of expertise and resources, and for closing existing gaps in the national research agenda. Linkages to technology users are important for improving the relevance of the research, developing a common understanding of the problem, improving the impact of research, and also encourage public perceptions of a university as an institution effectively working to serve society.

Details of research linkages with different types of institutions were available from Burkina Faso, Cote d'Ivoire, Uganda, and Zimbabwe (Figure 3). Linkages were measured by the share of a scientist's research time spent on research activities/projects that are linked to a specific type of organization.[3] The results for all university scientists show that: (1) more than 40% of all research activities are linked to international organizations, (2) a third are linked to the users of the technology; (3) a third are linked to international donors; (4) less than 20% show a link between the university and the NARO; and (5) less than 6% are linked to the private sector.

There are clear differences between the Anglophone and Francophone universities. Francophone universities have stronger linkages with international organizations but significantly fewer linkages with international donors and national organizations, particularly technology users (Table A3). The fact that universities and NAROs fall under the same Ministry in the two Francophone countries does not seem to have facilitated institutional linkages between them. This might reflect the fact that Francophone universities compared to Anglophone countries made fewer efforts to contribute to R&D, and that more agricultural research funding is available in Francophone countries.

Compared to universities, scientists at NAROs generally have more linkages and, therefore, conduct their research in less isolation than university scientists (Figure 3, Table A2). They are also more closely linked to the national system. Most of the NARO scientists have much stronger links to the users of research results and the private sector than scientists at universities. Only through these linkages with the national system, can universities become a more active component of the NARS and contribute to its objectives.



Note: Linkages are expressed in percent of research time that a scientist spends on research projects that are linked to this institutional category (see Table 4).

Figure 3. Research linkages of university and NARO scientists

[3] Researchers could indicate 18 different types of linkage mechanisms that serve four different functions: planning and coordination, collaborative professional activities, exchange of resources, and dissemination of knowledge and information.

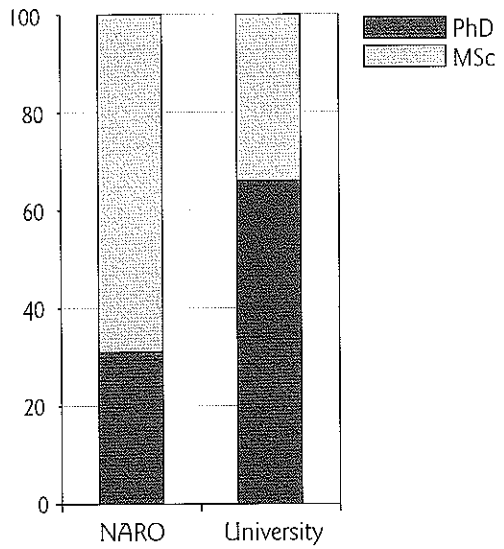
The following key conclusions can be drawn regarding the organization, structure, and linkages of universities:

- The organization and structure of universities is strongly related to the historical and cultural development of the country. All of the universities have formal structures for research activities; but, due to lack of financial resources that are allocated through these structures, they are not very effective.
- Only Anglophone universities offer a PhD level degree in agriculture or related sciences.
- Although universities are organized along disciplinary lines, scientists indicated that about two thirds of their research activities are multidisciplinary.
- University research activities seem to be conducted in more isolation than those of NAROs. However, universities have much stronger linkages with international organizations than with national organizations. University linkages with technology users, farmers and extension services, and NAROs are limited. This is particularly true for Francophone universities.

4.2.3 Human, financial, and physical resources and information

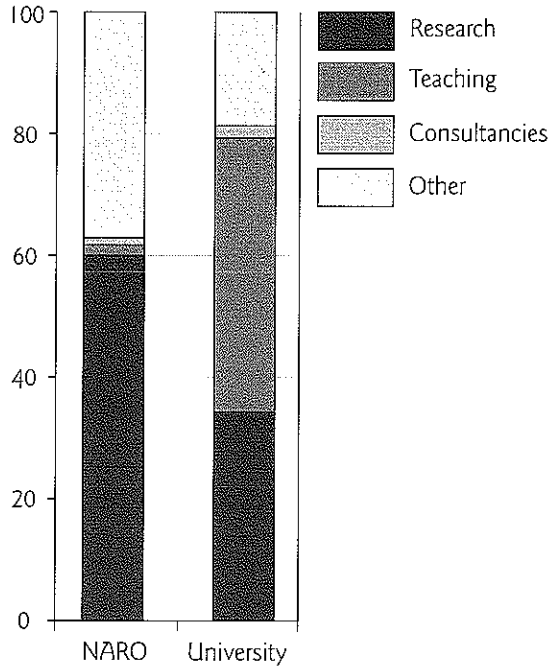
Human, financial, and physical resources, together with information management, determine how much a university can achieve in the area of development-oriented research. Data presented above indicated that universities have significant human resources available, but that financial resources for conducting agricultural research are extremely limited. The availability of properly-functioning physical resources for research at universities was also highly variable. Some faculties, particularly those in Benin and Zimbabwe, have received substantial support from international donors over the last few decades and this is reflected in better physical infrastructure.

Data collection also focused on the level of qualifications held, work experience, and time allocated to different functions. Across all of the universities, about 66% hold a PhD and have 8 years of job experience after obtaining their highest degree, a third are studying for a higher degree, and 12% are female (Table A4 and Figure 4). An average of 34% of university staff time was spent on research, 45% on teaching, and less than 2% was spent on either attending international workshops (1.4%) or consultancy (2.0%) (Figure 5 and Table A4).



Note: For definition of degrees see Table 7.

Figure 4. Highest degree attained by university and NARO scientists



Notes: **Teaching** includes lecturing and preparation of teaching materials. **Research** includes conducting research, supervision of theses, preparation of research proposals, publications, etc. **Consultancies** are those that are not directly related to teaching and research activities. **Other** includes management and administration, extension activities, participation at conferences, training courses, vacation, and sick leave.

Figure 5. Time allocation of university and NARO scientists

Compared to Anglophone universities, Francophone universities have a significantly higher share of scientists holding a PhD (76% compared to 57%), more study for a higher degree (39% compared to 29%), and the share of female scientists is significantly lower (8% compared to 16%) (Table A5). The higher qualification levels imply that Francophone universities have a much higher human resource potential than Anglophone universities. The high percentage of staff members studying for a higher degree may be a reflection of the different degrees offered within the Francophone system, e.g. a 'Dr d' Etat' can be obtained after completing the 'Doctorat de IIIème Cycle' or 'Doctorat d' Université'. The time allocation for different functions turned out to be comparable between Anglophone and Francophone university scientists, even though it was expected that the latter would have a higher allocation to teaching than research.

There are clear differences between university scientists and scientists working at NAROs. Compared to NARO scientists, significantly more university staff hold a PhD (66% compared to 30%) and more are studying for a higher degree (34% compared to 20%). Also staff time allocation clearly reflects the different institutional mandates (Figure 5). Compared to university staff, NARO staff spent 60% of their time on research (compared to 34% for university staff), 2% on teaching (compared to 45%), 2% on attending international workshops (compared to 1.4%), and 1% on consultancy (compared to 2.0%). The difference in consultancy was probably because it is easier to receive permission for consultancy at universities and that the actual allocation of time to different activities is determined much more by the scientists themselves at universities.

The following key conclusions can be drawn regarding human, financial, and physical resources and information:

- A high proportion of scientists at universities have a PhD, particularly at Francophone universities. NAROs employ a significantly lower percentage of PhD holders.

- Work experience after receiving the highest degree varies substantially among universities, NAROs, and countries.
- Staff at all universities spend about a third of their time on research and there is no difference between Anglophone and Francophone countries. NARO scientists spend a considerably greater amount of time on research. Teaching takes up almost half of the time of university scientists. NARO staff engage in very little teaching, with the exception of ABU Nigeria. University staff engage in more consultancy than NARS staff.
- Research, not teaching, is the most important criterion for the promotion of university staff. However, the promotion criteria are the same for all university staff and they do not take into account the special circumstances of the agricultural sector nor recognize a mandate for development-oriented research. They usually give more preference to articles in internationally recognized journals than to local articles on relevant development-oriented research.
- Financial resources of the universities for conducting research are very limited.
- Physical resources for conducting agricultural research are substantial at selected universities but in others, the availability of properly functioning physical resources is limited.

4.2.4 Program planning and management

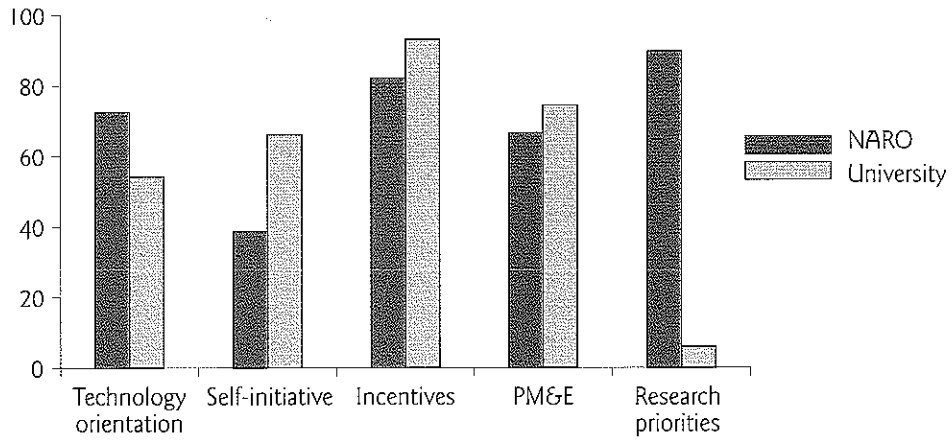
Program planning and management, including priority setting, strongly influence an institutions' performance. If individual scientists at universities determine their own research agendas and depend on funds from outside sources the likely result is that the overall research program will be poorly-focused and won't be closely linked to national research priorities and needs. If there is some planning system in place then there is the opportunity for coordination with the research of NAROs and other research entities in the NARS to avoid duplication of effort. Monitoring and evaluation will improve the quality of research and ensure financial control and accountability. Finally, incentives are crucial to motivate scientists to conduct quality research that is development-oriented.

Indicators on the technology orientation of the research program, the initiator of the research activities, research priorities, research planning, monitoring and evaluation, and staff incentives were available from Burkina Faso, Cote d'Ivoire, Uganda, and Zimbabwe (Figure 6 and Table A6). Overall, two thirds of all research activities at universities are initiated by the scientists themselves and about half of all research activities are classified as applied or adaptive compared to basic and strategic research. For 93% of university staff, research performance is one of the two most important criteria for promotion.[4] Three quarters of university staff work in units with some kind of PM&E system in place. However, there is more of a focus on monitoring and evaluation than on planning. Finally, only 6% work in units where there are formally spelled-out research priorities. According to key actors, university scientists do not relate their research activities closely to nationally-determined needs and priorities.

The study revealed that the technological orientation of research programs and the degree of self-initiated research by university scientists is comparable in Francophone and Anglophone countries (Table A7). However, the results show that there are significant differences in the management and planning of research activities in these countries, which affects the way they produce research results. Only half of staff in Francophone universities work in units with some kind of PM&E system in place (compared to 100% in Anglophone universities), while there are no research priorities set for staff in Anglophone universities (compared to 12% in Francophone universities). Also only 85% of staff in Francophone universities are evaluated based on their research performance, compared to all staff in Anglophone universities.

Compared to NAROs, universities show significant differences in their research program and management (Figure 6). Compared to university staff, NARO staff work significantly less on self-

[4] ABU in Nigeria is the only case where development-oriented research is recognized as a criterion for promotion.



Notes: **Technology orientation** = Share of research time spent on applied/adaptive research projects. **Self-initiative** = Share of research time spent on self-initiated research projects. **Incentives** = Performance in research is one of the two most important criteria for promotion in the organizational unit. **PM&E** = Planning, monitoring, and evaluation exists in the organizational unit. **Research priorities** = There are formally spelled-out research priorities in the organizational unit.

Figure 6. Research program planning and management at universities and NAROs

initiated research projects (39% compared to 66%) and 90% work in units with clearly spelled out research priorities (compared to 6%). Three quarters of their research activities involve applied and adaptive research compared to half at universities. However, universities usually provide more incentives to staff to conduct research than do NAROs; about 90% of all university staff are promoted based on their research performance compared to about 80% of NARO staff.

Based on the descriptive comparative analysis the following key conclusions can be drawn regarding program planning and management:

- University scientists indicated that more than half of their research activities are applied or adaptive.
- Research activities are more likely to be initiated individually by university rather than NARO staff, especially in Francophone countries.
- All countries except Zimbabwe are in the process of determining their needs and priorities with respect to agricultural research.
- Universities have not established formal research priorities and their research activities are not closely related to nationally-determined needs and priorities. In some countries these priorities are not well-known by university scientists.
- Most universities and all NAROs have a PM&E system in place.
- There is more focus on monitoring and evaluation at universities than on planning.

Based on these findings on institutional characteristics of universities in SSA, Chapter 5 analyzes the performance of university scientists and whether the institutional characteristics presented here have a significant impact on the research performance of university scientists.

Chapter 5. Study Results: Agricultural Research Performance at Universities

This chapter presents the results of the different analyses that assess the research performance of university scientists by testing the three research hypotheses:

1. Research performance at universities in SSA is lower than at NAROs.
2. Research performance at universities in SSA is influenced by the historical and cultural development of the country in which they are based.
3. Research performance at universities in SSA is determined by a set of institutional factors related to the breadth of their mandate, the structure and organization of their research, their resources, and programming and management of their research.

First, the research performance of university scientists is compared with NARO scientists for all countries and within each country study (to test Hypothesis 1). Second, research performance of university scientists is compared across countries with different historical backgrounds, i.e. Francophone and Anglophone countries (to test Hypothesis 2). Third, research performance of university scientists is related to a range of institutional factors (to test Hypothesis 3). Results of the partial correlations between individual performance indicators and individual performance predictors, and the multiple correlations between individual performance indicators and performance predictors are presented.

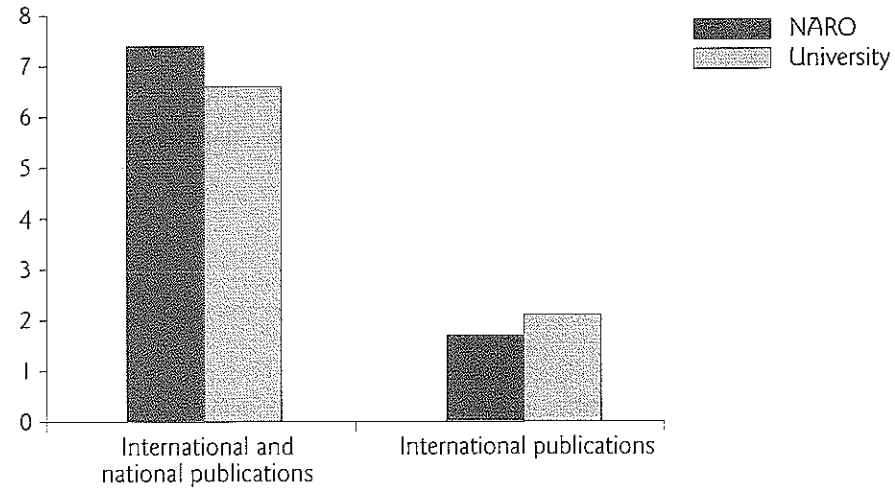
5.1 Research performance in universities compared to NAROs

The first hypothesis to be tested here, i.e. that the research performance at universities in SSA is lower than at NAROs, was based on two assumptions. First, universities, given their available resources, do not contribute appropriately to research as they focus on their education mandate. Second, universities do not contribute to development-oriented research, i.e. that type of research which is aimed at agricultural development in the country, as they consider themselves 'universal', serving an international rather than a national and local community.

To test the first hypothesis a range of performance indicators were developed that go beyond conventional measures such as the number of publications produced. Seven indicators were included in the analysis to try to capture the nature of development-oriented research and to take into account the additional functions of university scientists. However, teaching commitments of university scientists were not included as the focus of the study was on research for development. The performance indicators used were described in Chapter 3 (Table 4).

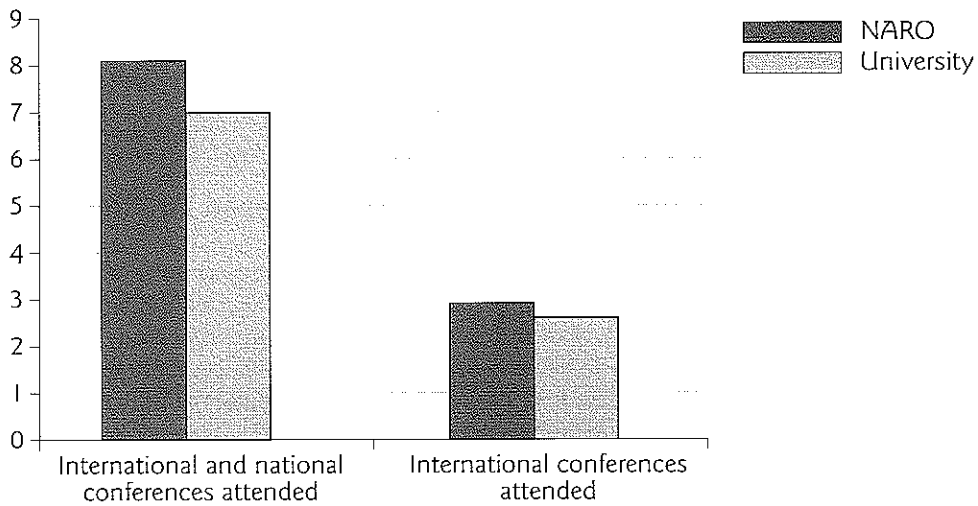
For university scientists it was found that on average, over a period of 5 years, they (1) produced 6.6 publications, of which 2.1 were published internationally, (2) attended 7 conferences, of which 2.6 were international conferences, (3) produced 1.5 outputs for extension, (4) attended 17.9 meetings with technology users, and (5) supervised 3.9 theses at MSc and PhD level (Figures 7–9 and Table A8).

Compared to this, NARO scientists had a higher average performance for all performance criteria except 'theses supervision' and 'international publications', though not at a significant rate (Figure 7–9 and Table A8). Differences are strongest in theses supervision, which shows a significantly higher average for universities (3.9 per researcher at universities in comparison to 0.8 at NAROs), which was expected given the educational mandate of university researchers. University staff also



Notes: **International and national publications** include national and international papers, conference papers, and books and book chapters published. **International publications** include international papers, international conference papers, and books and book chapters published

Figure 7. Number of publications published by university and NARO staff

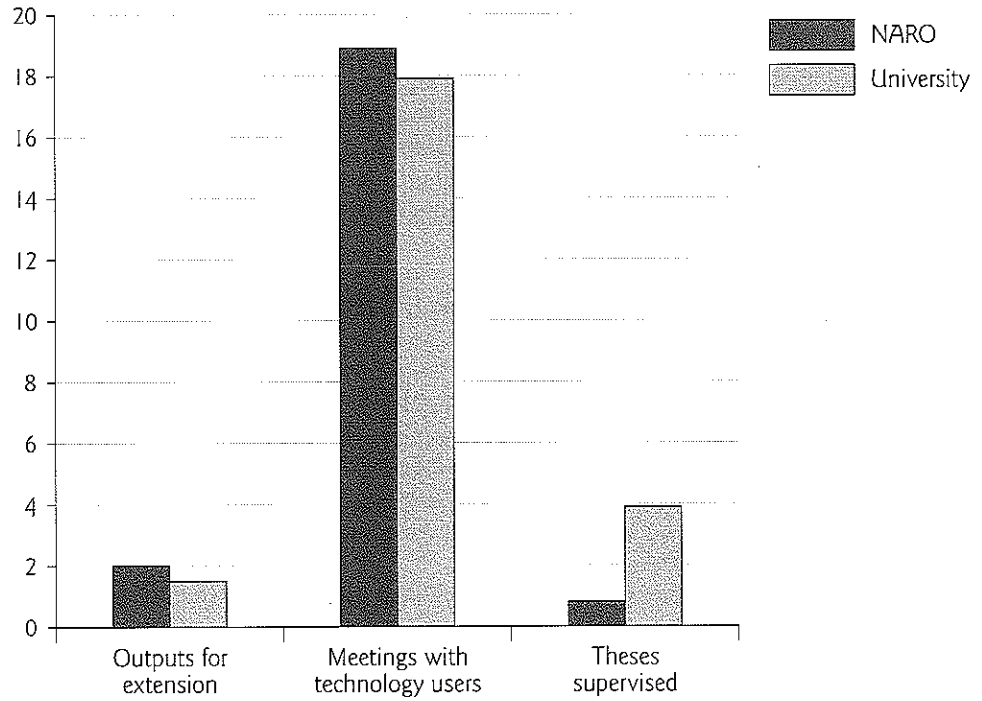


Notes: **International and national conferences attended** includes national and international conferences, workshops and seminars. **International conferences attended** includes international conferences, workshops, and seminars.

Figure 8. Number of conferences attended by university and NARO staff

show a higher average for international publications (2.1 per researcher at universities in comparison to 1.7 at NAROs) reflecting the greater international orientation of universities. Although at a lower rate than NARO staff, university staff are producing "outputs for extension" (1.5 per researcher at universities in comparison to 2.0 at NAROs) and have "meetings with national technology users" (17.9 per researcher at universities in comparison to 18.9 at NAROs).

Table A8 also shows that the performance of NARO and university scientists varied strongly at the country level which explains the overall lack of significant differences between university and NARO scientists. University staff in Burkina Faso and Uganda, for example, produced significantly more national and international publications than NARO staff. Concerning outputs for extension and



Notes: **Outputs for extension** include production recommendations for farmers, publications, and videotapes. **Meetings with technology users** includes meetings with farmers and extension services. **Theses supervised** includes completed MSc and PhD theses.

Figure 9. Number of outputs for extension, meetings with technology users, and theses supervised by university and NARO staff

meetings with technology users, university scientists in the Anglophone countries perform even better than NARO scientists, but in the Francophone countries they perform significantly less well.

These results therefore refute the hypothesis that university scientists in general have a lower research performance than NARO scientists. It shows that university scientists have a comparative performance with regard to the number of publications they produce and the number of conferences attended although they spend up to half of their time on teaching and have significantly less time and financial resources for research than NARO scientists. This seems to be due to the higher qualification levels of university scientists. The significantly lower involvement of NARO scientists in theses supervision can be explained both by their different institutional mandate and also by the lower average qualification level of NARO scientists. Finally, and somewhat surprisingly, university scientists in Anglophone, but not in Francophone, countries show a comparable and even better performance than NARO scientists with regard to their contribution to research for development, as measured by the number of outputs for extension and meetings with technology users.

5.2 Research performance in universities with different historical and cultural backgrounds

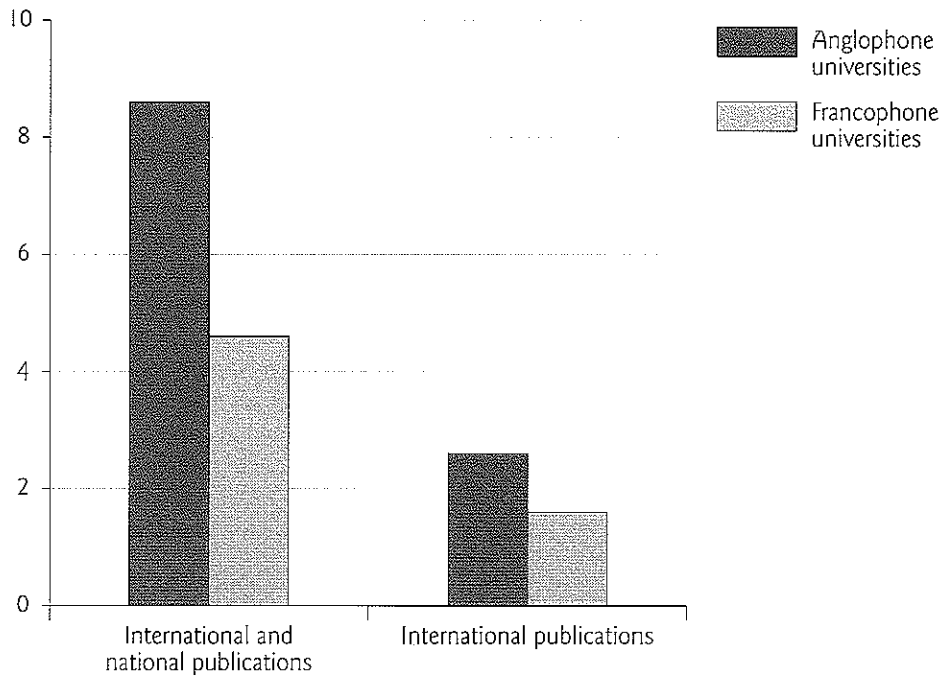
The second hypothesis to be tested here, i.e., that the research performance at universities in SSA is influenced by the historical and cultural development of the country, was based on two assumptions. First, scientists at Francophone universities have a much stronger focus on teaching than on research. They are also disadvantaged when it comes to publishing in international journals as most of the journals are in English. Second, Anglophone universities have made greater efforts to

integrate research, teaching, and outreach functions and strongly recognize the importance and contributions that universities can make to research and development.

To test the second hypothesis the above-described performance indicators were compared between Anglophone and Francophone universities. The results show that there are significant differences between the research performance criteria for universities with different cultural backgrounds, which confirm a stronger focus on research and development in the Anglophone universities (Figures 10–12 and Table A9).

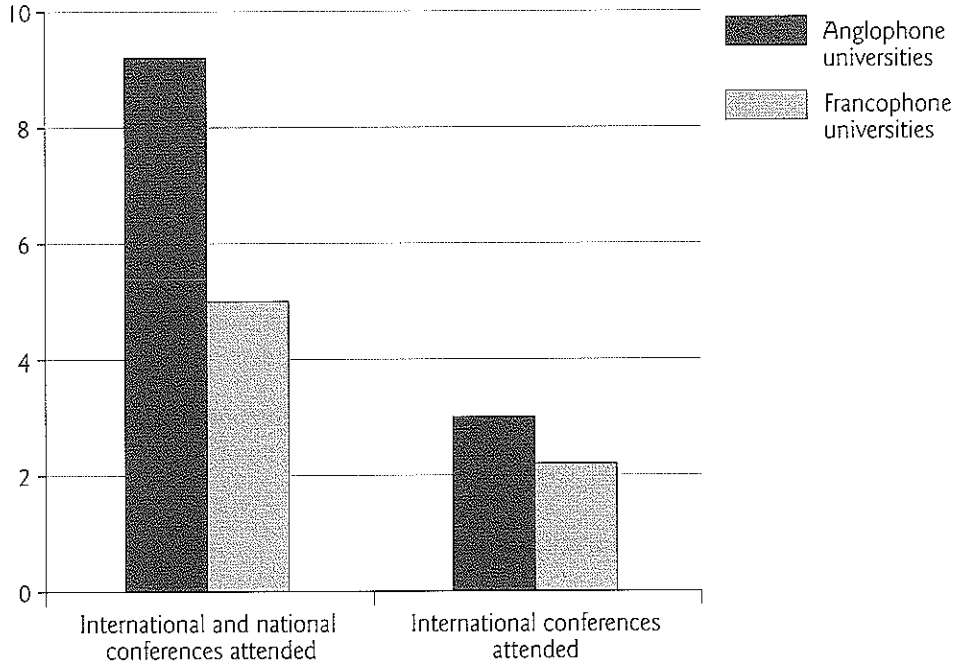
All performance criteria except 'theses supervision' show a lower research performance by scientists in Francophone universities. Compared to scientists in Anglophone universities, scientists in Francophone universities produce significantly fewer publications (4.6 compared to 8.6, of which 1.6 compared to 2.6 are international publications), attend less conferences (5.0 compared to 9.2, of which 2.2 compared to 3.0 are international conferences), produce less outputs for extension (0.5 compared to 2.7), and attend less meetings with technology users (3.0 compared to 31.5). However, they supervise significantly more theses than staff in Anglophone countries (6.9 compared to 1.5). The results are confirmed when comparing universities separately across countries (Table A8).

In conclusion, it is confirmed that a country's historical and cultural background has a significant influence on the research performance of university scientists. The research performance at universities in Francophone universities is significantly lower than in Anglophone countries and the reason for this seems to be that Francophone universities put less emphasis on scientific research but more on thesis work and teaching. In comparison, scientists at Anglophone universities are more involved in research for development through the production of extension outputs and interactions with technology users.



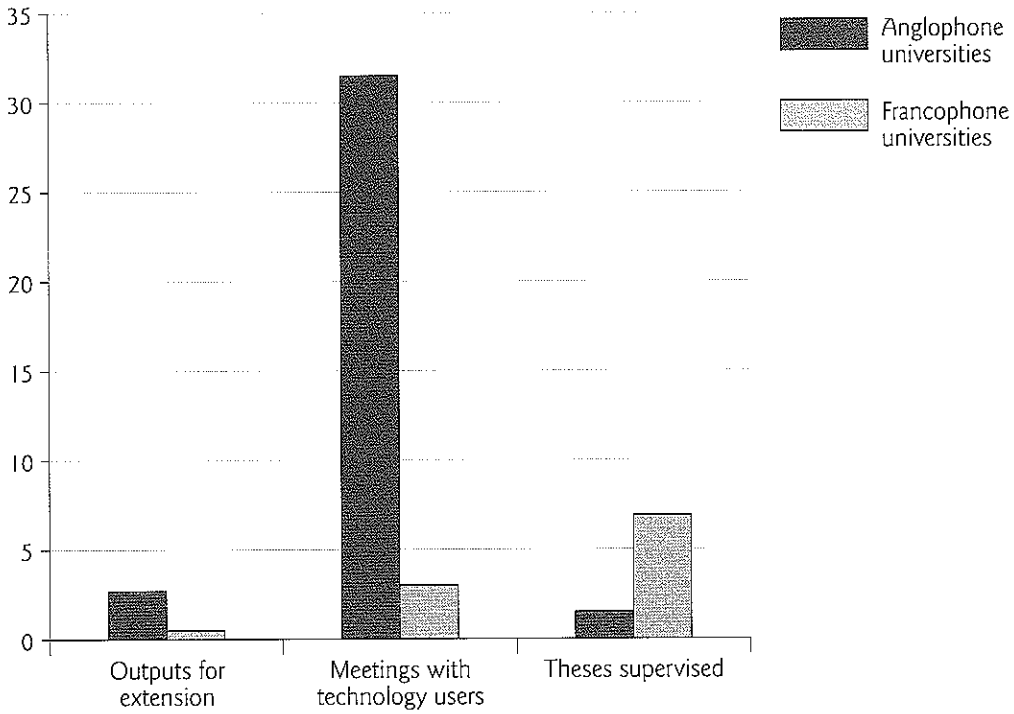
Notes: **International and national publications** include national and international papers, conference papers, and books and book chapters published. **International publications** include international papers, international conference papers, and books and book chapters published

Figure 10. Number of publications published by Francophone and Anglophone university scientists



Notes: **International and national conferences attended** includes national and international conferences, workshops, and seminars. **International conferences attended** includes international conferences, workshops, and seminars.

Figure 11. Number of conferences attended by Francophone and Anglophone university scientists



Notes: **Outputs for extension** include production recommendations for farmers, publications, and videotapes. **Meetings with technology users** includes meetings with farmers and extension services. **Theses supervised** includes completed MSc and PhD theses.

Figure 12. Number of outputs for extension, meetings with technology users, and theses supervised by Francophone and Anglophone university scientists

5.3 Institutional factors influencing the research performance in universities

The third hypothesis to be tested here, i.e. that research performance at universities in SSA is determined by a set of institutional factors, is based on the assumption that research performance depends on how research is conducted. The MORP concept (outlined in Chapter 3) explains research performance as being dependent on a set of factors related to the mandate, objectives, and policy for research at an organization; the organization and structure under which research is carried out and the linkages to other stakeholders; the resources available and the information with which the research is conducted; and program and activity planning and management within the research operation.

To test this hypothesis, those factors have been analyzed with regard to both their separate (partial) and their joint (multiple) influence on research performance.

5.3.1 Partial influence of performance predictors

The following four sections describe how the four categories of MORP factors (performance predictors) individually influence research performance, particularly how different performance predictors are significantly correlated with one or more of the performance indicators. This is done through partial correlation models. In our analysis we have applied correlation functions of the log-linear type, which are based on the assumption that research outputs are subject to decreasing rates of return from inputs into research, whether of organizational, resource, or management type. Table 8 presents results for all university scientists, while Tables A10 and A11 present results for Francophone and Anglophone university scientists, respectively.

The results show that all but 4 of 22 performance predictors had a significant correlation with one or more of the performance criteria. These were linkages with the international science community and with the private sector, gender, and the allocation of time to research. For these indictors it is not possible to conclude that they had any significant relationship with the research performance of scientists. The partial influences of the other performance predictors identified are discussed below.

5.3.1.1 Mandate, objectives, and policies

University research mandate. There is no positive and significant correlation between a mandate for development-oriented research and the performance indicators except for outputs for extension (Table 8). Attendance at international workshops and the supervision of theses show a negative correlation. These results reflect the case of Ahmadu Bello University in Nigeria, which has a mandate for development-oriented research and staff outputs for extension are particularly high. The issue of a mandate for development-oriented research is relevant: as revealed in individual interviews with key actors at the universities. Research key actors are convinced that an orientation towards development in the mandate of a university would actually constitute an important push into the right direction and encourage researchers.

University participation in NARSs. The results show that university staff produce significantly more publications and outputs for extension, attend more conferences, and have more meetings with technology users if the university participates in the development of a national strategic plan (Table 8). However, they also supervise significantly less theses. University participation in the NARS is the most important factor that is correlated with the number of meetings with technology users attended by university scientists. It is, therefore, important that universities participate in the development of a national agricultural development plan.

Table 8. Correlations Between Research Output Indicators and Indicators Explaining Research Outputs of University Scientists in Country Studies (number of outputs per researcher with MSc or PhD degree)

	Publications (log P1)	International publications (log P1a)	Conferences attended (log P2)	International conferences attended (log P2a)	Outputs for extension (log P3)	Meetings with users (log P4)	Theses supervised (log P5)
University mandate (M1)	0.03	−0.00	0.05	−0.18*	0.18*	n.a.	−0.16*
University participation in NARS (M2)	0.20*	0.09	0.26*	0.00	0.18*	0.34*	−0.21*
Degree of interdisciplinarity (O1)	−0.10	−0.01	−0.22*	−0.11	−0.01	−0.12	−0.11
NARO–University linkages (O2)	0.25*	0.13	0.25*	0.21*	0.21*	0.25*	0.08
User orientation (O3)	−0.02	−0.08	0.18*	−0.02	0.17*	0.23*	−0.05
Time at international conferences (O4)	0.25*	0.20*	0.25*	0.28*	0.05	0.07	0.24*
International science linkages (O5)	0.10	0.08	−0.01	0.01	0.04	0.02	0.00
Private sector involvement (O6)	0.12	−0.11	0.09	0.05	−0.07	−0.04	−0.08
International donor linkages (O7)	0.14	0.16*	0.27*	0.13	−0.01	0.28*	−0.05
Gender (R1)	0.00	0.01	−0.04	0.09	−0.06	0.10	−0.11
Research expenditure (R2)	0.04	0.06	−0.13*	0.15*	−0.05	−0.10	0.02
Research time (R3)	0.04	0.06	0.04	0.06	0.03	−0.04	−0.09
Job experiences (R4)	0.08	0.06	0.01	−0.08	0.03	0.11	0.21*
Academic qualifications (R5)	0.16*	0.21*	0.02	0.15*	−0.03	−0.23*	0.12
Teaching time (R6)	−0.18*	−0.11	−0.08	−0.09	−0.05	−0.06	−0.17*
Studying (R7)	−0.13*	−0.18*	−0.03	−0.09	−0.07	−0.08	−0.02
Consultancy (R8)	−0.01	−0.11*	−0.03	0.07	−0.02	0.21*	0.03
Technology orientation (PR1)	−0.14	−0.12	−0.19*	−0.13	0.10	0.01	−0.11
Degree of self-initiative (PR2)	0.05	0.10	−0.03	−0.19*	0.05	0.01	0.00
Incentives (PR3)	0.32*	0.19*	0.17*	0.13	0.12	0.17*	−0.08
Planning, monitoring, and evaluation (PR4)	0.15*	0.08	0.08	0.04	0.10	0.29*	−0.29*
Research priorities (PR5)	−0.17*	−0.19*	−0.01	0.01	−0.11	−0.21*	0.45*

* Significant correlation for error probability smaller than 5%
n.a. = not available.

5.3.1.2 Organization, structure, and linkages

Interdisciplinary character of research. An important organizational feature that can influence research performance is the degree to which research is interdisciplinary. The study revealed that university scientists involved in interdisciplinary research attend significantly fewer conferences, which can be explained by the fact that many conferences are discipline oriented (Table 8). Other correlations were not significant. The more involved Francophone university scientists are in interdisciplinary research the lower their performance (Table A10). This seems to indicate that disciplinary boundaries in universities play a much stronger role in the Francophone than in the Anglophone system, and that scientists working in interdisciplinary fields have fewer opportunities to publish their work and attend conferences.

Collaboration between universities and NAROs. It was found that as the level of collaboration with NARO scientists increases, the performance of university scientists is raised significantly (Table 8). University scientists with stronger linkages to NAROs produced significantly more publications and attended more (international) conferences. They also produced more outputs for extension and have significantly more meetings with technology users. This is particularly true for Francophone university scientists (A10). This could be explained by the fact that linkages between these institutions allow researchers to gain access to additional intellectual, financial, and physical resources, and that cooperation might help to upgrade the skills and improve the knowledge and experience of staff involved. University scientist's linkages to NARO scientists are the most important factor that is correlated with the number of outputs for extension produced by university scientists.

Involvement in projects linked to users. The more research time that university staff spent on research projects linked to users of agricultural technologies (farmers, extension agents, NGOs, development projects), the more conferences and meetings with technology users they attended, and the greater the number of outputs for extension they produced (Table 8). Linkages with technology users enhance the development-oriented character of agricultural research. The benefits include a higher relevance of research, as researchers become aware of the needs of users and develop a common understanding of the problem, which in the long-term is likely to increase the impact of agricultural research.

Involvement in projects linked to international donors. The more time university scientists spent on projects linked to international donors, the higher their research performance (Table 8). University scientists with stronger links to donors produce significantly more (international) publications, attend more conferences, and have more meetings with technology users. This can be explained by the fact that international donors provide financial resources to publish, attend conferences, conduct research, meet with users, interact with other institutions, etc. In return, donors get to specify the expected research outputs. The reorientation of donors towards poverty and food security might explain the positive impact of donor-supported research on meetings with users. University scientist's linkages to international donors are the most important factor that is correlated with the number of conferences attended by university scientists.

5.3.1.3 Human, financial, and physical resources and information

Research expenditure. One of the most commonly heard arguments for why research in Africa is not performing well is that it is underfunded. From the limited data that was available at the country (but not at the institutional) level it is not possible to conclude whether more expenditure per researcher leads to higher performance.

Job experience. University researchers with more work experience since obtaining their highest degree supervise more theses but do not perform significantly better on other performance indicators (Table 8), although Anglophone university staff with more work experience did publish signifi-

cantly more (also internationally) (Table A11). This might be explained by the fact that more experienced researchers know of more opportunities to publish.

Academic qualifications. The level of academic qualification a researcher has reached also affects research capacity. It was found that university scientists with a higher degree show a better research performance, and a significantly higher number of (international) publications and international conferences attended. However, they also have significantly less meetings with technology users. This can be explained by the fact that PhD holders compared to MSc holders have more scientific skills and experience in conducting research and in publishing research results. Also, most PhDs have been obtained directly from a developed country or in collaboration with a northern university. There is a stronger correlation between higher qualified university scientists and their number of (international) publications in Anglophone countries than in Francophone countries (Tables A10 and A11). The level of academic qualification of university scientists is the most important single factor that is correlated with the number of international publications produced by university scientists.

Allocation of time to teaching. The higher the teaching load, the lower the overall research performance for university staff (Table 8). University researchers with a higher teaching load published significantly less and supervised fewer theses. This is particularly relevant for Anglophone university scientists, who generate significantly fewer national and international publications the more time they spend on teaching (Table A11). Francophone university scientists with a higher teaching load supervised significantly less theses and attended fewer meetings with technology users (Table A10).

Allocation of time to international conferences and workshops. The more time that is spent at international workshops and conferences, the higher the performance of university scientists (Table 8). This was shown, for example, by an increase in the number of national and international publications. University scientists also supervised more theses. Conferences create an opportunity to present the results of research work and improve research skills. Often, attendance at these international events stimulates the preparation of scientific papers and subsequent publications.

Involvement in studying. University staff currently involved in studying for a higher degree published significantly less (Table 8). This was particularly relevant for Anglophone university scientists (Table A11). This can be explained by the fact that PhD students are usually less experienced researchers, are preparing for a major publication, and know about fewer opportunities to publish. Given the high numbers of staff members involved in studying for a higher degree this can have an important impact on the overall performance of universities.

Involvement in consultancy. Another issue that affects research performance is the amount of time scientists spend on external consultancy (Table 8). It was found that consultancy work negatively affects researchers' performance in producing international publications but positively affects the number of meetings attended with technology users. At Francophone universities, staff involvement in consultancy shows a significant positive impact on the number of international conferences attended and theses supervised (Table A10).

5.3.1.4 Program and activity planning and management

Technology orientation. University researchers who perform more adaptive and applied research generally produced fewer publications and attended significantly fewer conferences (Table 8). This can be explained by the fact that results from adaptive and applied research often do not qualify for presentation at conferences. This questions the perception of university key actors who are convinced that they have a comparitive advantage to do applied research compared to NAROs. Key actors outside the university do not share this perception. It is important for universities to address these differences in perceptions.

Degree of self-initiative. The degree of self-initiated projects has no significant impact on the performance indicators for university staff, except that fewer international conferences are attended (Table 8). This implies that the academic freedom of universities does not lower the performance of its scientists.

Incentives. Incentives have a clear impact on the performance of staff members (Table 8). If promotion of staff members depends on research performance, university researchers produce significantly more (international) publications and attend more conferences. They also attend more meetings with technology users (Table 8). Incentives are the most important single factor that is correlated with the number of publications produced by university scientists.

Planning, monitoring, and evaluation. The existence of planning, monitoring, and evaluation systems in universities had a significant impact on research performance, particularly the number of publications and meetings with technology users (Table 8). It also significantly decreased the number of theses supervised.

Research priorities. University researchers working in departments with formally spelled-out research priorities have a lower research performance than others (Table 8). Compared to other university scientists, they produced significantly fewer (international) publications, attended fewer meetings with technology users but supervised significantly more theses. However, these correlations are not necessarily cause–effect because only a small group of scientists from the University of Ouagadougou (representing 6% of all university scientists) worked in departments with formally spelled-out research priorities (Table A6). It is, therefore, not possible to conclude something about the relevance of priority-setting in general or that the creativity or productivity of university scientists was reduced by priority-setting.

5.3.2 Multiple influence of performance predictors

This section presents how performance predictors jointly influence research performance, by applying a simple multivariate regression model. In the partial correlation it was found that all predictors are significantly linked to one or more of the performance indicators, with the exception of linkages with the international science community, gender, and allocation of time to research.

To capture the combined effect of each performance predictor on the performance indicators one has to control for all other independent variables. This is done through multiple regression models. In our regression analysis we have applied regression functions of the log-linear type that are based on the assumption that research outputs are subject to decreasing rates of return of inputs into research, be they of organizational, resource, or management type. We estimated seven separate models, each one for the seven research outputs, i.e. number of publications and international publications, number of conferences and international conferences attended, number of outputs for extension, number of meetings with users, and number of theses supervised. The results are presented in Table 9.

The results of the regression analysis suggest that the research performance at universities in terms of research output can be explained through a set of factors related to organization, resources, and program, as well as the cultural and historical background of the country. The overall fit of the models was significant in each case, it has been indicated by $R=0.74$ for meetings with users, $R=0.68$ for theses supervised, $R=0.63$ for publications, $R=0.56$ for conferences attended, $R=0.53$ for international publications, $R=0.49$ for international conferences attended, and $R=0.43$ for extension outputs. This implies that our performance assessment model, depending on the performance indicator, explains between 43% and 74% of the research performance of university scientists. Some of the residuum in the regression model might be explained by the fact that we were not able

Table 9. Multiple Regression Model for Research Output Indicators and Indicators Explaining Research Outputs of University Scientists In Country Studies

	Model 1 Publications	Model 2 International publications	Model 3 Conferences attended	Model 4 International conferences attended	Model 5 Outputs for extension	Model 6 Meetings with users	Model 7 Theses supervised
Dependent variable	**Log P1**	**Log P1a**	**Log P2**	**Log P2a**	**Log P3**	**Log P4**	**Log P5**
				General fit of model			
N	152	152	152	120	152	152	152
Multiple *R*	0.63	0.53	0.56	0.49	0.43	0.74	0.68
Multiple R^2	0.39	0.28	0.31	0.24	0.19	0.55	0.46
Adjusted R^2	0.30	0.17	0.21	0.08	0.06	0.48	0.38
F	4.23	2.56	3.00	1.54	1.51	7.96	5.64
P	0.00	0.00	0.00	0.09	0.09	0.00	0.00
Standard Error of Estimate	0.90	0.70	0.95	0.75	0.71	1.17	0.84
				Beta values of variables			
Cultural background	0.26*	0.14	0.25*	−0.08	0.37*	0.72*	−0.26*
Degree of inter-disciplinarity (O1)	−0.13	−0.05	−0.23*	−0.13	−0.01	−0.07	−0.13
NARO–university linkages (O2)	0.22*	0.12	0.18*	0.20*	0.16	0.12	0.16*
User orientation (O3)	−0.17*	−0.19*	0.08	0.00	0.08	0.02	0.01
Time at international conferences (O4)	0.17*	0.16	0.23*	0.23*	0.10	0.13	0.21*
International science linkages (O5)	0.13	0.06	−0.07	−0.02	0.04	0.07	−0.09
Private sector involvement (O6)	0.09	−0.13	0.02	−0.01	−0.09	−0.09	−0.10
International donors linkages (O7)	−0.01	0.12	0.17*	0.08	−0.15	0.09	0.04
Gender (R1)	−0.05	−0.02	−0.08	0.04	−0.08	0.07	−0.03
Research time (R3)	−0.15	−0.05	−0.05	0.03	−0.08	−0.14	−0.18*
Job experiences (R4)	0.06	0.08	0.01	−0.08	0.01	0.12	0.15*
Academic qualifications (R5)	0.20*	0.19*	0.09	0.18	0.00	−0.14*	0.04
Teaching time (R6)	−0.20*	−0.08	−0.03	0.01	−0.10	−0.11	−0.26*
Studying (R7)	−0.02	−0.08	0.02	−0.02	0.00	−0.03	0.03
Consultancy (R8)	−0.02	−0.09	−0.04	0.09	−0.04	0.16*	−0.03
Technology orientation (PR1)	−0.08	−0.09	−0.13	−0.11	0.13	0.07	−0.10
Degree of self-initiative (PR2)	0.09	0.11	−0.03	−0.17	0.04	0.06	−0.05
Incentives (PR3)	0.20*	0.11	0.01	0.11	0.00	−0.12	−0.06
Planning, monitoring, and evaluation (PR4)	−0.05	−0.11	−0.12	0.08	−0.14	−0.32*	−0.04
Research priorities (PR5)	−0.20*	−0.26*	0.01	0.03	−0.11	−0.16*	0.36*

* Significant with an error probability smaller than 5%.

to include factors on the research mandate of the university, university links to the NARS, or financial resources for research.

The multiple regressions showed that the combined impact of the performance predictors resulted in different importance in explaining the research output of university staff. Many of the factors that showed a significant correlation/relationship to one or more of the performance indicators in the partial analysis cannot predict performance indicators when simultaneously analyzed. While the importance of the relationship might have changed, the direction of the relationship, i.e. positive or negative, remained unchanged.[1]

The most significant predictors of research performance have been the cultural background (for all but international publications and international conferences attended), linkages with NARO scientists (positively correlated with publications, (international) conferences attended, and theses supervised), time at international conferences (positively correlated with publications, (international) conferences attended, and theses supervised), spelled-out research priorities (negatively correlated with (international) publications and meetings with technology users and positively correlated with supervision of theses), and academic qualifications (positively correlated with (international) publications and negatively correlated with theses supervised).

Factors such as user orientation (negatively correlated with (international) publications), time allocated to teaching (negatively correlated with publications and theses supervised), degree of interdisciplinarity (negatively correlated with conferences attended), linkages with international donors (positively correlated with conferences attended), allocation of time to research (negatively correlated with supervision of theses), job experience (positively correlated with supervision of theses), involvement in consultancy (positively correlated with meetings with technology users), incentives (positively correlated with publications), and planning, monitoring, and evaluation (negatively correlated with meetings with users) are only significant in specific cases.

Based on the results of the regression model it can be predicted that university scientists will:[2]

- Produce more publications if they work at an Anglophone university, if they have more linkages with NAROs, have a PhD, work in departments with incentives for conducting research, and spend more time at international meetings. They will produce less publications the higher their teaching load, if research priorities are spelled out in their department, and if they attend more meetings with technology users.
- Produce more international publications if they have a PhD and produce less if research priorities are spelled out in their department and if they attend more meetings with technology users.
- Attend more workshops if they work at an Anglophone university, spend more time at international conferences, and have more linkages with NAROs and international donors. They attend less workshops the more multidisciplinary research they conduct.
- Attend more international workshops the more time they spend at international conferences and the more linkages they have to NAROs.
- Produce more outputs for extension if they work at an Anglophone university.
- Meet more often with technology users if they work at an Anglophone university and the more they are involved in consultancy. They attend less meetings if there is a planning, monitoring, and evaluation system in place or if research priorities are set in the department and if they have a PhD.
- Supervise more theses if they work at a Francophone university, if research priorities are spelled out in their department, if they spend more time at international workshops, and if they have

[1] The only change in the direction of a relationship was the negative influence of PME on the number of meetings with technology users.

[2] Factors are listed in the order of importance.

more linkages with NAROs. They supervise less the higher their teaching load and the more time they allocate to research.

From the results of the partial correlation and multiple regressions is can be concluded that research performance at universities in the country studies could not be determined by a single but by a set of institutional factors related to their mandate, the structure and organization of their research, their resources, and the programming and management of their research. Consequently, the third hypothesis was tested positively.

Conclusions and Recommendations

The results of the data analysis lead to several conclusions and recommendations.

Conclusions

Based on the comparative analysis in this study, the following conclusions can be reached about the three research hypotheses, given the definition of research performance used in this study.

Performance in research at universities in SSA compares well with that of NAROs

The research performance of university and NARO scientists was compared because both organizations have complementary mandates and distinctly different resources to contribute to national development-oriented research. Although the focus is on the research performance of universities, converting universities into purely research organizations is not the intention. Both organizations can make significant contributions towards solving the problems of farmers and providing them with new opportunities.

This study shows that scientists at universities in SSA often perform equally to scientists at organizations with an official mandate for agricultural research, i.e. NAROs. There are several explanations for this:

- All universities have a mandate for research and some have an explicit mandate for development-oriented research.
- Some universities are recognized as a NARS component and actively contributed to the development of a national strategic plan for research.
- Universities have more highly qualified human resources than NAROs and a diversified infrastructure, both of which can be used for research. Despite the lack of a specific research budget at universities in most countries, the existence of a teaching infrastructure enabled staff to carry out research.
- University scientists spend about 30% of their time on research.
- Universities, particularly those that offer PhD and MSc degrees, benefit from students. They provide a critical mass for scientific discourse, carry out adaptive research (e.g. through theses), and provide inexpensive labor for assistance and fieldwork.
- There are more incentives for university scientists than for NAROs scientists to conduct research as it determines their career and promotion opportunities.
- University staff work have greater academic freedom than other research institutions. University departments reflect this in the absence of program planning and setting of research priorities; university scientists reflect this by a high percentage of self-initiated projects.
- University staff have a wide range of research linkages with the international science and donor community, but they are less linked to national institutions, particularly with NAROs and technology users.

It can be concluded that many universities already significantly contribute to national agricultural research. But, there is a high potential that remains untapped, in some universities more than others. Universities need to make strategic decisions on their role in the national research system.

They should then identify their niche in the NARS based on their strengths and weaknesses for specific research areas and different types of research (basic, strategic, applied, and adaptive). Comparative advantages can thereby be related to specific skills of staff, research facilities, financial resources, and location; but, comparative advantages can also be built and developed over time.

There is also a note of caution to be made, as there are trade-offs – as shown by the results. The more that university scientists get involved with development-oriented research, the less likely they will be able to publish in internationally recognized journals. If the university is making a strategic decision towards contributing to development-oriented research, it will be important that it also provides the necessary means and incentives to reorient scientists.

Research performance at universities in SSA is influenced by the historical and cultural development of the country in which they are based.

The research performance of universities with different cultural and historical backgrounds, i.e. Anglophone and Francophone universities, were compared because it is important to recognize the differences between these universities. It was not done to make a general comparison of the overall performance of scientists, but to show whether there were significant differences in research performance.

The study shows that scientists in Anglophone universities often have a better research performance than scientists in Francophone universities. There are several explanations for this:

- The focus of the higher education system in Francophone countries is less towards research and development and more towards teaching and thesis supervision (see Chapter 1.1). Anglophone universities have made greater efforts to integrate research, teaching, and outreach (also promoted by the US land-grant system). The Francophone system with its distinction of universities and "Grandes Ecoles" does not encourage research. The "better" students do not go to universities, where research is conducted, but to the "Grandes Ecoles" where the focus is on gaining work-related experience.
- Some Anglophone but no Francophone universities have an explicit mandate for development-oriented research.
- Anglophone university scientists have much closer links to research organizations and technology users, i.e. farmers and extension services, than Francophone university scientists.
- The average time Anglophone and Francophone university scientists spent on research was comparable, but the latter used more of this time to supervise student theses.
- Francophone universities offered less PhD and MSc courses so that they benefit less from the advantages students provide (such as low cost human resources for fieldwork).
- Anglophone countries have better access the international science network, which is predominantly characterized by the use of the English language.
- More Anglophone than Francophone university scientists are promoted because of their research performance, which is partly measured by the number of papers published in scientific journals. They therefore have more incentives to conduct research and to have publishable results.

It can be concluded that universities, particularly those in Francophone countries, could make a significantly stronger contribution to national agricultural research. But, there are many institutional problems that would need to be addressed. Again, universities need to make a strategic decision on their role in the national research system and then identify their niche in the NARS. This might be facilitated by the fact that, in some Francophone countries, universities and national research organizations belong to the same Ministry.

Research performance at universities in the case studies is determined by a set of institutional factors

Partial correlation and multiple regression analyses of a wide range of institutional factors were performed to try to explain the observed research performance of university scientists. These results will guide the recommendations for improving this performance.

This study shows that research performance at universities in the country studies could not be determined by a single factor but instead by a combination of institutional factors. Factors related to all four institutional MORP dimensions, i.e. (1) mandate, objectives, and policies, (2) structure and organization of their research, (3) their resources, and (4) planning and management of their research, had a significant impact on the partial and multiple analyses on the scientists' performance. The multiple regression models could significantly explain between 43% and 74% of the scientists' performance related to different indicators. Based on the analysis, there are eight factors that seem to be of particular importance for increasing the overall research performance of university scientists and particularly those that have a similar cultural and historical background:

- Active participation of the university in defining the national agricultural research strategy. Official policies need to reflect the research potential of universities and identify universities as a component of the NARS.
- Strong linkages with NARO scientists (particularly for Francophone university scientists). These are important for avoiding duplication of effort, ensuring a critical mass of expertise and resources, and closing existing gaps in the national research agenda.
- Increased linkages with technology users (particularly for Francophone university scientists). These are important for improving the relevance of research, developing a common understanding of the problem, and improving the impact of research.
- Increased linkages with international donors. These are important when seeking additional funding for conducting research. Donors are also very output and impact-oriented.
- More opportunities to attend international conferences. This is important because they create opportunities for presenting research results and seeking additional resources, and provide access to new knowledge.
- Higher academic qualifications, i.e. a PhD degree. PhD holders have more scientific skills and expertise in conducting research and in publishing the results.
- A reduced teaching load (particularly for Anglophone university scientists). A high teaching load limits the ability of staff to conduct research.
- More incentives for conducting research (particularly for Francophone university scientists). If research performance becomes an important criterion for promotion then scientists are motivated to conduct quality research.

There is a note of caution to be made before drawing policy recommendations. The research process is a very complex process and through this process different groups of factors have a significant impact. It is important to recognize this complexity when trying to impose changes. The research outputs are difficult to determine and there is no single performance indicator. Here, we have used a wide range of performance indicators that should be understood as proxies of outputs that are very hard to quantify and that go beyond (international) publications as a single criterion for measuring research performance. Different performance indicators are influenced by different groups of performance predictors.

Recommendations

Recommendations that are based on the findings are addressed to (1) national policymakers, NARSs, and university managers and (2) international donors. In addition, recommendations for further research are identified.

Recommendations for national policymakers, NARS, and university managers

This study shows that universities, given their mandate for teaching and research, contribute to national agricultural research for development. But, it also showed that universities have significant resources and great potential to significantly improve this contribution and increase their impact on agricultural development. It is important to emphasize that factors influencing the research performance differ from country to country and from university to university, implying that strategies and actions must be tailored to each situation. There is no blueprint or model for a new, research-based university that can address all of the specific constraints each university is facing. In each case study country, the structure and organization of the NARS varied substantially as well as the organization and management of its component institutions. NARS institutions belonged to different ministries, had different degrees of autonomy and responsibilities, and different numbers of institutions, etc. The only common factor was that, in all case study countries, NAROs are the most prominent components of the NARS and they have the central mandate for agricultural research. It is therefore, recommended that policymakers, NARSs, and university managers, study their own situation to identify the specific factors limiting the contribution of their universities to national agricultural research, taking into account the findings of this report.[1]

There are a number of potential strategies and actions supported by the findings of this study that can improve the contribution and impact of universities on agricultural development. Some of these can be implemented in the short-term and at low cost, while others require long-term and costly investments:

- Involve the university in the NARS. Mandates and strategic roles of all relevant NARS institutions should be clarified. Effective cooperation within a national system also requires that an understanding of the dimensions of institutional independence and institutional boundaries be established. Universities should actively participate in the development of a national strategic plan for agricultural research and national policies should promote linkages between NARS component institutions.
- Establish or strengthen formal linkages with NAROs and other research institutions, particularly in Francophone countries. Both universities and NAROs can benefit from better linkages as they have complementary mandates and distinctly different resources for contributing to national development-oriented research. Only through such linkages can universities become a more active component of the NARS and contribute to its objectives. There are many options on how to strengthen these linkages, e.g. by supporting the establishment or strengthening of an apex body for agricultural research; by formalizing cross representation on boards and councils; or by developing mechanisms for joint research activities and human resource exchanges (e.g. teaching of NARO staff at universities, theses supervision of NARO staff, sabbatical of university staff at NAROs). Organizing universities and NAROs under the same ministries, as is the case in Burkina Faso and Cote d'Ivoire, did not lead to improved linkages.
- Establish or strengthen linkages with technology users, particularly in Francophone countries. Only through these linkages will university research become more impact-oriented and relevant. Potential actions to strengthen these linkages include the establishment of an office for the coordination of extension at university and faculty levels or the establishment of an organizational mechanism for dissemination of research results.
- Strengthen relationships with international donors to secure additional funding for agricultural research.
- Improve university human resource capacity and incentives for research. This could be achieved by allocating time for research and teaching in individual staff contracts; by ensuring that promotion criteria provide incentives for staff to conduct development-oriented research; by

[1] Based on the results of the "University in NARS" study, ISNAR developed a research management guideline. It provides practical help for policymakers and NARS leaders that have recognized the need for reform but who may be wondering how best to proceed. It also offers a practical road map to guide a review and change process, complete with a comprehensive set of decision-making tools and numerous examples (Michelsen et al. 2003a and 2003b).

encouraging staff to improve their research skills; and by introducing research awards and rewards for staff.
- Improve funding for agricultural research. Suggestions are: establishing a research budget for the university, identifying alternative funding sources for agricultural research at universities, and establishing a national agricultural research fund that is accessible by universities.

Policymakers traditionally play the most important role in implementing these changes. However, the leaders and managers of universities and NAROs can also bring about some important internal changes particularly in relation to their linkages, the management of the available resources, as well as program and activity planning and management.

It should be clear that there is no single strategy or action that can address all the identified constraints in a specific situation. A prerequisite for any decision-making on the appropriate strategy mix is reliable information on things such as the specialized skills of staff, financial resources, research facilities, and infrastructure (e.g. laboratories, libraries, research stations), and on ongoing and completed research activities and related outputs. There is a need to build up a solid foundation of information particularly for identifying problem areas that are unknown, unclear, or not fully recognized by staff, management, and/or policymakers. It is surprising how little quantitative information about universities in SSA is available, given the fact that university scientists are swamped with filling out questionnaires. New information and communication technologies can support these efforts and help bring institutions closer.

Recommendations for international donors

The international donor community is asked to support efforts of countries that are trying to improve the contribution of their universities to national agricultural research for development. Investments to strengthen the higher education capacity in SSA are necessary and have a potentially high pay-off.

What is needed is a coordinated effort by the international donor community to address the 'severe' crisis of universities in SSA. An example is the Association for the Development of Education in Africa (ADEA) established on the initiative of the World Bank in 1988 (see the ADEA website at www.adeanet.org). Then called "Donors to African Education", its objective was fostering collaboration and coordination between development agencies in support of education in Africa. ADEA now focuses on developing partnerships between ministers of education and funding agencies in order to promote effective education policies based on African leadership and ownership. An example is the Working Group on Higher Education, founded in 1989 to strengthen collaboration among African governments, development partners, and tertiary education institutions to improve the effectiveness of development assistance and more broadly, to support the revitalization of African universities, polytechnics, and teacher training colleges. However, the outputs and impact with regard to donor coordination of this initiative needs to be evaluated.

Building institutional higher education capacity in SSA should be the focus of the external investment. This should also include the administrative capacity of universities. It has been known for a long time that reliance on overseas postgraduate training to develop qualified staff for agricultural research and extension is no longer feasible (Steele and Mattocks 1991; World Bank 1999). It is very expensive and the impact on institutional capacity building in the South has been limited. As institutions cannot change over night, any institutional change program requires a long-term effort that goes far beyond a five-year plan. Programs should take into account the short- and medium-term absorption capacity of countries and their institutions as well as long-term sustainability.

The holistic nature of AKIS and the complementary nature of research, education, and extension dictate not only closer ties between these activities and the various institutions that participate in

pluralistic national technology systems but also a more balanced development of these institutions (Eicher 1999). Most developing countries supported by external donors have focused their efforts over the years either on the development of higher education or extension services or research institutes. Taking an AKIS perspective for designing capacity building programs increases the complexity but can significantly improve the long-term impact on sustainable capacity building.

The structure of many donor organizations does not always support the development of more holistic AKIS programs: higher education and agriculture are usually addressed in different departments that are not linked. This became apparent when we tried to collect information from key international donors regarding their support to agricultural research at universities.

International donors, particularly UNESCO, as the only UN body with a mandate to support national capacity-building in higher education, are encouraged to collect and provide reliable and current cross-country data.

Recommendations for further research

Evaluating agricultural research is a particularly difficult undertaking, as the research process is complex and very hard to measure, with a high degree of unpredictability in its output. Developing and quantifying appropriate indicators for evaluating research performance proved challenging, but necessary to rationalize perceptions and decision-making. More research is needed to identify appropriate indicators at the individual scientist level to measure and explain research performance, particularly for countries in SSA where the statistical database is very weak. It would have been very useful to have the complete set of indicators available from all eight countries or to have been able to include other African countries in the analysis. This would have made our case and findings stronger.

Our performance assessment model was able to explain a significant part of the university scientists' research performance. However, we analyzed and explained the different performance indicators (e.g., publications, outputs for extension) in isolation. Given the diverse character of performance indicators used in this study we felt that it was not appropriate to aggregate these indicators into a single cumulative indicator. This can be seen as a limitation of our performance assessment model as it does not take into account the high degree of complexity and many interactions occurring between the performance criteria. In fact, we faced a situation in which a set of performance predictors influenced a set of different performance criteria. A potential solution to this problem is the use of multivariate analysis, such as the canonical analysis. This allows simultaneous analysis of the correlations between a set of performance predictors and a set of performance criteria but has several limitations regarding the interpretation of results (Tabachnick and Fidell 1996). More research is needed to make the use of these multivariate techniques feasible for institutional performance assessment.

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Appendix 1. Structure of the NARSs in Case Study Countries

Case study country	Cultural background / Size of the NARS	NARS Component	Supervising agency	Institution
Benin	Francophone / small	Research Organization	Ministry of Rural Development	INRAB
		Academic	Ministry of Higher Education and Research/UNB	FOA, others (FLASH, FAST, INE, CPU)
Burkina Faso	Francophone / small	Research Organization	Ministry of Higher Education and Scientific Research/CNRST	INERA, IRSAT, IRSS, INSS
			Ministry of Agriculture	BUNASOLS, DVA, LNE
			Ministry of Environment and Water	CNSF
		Academic	Ministry of Higher Education and Scientific Research/UO	IDR, others (FAST, FASEG, FLASHS)
Cameroon	Francophone / medium	Research Organization	Ministry of Scientific Research and Technology	IRAD, IMPM
			Ministry of Agriculture	Centre National Etudes et Expérimentation du Machinisme Agricole
			Ministry of Livestock, Fishery, and Animal Industry	Laboratoire National Vétérinaire
		Academic	Ministry of Higher Education	Dschang University, Ngaundere University, University of Yaounde, University of Buea
Côte d'Ivoire	Francophone / large	Research Organization	Ministry of Higher Education, Research and Innovation	IDEFOR, IDESSA, CRO, CIRT
		Academic	Ministry of Higher Education, Research and Innovation/UNCI	ENSA, CIRES, others (IET, CNF, CIREJ, IREN, FAST)

Case study country	Cultural background / Size of the NARS	NARS Component	Supervising agency	Institution
Nigeria-ABU	Anglophone / large	Research Organization	Ministry of Agriculture and Natural Resources	IAR, NAPRI, NAERLS
		Academic	Ministry of Education/ABU	FOA, FVM, others (FENG, FOS, CSER)
Tanzania	Anglophone / large	Research Organization	Ministry of Agriculture, Livestock Development and Cooperatives, Tanzania	DRD (Agriculture and Livestock Division, Planning and Marketing Division), TPRI
			Ministry of Natural Resources, Tourism and Environment	TAFORI
		Academic	Ministry of Higher Education	Sokoine University of Agriculture (SUA), University of Dar es Salaam (UDS)
Uganda	Anglophone / medium	Research Organization	Ministry of Agriculture, Animal Industry and Fisheries/NARO	KARI, NAARI, SAARI, LIRI, FIRI, FOSRI, FORI, AEATRI, COREC
		Academic	Ministry of Education/MU	FAF, FVM, MUARIK, others (FSC)
Zimbabwe	Anglophone / medium	Research Organization	Ministry of Agriculture	DRSS, DVS, AGRITEX
			Ministry of Environment and Tourism	DNPWN, DNR
		Academic	Ministry of Education/UZ	FOA, FVS, others (FSS)
			Ministry of Education/AU	FOANR

Source: Analytical country reports of the ISNAR University in NARS study (Burkina Faso 1997a; Republic of Nigeria 1995a, 1999; Republic of Uganda 1997a; Republic of Zimbabwe 1998; République de Côte-d'Ivoire 1998a; République de Bénin 1995a) and Hartwich (2000).

Notes: See acronym list for definitions of institutional acronyms. FOA, faculty of agriculture; FVM, faculty of veterinary medicine.

Appendix 2. Result Tables

Table A1. Human and Financial Resources of NARS Components of Case Study Countries (1993–95)

Case study country	NARS component	Number of FTE researchers (%)	Funds in US$ million (%)
Benin	Research Organization	52 (63%)	3.34 (95%)
	Academic	31 (37%)	0.16 (5%)
Burkina Faso	Research Organization	124 (83%)	6.10 (100%)
	Academic	26 (17%)	0.02 (0%)
Cameroon[a]	Research Organization	293 (82%)	n.a.
	Academic	65 (18%)	n.a.
Côte d'Ivoire	Research Organization	117 (80%)	3.03 (89%)
	Academic	29 (20%)	0.36 (11%)
Nigeria-ABU	Research Organization	70 (55%)	1.54 (93%)
	Academic	56 (44%)	0.12 (7%)
Tanzania[b]	Research Organization	433 (84%)	10.8 (84%)
	Academic	80 (16%)	2.0 (16%)
Uganda	Research Organization	118 (65%)	9.47 (93%)
	Academic	65 (35%)	0.72 (7%)
Zimbabwe	Research Organization	61 (52%)	8.94 (92%)
	Academic	56 (48%)	0.17 (8%)

Source: Michelsen (1997) and ISNAR (2003) (ASTI dataset for Tanzania and Cameroon).
Notes: a. Data from 1990. b. Data related to 1996; financial resources are in PPP$ in 1993; n.a. = not available.

Table A2. Mean Organizational Performance Predictors at NAROs and Universities in SSA (Average % per researcher with MSc or PhD degree)

		Degree of inter-disciplinarity	NARO–university linkages	User orientation	Time at international conferences	International science linkages	Private sector involvement	International donor linkages
Benin	NARO	n.a.	n.a.	n.a.	2.3	n.a.	n.a.	n.a.
	University	n.a.	n.a.	n.a.	1.2	n.a.	n.a.	n.a.
	t-value				**–2.0**			
Burkina Faso	NARO	82.1	19.0	50.6	2.6	39.4	9.1	37.4
	University	65.8	9.8	14.6	2.2	53.7	2.4	19.2
	t-value	**–1.9**	**–1.3**	**–3.9***	**–0.9**	**1.4**	**–1.4**	**–2.0**
Côte d'Ivoire	NARO	70.2	39.1	50.4	2.8	52.3	28.1	21.6
	University	79.9	8.7	35.3	0.8	40.3	8.7	18.6
	t-value	**1.1**	**–3.3***	**–1.5**	**–3.3***	**–1.2**	**–2.3***	**–0.4**
Nigeria	NARO	n.a.	n.a.	n.a.	1.4	n.a.	n.a.	n.a.
	University	n.a.	n.a.	n.a.	0.8	n.a.	n.a.	n.a.
	t-value				**–1.4**			
Uganda	NARO	68.0	36.4	51.5	2.0	56.0	10.5	43.3
	University	60.4	27.4	46.7	1.9	35.2	4.8	53.5
	t-value	**–1.0**	**–1.1**	**–0.6**	**–0.3**	**–2.6***	**–1.2**	**1.2**
Zimbabwe	NARO	52.6	28.5	40.0	2.0	52.2	17.9	34.0
	University	56.6	16.9	25.6	1.3	53.1	8.9	20.0
	t-value	**0.4**	**–1.2**	**–1.4**	**–1.5**	**0.1**	**–1.2**	**–1.5**
All countries	NARO	67.2	32.4	48.1	2.3	51.1	17.8	32.9
	University	64.8	17.6	32.7	1.4	43.9	5.6	32.5
	t-value	**0.54**	**3.5***	**3.3***	**4.2***	**1.5**	**3.8***	**0.1**

* Average performance predictor at NARO and universities is significantly different at a probability of 5%.
n.a. = not available.

Table A3. Mean Organizational Performance Predictors in Anglophone and Francophone Universities (Average % per researcher with MSc or PhD degree)

	Degree of inter-disciplinarity	NARO–university linkages	User orientation	Time at international conferences	International science linkages	Private sector involvement	International donor linkages
Anglophone universities	59.3	24.2	40.2	1.4	40.6	6.1	43.3
Francophone universities	71.8	9.3	23.4	1.4	48.0	5.1	18.9
t-value	**1.7****	**–2.5***	**–2.3***	**–0.0**	**1.0**	**–0.3**	**–3.4***

* Average performance predictor in Anglophone and Francophone countries is significantly different at a probability of 5% (**10%).

Table A4. Mean Resource Performance Predictors at NAROs and Universities in SSA (Average number/percent per researcher with MSc or PhD degree)

		Gender	Research expenditure	Research time	Job experience	Academic qualifications	Teaching time	Studying	Consultancy
Benin	NARO	3.0	112	63.2	13.7	6.1	6.3	6.5	0.5
	University	9.1	112	31.8	9.3	65.2	41.0	35.4	2.4
	t-value	**27.0**	**n.a.**	**-6.8***	**-3.0***	**0.0***	**9.2***	**0.3***	**1.5**
Burkina Faso	NARO	12.6	134	59.5	6.4	31.6	1.3	21.1	1.1
	University	9.8	134	33.1	8.3	84.3	47.9	42.0	1.2
	t-value	**61.3**	**n.a.**	**-6.1***	**1.9**	**0.0***	**27.2***	**0.6***	**0.1**
Cameroon	NARO	11.1	112	54.2	n.a.	41.7	n.a.	n.a.	n.a.
	University	0.0	112	53.0	n.a.	55.6	n.a.	n.a.	n.a.
	t-value	**30.0**	**n.a.**	**-0.2**		**45.8**			
Côte d'Ivoire	NARO	5.8	127	66.9	11.1	36.7	1.3	15.0	1.5
	University	5.3	127	29.6	8.3	86.8	48.5	39.5	1.5
	t-value	**89.5**	**n.a.**	**-11.1***	**-2.7***	**0.0***	**28.7***	**0.1***	**-0.0**
Nigeria	NARO	11.1	86	52.1	7.3	42.9	2.4	44.4	1.8
	University	8.9	86	42.2	6.9	44.4	40.2	46.7	2.1
	t-value	**70.8**	**n.a.**	**-2.6***	**-0.4**	**87.0**	**14.4***	**82.0**	**0.5**
Tanzania	NARO	17.1	137	50.9	n.a.	26.8	n.a.	n.a.	n.a.
	University	4.3	137	51.6	16.0	87.0	n.a.	n.a.	n.a.
	t-value	**14.3**	**n.a.**	**0.2**	**n.a.**	**0.0***			
Uganda	NARO	14.9	112	63.8	7.5	28.7	0.9	16.5	0.6
	University	13.6	112	28.7	9.1	50.0	48.1	21.2	2.3
	t-value	**82.0**	**n.a.**	**-11.6***	**1.3**	**0.8***	**29.6***	**45.9**	**5.9***
Zimbabwe	NARO	23.0	149	55.9	6.5	23.0	1.2	20.7	1.3
	University	37.5	149	31.3	6.3	68.8	44.4	21.9	2.1
	t-value	**11.5**	**n.a.**	**-4.8***	**-0.1**	**0.0***	**15.9***	**88.9**	**1.2**
All countries	NARO	12.6	123.6	60.0	8.4	31.0	1.7	20.4	1.2
	University	11.8	118.9	34.3	8.3	66.4	45.0	34.0	2.0
	t-value/p-level	**72.1**	**3.7***	**17.0***	**0.2**	**0.0***	**-48.5***	**0.0***	**-2.9***

* Average performance predictor in countries is significantly different at a probability of 5%. n.a. = not available.

Table A5. Mean Resource Performance Predictors in Anglophone and Francophone Universities (Average number/percent per researcher with MSc or PhD degree)

	Gender	Research expenditure	Research time	Job experience	Academic qualifications	Teaching time	Studying	Consultancy
Anglophone universities	15.7	115.5	35.9	7.8	57.2	44.8	29.2	2.2
Francophone universities	7.9	122.3	32.8	8.7	75.6	45.1	38.6	1.8
t-value/p-value	**3.0***	**3.5***	**-1.5**	**1.2**	**0.4***	**0.2**	**8.8****	**-0.8**

* Average performance predictor in Anglophone and Francophone universities is significantly different at a probability of 5% (**10%).

Table A6. Mean Programmatic and Managerial Performance Predictors at NAROs and Universities in SSA (Average number of outputs per researcher with MSc or PhD degree)

		Technology orientation	Degree of self-initiative	Incentives	PME	Research priorities
Burkina Faso	NARO	73.1	29.5	89.5	0.0	100.0
	University	56.1	75.6	100.0	58.8	21.6
	t-value/p-value	**-1.8****	**5.0***	**1.7***	**0.0***	**0.0***
Côte d'Ivoire	NARO	78.4	28.2	100.0	71.7	100.0
	University	57.0	54.9	65.8	34.2	0.0
	t-value/p-value	**-2.5***	**2.8***	**0.0***	**0.0***	**0.0***
Uganda	NARO	72.4	53.7	95.4	100.0	100.0
	University	52.6	71.2	100.0	100.0	0.0
	t-value/p-value	**-2.5***	**2.2***	**7.9****	**100.0**	**0.0***
Zimbabwe	NARO	64.4	42.8	40.2	98.9	54.0
	University	52.1	52.4	100.0	100.0	0.0
	t-value/p-value	**-1.2**	**0.9****	**0.0***	**59.2**	**0.0***
All countries	NARO	72.5	38.7	82.1	66.6	89.7
	University	54.2	66.1	93.1	74.4	5.9
	t-value/p-value	**4.2***	**-6.0***	**0.00***	**0.06**	**0.00***

* Average performance predictor at NARO and Universities in countries is significantly different at a probability of 5% (** 10%).
n.a. = not available.

Table A7. Mean Programmatic and Managerial Performance Predictors in Anglophone and Francophone Universities (Average number of outputs per researcher with MSc or PhD degree)

	Technology orientation	Degree of self-initiative	Incentives	PME	Research priorities
Anglophone Universities	52.5	65.5	100.0	100.0	0.0
Francophone Universities	56.5	66.9	85.4	48.3	12.4
t-value/p-value	**0.5**	**0.2**	**0.0***	**0.0***	**0.0***

* Average performance predictor in Anglophone and Francophone universities is significantly different at a probability of 5%.

Table A8. Mean Research Output at NAROs and Universities in SSA (Average number of outputs per researcher with MSc or PhD degree)

		Publications (of which international)	Conferences attended (of which international)	Outputs for extension	Meetings with users	Theses supervised
Benin	NARO	6.8 (0.6)	8.9 (4.3)	2.0	n.a.	n.a.
	University	3.8 (0.9)	4.1 (1.7)	0.6	n.a.	n.a.
	t-value	**-1.9 (0.79)**	**-2.7* (-3.2*)**	**-2.6***		
Burkina Faso	NARO	4.8 (0.9)	8.4 (3.4)	1.7	23.1	0.8
	University	6.8 (2.7)	5.9 (3.0)	0.4	3.3	9.9
	t-value	**2.0* (4.5*)**	**-1.7 (-0.5)**	**-2.8***	**-3.0***	**6.2***
Cameroon	NARO	4.0 (3.1)	n.a. (n.a.)	n.a.	n.a.	2.0
	University	2.7 (2.3)	n.a. (n.a.)	n.a.	n.a.	3.4
	t-value	**-0.9 (-0.6)**				**1.0**
Côte d'Ivoire	NARO	9.7 (2.4)	7.0 (3.1)	1.9	11.7	1.3
	University	3.7 (1.1)	5.4 (1.8)	0.3	2.5	3.8
	t-value	**-3.5* (-2.4*)**	**-1.3 (-2.3*)**	**-3.0***	**-2.8***	**3.5***
Nigeria	NARO	11.6 (2.1)	8.7 (1.2)	3.8	n.a.	n.a.
	University	9.3 (2.9)	7.7 (1.8)	3.6	n.a.	n.a.
	t-value	**-1.2 (1.3)**	**-0.6 (0.8)**	**-0.1**		
Tanzania	NARO	2.7 (0.6)	n.a. (0.7)	n.a.	n.a.	0.3
	University	3.5 (1.0)	n.a. (0.7)	n.a.	n.a.	1.0
	t-value	**0.8 (1.2)**	**(0.0)**			**2.3***
Uganda	NARO	5.7 (1.1)	7.3 (3.0)	1.3	14.1	0.2
	University	8.4 (2.4)	12.3 (4.1)	1.5	26.3	2.0
	t-value	**2.2* (2.8*)**	**4.0* (1.9)**	**0.4**	**3.0***	**4.6***
Zimbabwe	NARO	9.4 (2.3)	9.4 (3.5)	2.0	28.9	0.3
	University	11.7 (3.9)	4.6 (4.2)	4.0	42.3	1.0
	t-value	**1.1 (1.9)**	**-2.6* (0.8)**	**1.7**	**1.0**	**2.6***
All countries	NARO	7.4 (1.7)	8.1 (2.9)	2.0	18.9	0.8
	University	6.6 (2.1)	7.0 (2.6)	1.5	17.9	3.9
	t-value	**1.28 (-1.91)**	**1.90 (1.00)**	**1.47**	**0.27**	**-7.8***

* Average research output in these countries is significantly different at a probability of 5%.
n.a. = not available.

Table A9. Mean Research Output in Anglophone and Francophone Universities (Average number of outputs per researcher with MSc or PhD degree)

	Publications (of which international)	Conferences attended (of which international)	Outputs for extension	Meetings with users	Theses supervised
Anglophone University	8.6 (2.6)	9.2 (3.0)	2.7	31.5	1.5
Francophone University	4.6 (1.6)	5.0 (2.2)	0.5	3.0	6.9
t-value	**-4.8* (-3.0*)**	**-4.7* (-1.9**)**	**-3.9***	**-4.7***	**4.9***

* Average research output in Anglophone and Francophone universities is significantly different at a probability of 5% (**10%).

Table A10. Correlations Between Research Output Indicators and Indicators Explaining Research Outputs of University Scientists in Francophone Study Countries (Number of outputs per researcher with MSc or PhD degree)

	Publications (log P1)	International publications (log P1a)	Conferences attended (log P2)	International conferences attended (log P2a)	Outputs for extension (log P3)	Meetings with users (log P4)	Theses supervised (log P5)
University mandate (M1)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
University participation in NARS (M2)	−0.09	−0.11	−0.01	−0.11	−0.06	−0.06	−0.22*
Degree of interdisciplinarity (O1)	−0.25*	−0.04	−0.31*	−0.24	−0.19	−0.28*	−0.35*
NARO–university linkages (O2)	0.31*	0.27*	0.27*	0.26	0.43*	0.33*	0.22
User orientation (O3)	−0.05	−0.05	0.11	0.11	0.31*	0.37*	−0.09
Time at international meetings (O4)	0.37*	0.21*	0.37*	0.37*	0.11	0.11	0.33*
International science linkages (O5)	0.13	0.22	0.02	−0.09	0.02	0.09	−0.04
Private sector involvement (O6)	0.21	−0.09	0.33*	0.26	−0.06	0.02	−0.04
International donor linkages (O7)	0.23	0.33*	0.22	0.26	0.22	0.16	0.00
Gender (R1)	−0.01	0.05	−0.05	0.04	−0.08	−0.06	−0.06
Research expenditure (R2)	0.25*	0.27*	0.16	0.12	−0.05	0.06	0.20
Research time (R3)	0.09	0.11	0.04	−0.03	−0.07	0.03	−0.09
Job experiences (R4)	0.05	−0.08	0.06	0.03	0.06	0.06	0.26*
Academic qualifications (R5)	0.20*	0.11	0.20*	0.24*	0.10	−0.16	−0.12
Teaching time (R6)	−0.16	−0.05	−0.15	−0.05	−0.06	−0.25*	−0.29*
Studying (R7)	−0.03	−0.06	−0.02	−0.08	−0.08	0.05	−0.11
Consultancy (R8)	−0.03	−0.07	−0.01	0.25*	−0.01	0.06	0.24*
Technology orientation (PR1)	−0.20	−0.16	−0.22	−0.16	0.02	−0.03	−0.11
Degree of self-initiative (PR2)	0.02	−0.01	−0.13	−0.22	−0.12	−0.09	−0.15
Incentives (PR3)	0.35*	0.27*	0.15	0.17	0.10	−0.01	0.03
Planning, monitoring, and evaluation (PR4)	−0.05	0.04	−0.20	−0.11	−0.23*	−0.22*	−0.13
Research priorities (PR5)	−0.13	−0.27*	0.09	0.08	−0.09	−0.11	0.46*

* Significant correlation for error probability smaller than 5%.
n.a. = not available

Table A11. Correlations Between Research Output Indicators and Indicators Explaining Research Outputs of University Scientists in Anglophone Study Countries (Number of outputs per researcher with MSc or PhD degree)

	Publications (log P1)	International publications (log P1a)	Conferences attended (log P2)	International conferences attended (log P2a)	Outputs for extension (log P3)	Meetings with users (log P4)	Thesis supervised (log P5)
University mandate (M1)	−0.21*	−0.11	−0.13	−0.27*	0.07	n.a.	−0.10
University participation in NARS (M2)	0.27*	0.20*	n.a.	0.11	n.a.	n.a.	0.14
Degree of interdisciplinarity (O1)	0.09	0.03	−0.11	−0.04	0.10	0.06	0.06
NARO–university linkages (O2)	0.15	0.04	0.17	0.16	0.10	0.11	0.12
User orientation (O3)	−0.11	−0.14	0.16	−0.12	0.07	0.06	0.11
Time at international meetings (O4)	0.12	0.22*	0.11	0.24*	0.03	0.03	0.13
International science linkages (O5)	0.13	0.00	0.00	0.11	0.08	0.09	−0.01
Private sector involvement (O6)	0.04	−0.12	−0.09	−0.06	−0.09	−0.13	−0.13
International donor linkages (O7)	−0.05	0.04	0.21*	0.03	−0.18	0.14	0.10
Gender (R1)	−0.06	−0.04	−0.12	0.10	−0.12	−0.01	−0.06
Research expenditure (R2)	0.06	0.04	−0.14	0.19	0.06	0.09	−0.15
Research time (R3)	−0.04	0.00	0.01	0.11	0.06	0.00	−0.11
Job experiences (R4)	0.17*	0.19*	0.01	−0.15	0.06	0.18	0.25*
Academic qualifications (R5)	0.27*	0.33*	0.01	0.14	0.04	0.01	0.25*
Teaching time (R6)	−0.23*	−0.17*	−0.01	−0.13	−0.05	0.08	−0.09
Studying (R7)	−0.18*	−0.25*	0.01	−0.07	−0.03	0.10	−0.13
Consultancy (R8)	−0.04	−0.21*	−0.09	−0.11	−0.07	0.19	−0.09
Technology orientation (PR1)	−0.07	−0.09	−0.16	−0.13	0.16	0.09	−0.18
Degree of self-initiative (PR2)	0.08	0.18	0.06	−0.18	0.13	0.08	0.19
Incentives (PR3)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Planning, monitoring, and evaluation (PR4)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Research priorities (PR5)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

* Significant correlation for error probability smaller than 5%.
n.a. = not available.

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Universities in sub-Saharan Africa have considerable human resources and substantial scientific infrastructure, but are often criticized for not contributing enough to national agricultural research and development (R&D). To examine this criticism, documented evidence is needed which addresses questions like: How does the research performance of university scientists compare to the research performance of other research scientists? Are there major differences in performance between universities? What are the factors that explain university scientists' research performance?

This report presents the analytical results of data collected from over 980 scientists in eight countries in sub-Saharan Africa, namely, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Nigeria, Uganda, Tanzania, and Zimbabwe. It identifies several factors that can explain a scientist's research performance. These are related to the university research mandate, objectives, and policies; the organization and structure of research and research linkages; the human, financial, and physical resources available; and the research program and how it is planned and managed. This report compares the research performance of university scientists with scientists in the national agricultural research organizations as well as between university scientists in Anglophone and Francophone countries. Several recommendations are made to policymakers and university managers to improve current research performance. Most importantly, they are urged to define the specific constraints facing their country and find the appropriate mix of strategies to address them. Detailed guidance for this process is provided in an ISNAR Research Management Guideline publication. Long-term and coordinated support from the international donor community to strengthen the higher education capacity in sub-Saharan Africa remains a necessary, and potentially high pay-off, investment.

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