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UGANDA

By Nienke M. Beintema and Clesensio Tizikara

This brief reviews the major investment and institutional trends in Ugandan public agricultural research since the early 1990s, drawing directly on a new set of survey data collected through the Agricultural Science and Technology Indicators (ASTI) initiative.¹

INSTITUTIONAL DEVELOPMENTS

We identified 14 Ugandan agencies involved in agricultural research and development (R&D) in 2000,² employing a total of 250 full-time equivalent (fte) researchers and having a combined agricultural research expenditure of 18 billion 1999 Ugandan shillings or an equivalent of \$50 million in 1993 international prices (Table 1).³ The National Agricultural Research Organisation (NARO) accounted for about three quarters of both total research spending and agricultural researchers.⁴ Established in 1992 as a semi-autonomous agency that sets its own administrative policies, NARO consists of a secretariat and nine research institutes, of which six are located near Kampala. It has a broad mandate covering crop, livestock, forestry, and fisheries research.

NARO recently undertook a revision of its operating policy and prepared a 10-year strategy for the period 2000-2010 in compliance with the requirements for the government's Plan for Modernization of Agriculture (PMA), which is a part of the government's broader strategy to eliminate poverty. The PMA is designed to modernize the agricultural sector by increasing its productivity and promoting the

Table 1—Composition of agricultural research expenditures and total researchers, 2000

Type of agency	Spending		Researchers ^a (fte's)	Share		Agencies in sample ^b (number)
	1999 Ugandan shillings (millions)	1993 international dollars		Spending (percent)	Researchers	
<i>Public agencies</i>						
NARO ^c	13,798.6	37.8	186.0	75.8	74.4	1
Other government ^d	430.3	1.2	5.8	2.4	2.3	3
Nonprofit agencies	33.9	0.1	2.5	0.2	1.0	1
Higher education ^d	3,604.7	9.9 ^e	50.6	19.8	20.2	7
Subtotal	17,867.4	48.9	244.9	98.2	98.0	12
<i>Business enterprises</i>						
	328.2	0.9	5.0	1.8	2.0	2
Total	18,195.7	49.9	249.9	100	100	14

Sources: Compiled by the authors from survey data and ACU (various years).

^a Include national and expatriate staff.

^b For a list of the 14 agencies included in the sample see note 2.

^c NARO's financial data are from budget year 1999/2000.

^d Expenditures for the other government agencies and higher-education agencies are estimates based on NARO's average expenditures per researcher.

^e The higher education agencies employed 252 faculty staff dedicating between 10 and 30 percent of their time to research. This translates as 50.6 full-time equivalent researchers.

KEY TRENDS

- Since the early 1980s, total numbers of agricultural researchers increased only slightly. Numbers of researchers working in the higher education sector quadrupled during the past two decades, but this increase was offset by a contraction of researcher numbers in the government sector of about 10 percent over the same period.
- NARO is the main agricultural research agency in Uganda and accounted for about three quarters of Uganda's total spending and research staff in 2000.
- The intensity of Uganda's investment efforts in agricultural research (that is, research investments' share of total agricultural GDP) increased during the 1990s to 0.5 percent in 2000, but appears to remain below the sub-Saharan African average.
- NARO is highly dependent on donor funding. During 1995–2001, close to two thirds of total revenue came from the World Bank and other donors.
- Donor funds to NARO will decrease by half in the next few years, and it is not expected that government and other funding sources will increase sufficiently to maintain NARO's current funding levels.

ABOUT ASTI

The Agricultural Science and Technology Indicators (ASTI) Initiative consists of a network of national, regional, and international agricultural R&D agencies managed by IFPRI and ISNAR. The initiative compiles, processes, and makes available internationally comparable data on institutional developments and investments in public and private agricultural R&D worldwide, and analyses and reports on these trends in the form of occasional policy digests for research policy formulation and priority setting purposes.

Primary funding for the ASTI initiative was provided by the CGIAR Finance Committee/World Bank with additional support from the Australian Center for International Agricultural Research (ACIAR), the European Union, and the U.S. Agency for International Development (USAID).

developments of subsistence farmers toward commercial farming by identifying and responding to their needs. The plan indicates that NARO—as a public research institution—should focus on crop research. The plan also outlines increased outreach capacity for NARO primarily through its network of Agricultural Research Development Centers (ARDCs), which are located in each of the country's 12 ecoregional zones (Cook and Chema 2001).

Three additional government agencies were involved in natural resources or forestry research, but these accounted for only a small share of agricultural research in 2000.

The seven higher education agencies involved in agricultural research in 2000—of which six within Makerere University—accounted for 20 percent of the total financial and human resources in agricultural research. Most of this research was conducted by Makerere University's Faculty of Agriculture and to a lesser extent by the Faculty of Veterinary Medicine and the Faculty of Forestry and Natural Conservation. Professional staff at the faculties spent between 10 to 30 percent of their time on research.

Producer organizations exist for various crops including cotton, coffee, tea, oilseeds, flowers, and horticulture. The coffee and cotton organizations are public institutions and receive most of their funding through taxes levied on export proceeds, while the oilseed and flower organizations receive government grants and donor funding, respectively (Cook and Chema 2001). Although the Ugandan Coffee Development Authority (UCDA) conducts some research, most of the country's coffee research is done at NARO's Coffee Research Institute. The Uganda Flower Exporter's Association (UFEA) and the Uganda Horticultural Exporters Association (HORTEXA) both have very small research facilities. Since these were initiated only recently, they are not included in the data analysis of this brief.

Most of the Ugandan private-for-profit business enterprises contract NARO, other agencies, or individuals to undertake their research needs. We identified only two Ugandan companies with significant ongoing own research activities.

There is a fair amount of collaboration among the various Ugandan agricultural research agencies, as well as collaboration with regional and international agencies. NARO, for example, conducts some projects jointly with Makerere University and has numerous collaborative projects with the private sector, donor organizations, and the international agricultural research centers.

Many have argued that the national agricultural research system (NARS), dominated by NARO, is not responding adequately to the needs of farmers. A review and reform of the NARS is ongoing, addressing issues such as how the system's research activities conform to PMA principles and how to improve the institutional framework so as to provide better coordination for technology generation and services to farmers through the National Agricultural Advisory Services (NAADS).

HUMAN AND FINANCIAL RESOURCES IN AGRICULTURAL R&D

Overall Trends in Public Agricultural Research

The total number of public agricultural researchers increased by 8 percent per year during the period 1971–83,⁵ but growth has virtually stagnated since then (Figure 1a). The total number of agricultural researchers has remained fairly constant since 1983 but the growth rates varied among different institutional categories. Total researchers in the government sector increased considerably during the 1970s but experienced negative annual growth rates thereafter. In contrast, total agricultural researchers employed in the higher-education sector grew by about 8 percent per year during the 1980s and 1990s after slow growth

A Short History of Government-Based Agricultural Research in Uganda

A number of the current research institutes under NARO were established as agricultural research stations under the Department of Agriculture and the Department of Veterinary Services during the early colonial era of the 1920s. Makerere University initiated its agricultural training in the 1920s and its agricultural research in the late 1950s. Until after World War II, the responsibility for agricultural research was mainly with the local colonial government. The new development strategy during World War II sought a more active role by the British government in the promotion of science and technology in its colonies. This led to the creation of several regional agricultural research organizations in East Africa, which complemented or partially replaced existing research institutes. Two of these were located in Uganda: the East African Freshwater Fisheries Research Organization (EAFFRO) and the East African Trypanosomiasis Research Organization (EATRO).

Following the years after independence in 1962, all the national agricultural research agencies were transferred to the national government, and no major organizational change occurred until the 1980s. The regional research organizations remained—with little changes in their operational structure—until the collapse of the East African Community in 1977 and the Ugandan government inherited EAFFRO and EATRO. Research continued to be heavily focused on the principal export commodities such as cotton, tea, and coffee, although the mandate gradually broadened to include food crop research. After independence, the Ugandan research agencies continued to be highly dependent on British researchers but these were gradually replaced as more Ugandans graduated in the agricultural sciences from the Makerere University and universities abroad. As a result of the “economic war” program of the military regime during the late 1970s, this “phasing out” of British (and other expatriate) researchers was expedited. Also, agricultural research budgets decreased dramatically over this period. As a result of the 1979 liberation war, the existing research infrastructure was severely damaged. During the 1980s, the government strived to revamp Uganda's agricultural research infrastructure as part of a national plan to rebuild the country and its economy, but attempts failed because of continued guerilla warfare occurring in the countryside.

A national taskforce on agricultural research recommended the establishment of a semi-autonomous agricultural research agency with a mandate covering crops, livestock, forestry, and fisheries, leading to the establishment of NARO in 1992. In 1992, NARO inherited the six existing research institutes from the Ministries of Agriculture, Animal Industry and Fisheries, and Cooperation, which focused on crops, livestock, fisheries, and forestry research. Two additional institutes for agricultural engineering and food science were created. Since its establishment, NARO has directed its efforts toward building its institutional infrastructure and training staff, moving away from a scientist-driven research agenda toward an approach focusing on farmer needs.

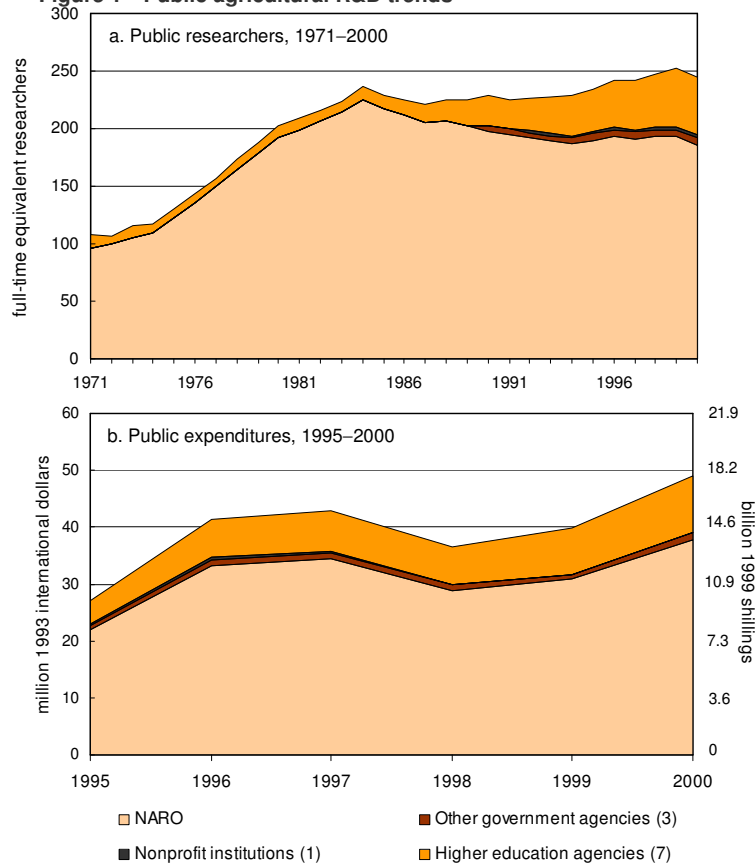
Sources: Opio-Odongo 1992; Kiwuwa and Nabasiye 1997, and Cook and Chema 2001.

in the 1970s. NARO appears to have had problems with staff turnover recently; by mid 2001 researcher numbers dropped to 170 through a high number of resignations (Cook and Chema 2001).

The expatriate share of total research staff was low for Uganda throughout the period—mainly because of internal political instability during the 1980s. In 2000, NARO and the Faculty of Veterinary Medicine employed two expatriate researchers each.

Public R&D spending data were only available for the period 1995–2000 during which it increased 75 percent over the 1995 level (\$49 and \$27 million respectively or, in 1999 local currencies, 18 versus 10 billion Ugandan shillings) (Figure 1b). This increase was mainly the result of World Bank funding to NARO through the first Agricultural Research and Training project (ARTP-I) and increased research activities at the higher education agencies. Spending per scientist also increased from \$115,000 in 1995 to \$202,000 in 2000.

Figure 1—Public agricultural R&D trends



Sources: 1995–2000 data compiled by the authors from surveys and ACU (various years). Total research staff prior to 1995 have been estimated using various secondary sources.

Notes: See Table 1. Sample number shown in brackets. Figures exclude business enterprises. Underlying data is available on the ASTI website (www.asti.cgiar.org).

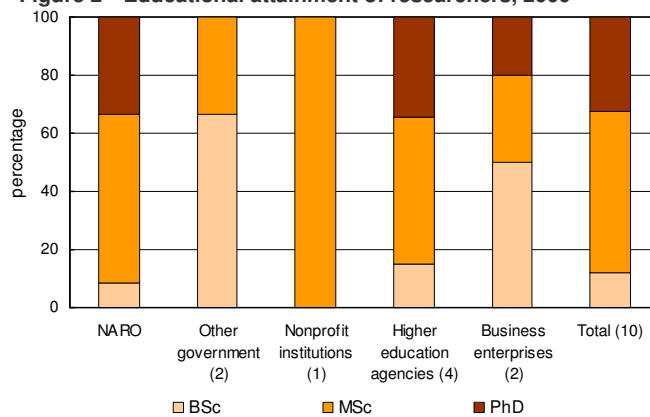
Human Resources

In 2000, 88 percent of the 242 fte researchers in a 10-agency sample had postgraduate level training, with close to one third holding doctorate degrees (Figure 2). A higher proportion of NARO and university staff held postgraduate degrees compared with staff at other agencies. This is in line with other African

countries and regions (Pardey et al. 1997 and Beintema and Pardey 2001).

Although NARO's total number of researchers remained fairly constant during 1994–2000, the quality of staff—measured as the share of researchers with PhD and MSc—increased considerably. Due to a policy of recruiting MSc holders for research positions only (Tizikara 2001), the share of BSc holders among research staff dropped from 29 percent in 1994 to 9 percent in 2000. The share of researchers with postgraduate degrees at the four higher education agencies also increased from 78 to 92 percent.

Figure 2—Educational attainment of researchers, 2000



Source: Compiled by the authors from survey data.

Note: Number of agencies in sample shown in brackets. Figure excludes expatriate staff.

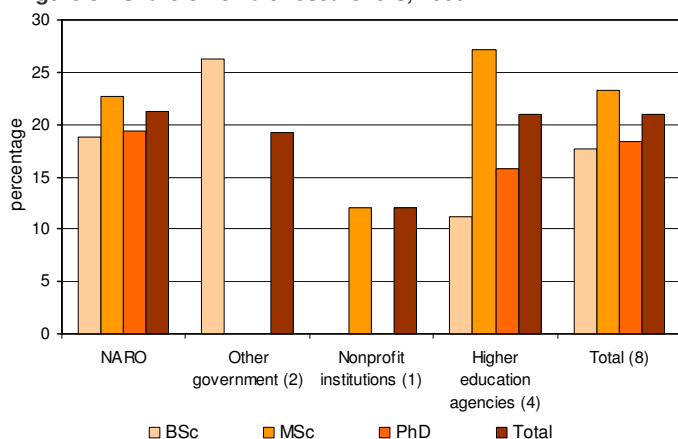
The significant increase in staff trained to the postgraduate level is largely the result of World Bank funding. The first phase of the World Bank project included a training component for staff at NARO and Makerere University. The latter was intended to build capacity at the university to foster future training of NARO staff. Most of the recipients of MSc training under the project attended Makerere University, while all the doctorate degrees were obtained abroad. Some funds also came from the Danish International Development Agency (DANIDA) and other donors for research staff training to the postgraduate level.

In addition to academic training, the World Bank project enabled NARO staff to attend a large number of conferences and workshops, publish, and obtain recent literature.

Makerere University has MSc and PhD programs, originally by research only but recently the university initiated a postgraduate program for veterinary medicine.

For an 8-agency sample, an average of 21 percent of total research staff in 2000 were female, ranging from 21 percent at NARO and the higher education agencies to only 12 percent at the only nonprofit institution, UCDA (Figure 3). Relatively more female researchers held MSc degrees than those with BSc or PhDs.

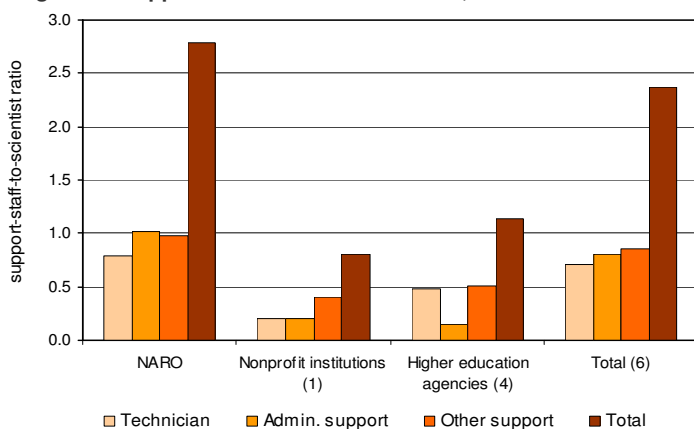
In 2001, 36 out of 100 support staff at NARO were female (excluding technicians)—considerably higher than the researcher and technical support staff shares (Figure 3).

Figure 3—Share of female researchers, 2000

Source: Compiled by the authors from survey data.

Note: Number of agencies in sample shown in brackets. Figure excludes expatriate staff and business enterprises.

In 2000, the average number of support staff per scientist in a 6-agency sample was 2.4—comprising 0.7 technicians, 0.8 administrative personnel, and 0.9 other support staff such as laborers, guards, drivers and so on (Figure 4). NARO had the highest ratio of support staff per scientist (2.8) while UCDA only employed 0.8 support staff per scientist. This is low compared to other African countries (Pardey et al 1997).

Figure 4—Support-staff-to-researcher ratios, 2000

Source: Compiled by the authors from survey data.

Note: Number of agencies in sample shown in brackets. Figure excludes expatriate staff and business enterprises

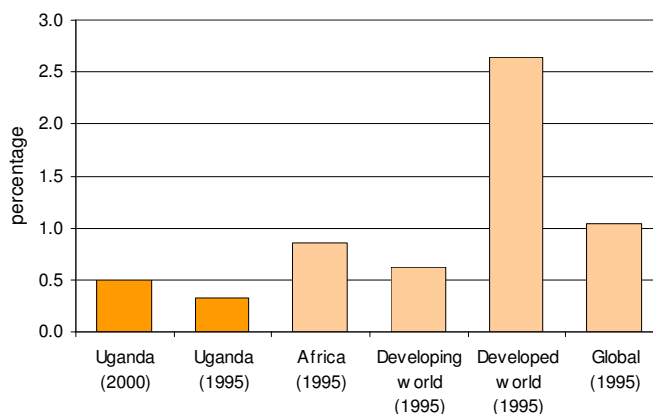
Spending

Total public spending as a percent of agricultural output (AgGDP) is a common research investment indicator that helps place a country's agricultural R&D spending in an internationally comparable context. In 2000, Uganda invested \$0.50 for every \$100 of agricultural output; which was higher than the country's ratio five years earlier (0.32 percent), but considerably lower than the average ratio for Africa or the developing world in 1995 (Figure 5).

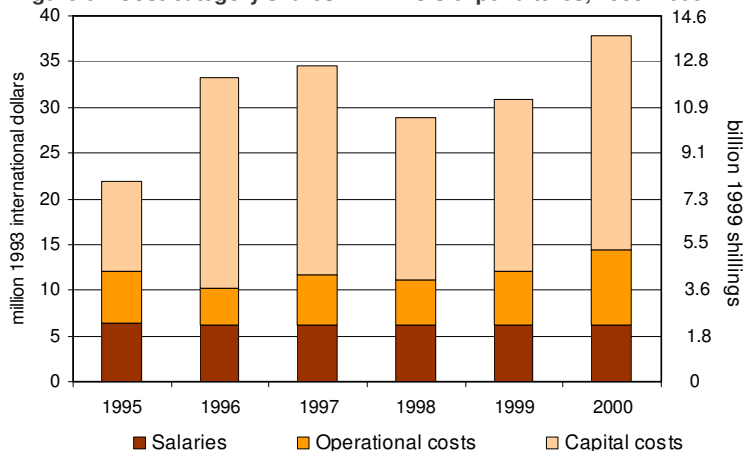
The Government of Uganda aims to invest at least 2 percent of total AgGDP (Cook and Chema 2001), which is four times the current intensity ratio. These ratios are to be worked out under the current on-going review of the national agricultural research system.

As a result of the World Bank loan, NARO has invested significantly in its physical infrastructure, equipment, and training of staff. This is reflected in a high average share of capital costs in total spending (62 percent) during the period 1995–2000. Total salaries and operational costs accounted each for about one fifth of total NARO spending (Figure 6).

Of note, the World Bank project underwrote part of the total salary bill, which made this the first World Bank project to allocate funds for salaries. Despite these allocations, one of NARO's most serious problems since its establishment has been the continuous erosion of staff salary levels in real terms (adjusted for inflation). Current salary levels for NARO researchers are far below the salary levels of their colleagues at similar agencies. As a result, NARO has been unable to compete for qualified staff, and a large number of staff has resigned to join agencies offering better remuneration. In addition, NARO's relatively low salary levels negatively impact on staff motivation (Cook and Chema 2001).

Figure 5—Uganda's public agricultural research intensity compared regionally and globally

Sources: Uganda compiled from Table 1; AgGDP from World Bank 2002; other intensity ratios from Pardey and Beintema 2001.

Figure 6—Cost-category shares in NARO's expenditures, 1995–2000

Source: Compiled by the authors from survey data.

Note: 1995 data are from budget year 1994/1995 and so on. Figure includes estimated salaries for expatriate staff.

FINANCING PUBLIC AGRICULTURAL R&D

In addition to World Bank funding, NARO has received funding from other donors as well as the private sector. Research at Makerere University is almost completely funded through donor contributions such as the Rockefeller and Ford Foundations, the European Union, DANIDA, and the Swedish International Development Cooperation Agency (SIDA). Possibilities to obtain donor funding apparently have increased for the university in the past few years. This is, in part, the result of changes in government policies and internal structural adjustments in institutional management and operation that have revitalized interest among external donors.

The National Agricultural Research Organisation

NARO's high dependency on donor funding is shown in Figure 7. During the period 1995–2001, multilateral (meaning the ARTP-I project funded by the World Bank) and bilateral donor funding accounted for 51 and 14 percent of total funding revenues respectively, while government contributions to NARO were slightly above one third (Figure 7). NARO has received only limited funding from producer organizations and private companies (combined less than 1 percent of total funding).

From 1992 to 2000, NARO depended largely on ARTP-I funding to meet its total funding needs. Most of the total of US\$25 million was allocated to support NARO's institutional development, its execution of high priority research programs, and rehabilitation of its research institutes. In addition, US\$5.3 million were earmarked to support postgraduate training of Makerere University staff, either at the university or abroad, and to upgrade the university's facilities and equipment. ARTP-I was followed by a second World Bank loan of US\$26 million (ARTP-II). ARTP-II provides additional support to NARO's institutional development as well as technology development and adoption, and outreach, extension, and dissemination through the creation of Agricultural Research Development Centers (World Bank 1999).

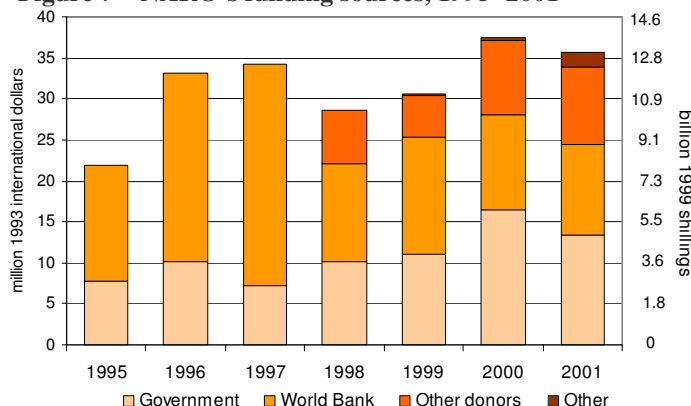
In recent years government contributions to NARO have increased. Also discrepancies between budget allocation and actual disbursement of the government contributions have decreased. In the past four years NARO received about 80–90 percent of budgeted funding—a high rate compared with other government agencies.

Prior to 2001, internally generated revenue was not reflected in NARO's accounting books, but data for 2001 revealed that 5 percent of its total funding revenue was self generated. Current arrangements, however, do not provide incentive for NARO to generate more revenue: All funds raised are either deposited on the consolidated account under the control of the Ministry of Finance, Planning and Economic Development or are authorized for use as "appropriation-in-aid." In case of the latter the Ministry of Finance deflects the amount from the approved NARO budgets.

It is unclear if NARO will be able to maintain its current funding level. NARO's Medium-Term Plan (MTP) projects that donor contributions will decline (in current prices, not adjusted for inflation) to US\$2 million in 2005—one fifth of its current

level. Although government contributions are expected to increase by 5 percent per year, it seems likely that the funding will be half the current level by 2005 (NARO 2001 cited in Cook and Chema 2001). NARO has opportunities to generate income from leasing excess land or capital, conducting research for private companies, and selling or licensing technologies that were developed internally (Cook and Chema 2001). It is unlikely, however, that these other forms of revenue will be sufficient to replace the expected decline in future donor funding. In addition, these initiatives are only possible if the current NARO statute is amended to enable commercial activities.

Figure 7—NARO's funding sources, 1995–2001



Source: Compiled by the authors from survey data.

Note: Other donors include USAID, DANIDA, Rockefeller Foundation, Gatsby Foundation, European Union, IDRC, DFID, and various UN agencies.

Commercialization of Research⁶

An additional source of funding for agricultural research is through the taxation of agricultural products or exports. A number of Latin American countries have been successful in raising additional research funds through this mechanism, notably Colombia (Beintema and Pardey 2001). In Uganda, however, only limited revenues from commodity levies have been allocated to research.

Commodity levies are currently being collected on coffee, tea, and cotton exports, and have been proposed for fisheries and oilseeds. However, almost all of the collected tax revenues have been used for marketing, extension, and the administrative costs of managing these revenues. Only a small portion of the revenues of the coffee levy has been assigned for research; a meager 0.15 percent of the total. NARO's Coffee Research Institute remains responsible for coffee research, which is funded mostly by the government and donor organizations.

Under the PMA, NARO will primarily focus its research activities on noncommercial crops while research on commercial crops will gradually become the responsibility of the private sector. However, the willingness of the existing producer organizations to commit funds to research has been very limited so far, particular as government (coffee) or donors (cotton) have been willing to fund research.

PRIVATE AGRICULTURAL R&D

Agricultural R&D performed by the private sector in Uganda is very small; accounting for only two percent of total agricultural R&D investments in 2000.⁷ Many of the larger private companies do not employ own research staff, but contract research out to NARO and other researchers, often through short-term informal personal contracts.

Uganda has a number of tea companies, but none of them conduct research in Uganda. However, discussions are ongoing about the creation of a tea research institute. A tea producer association has already been established and is currently in the process of creating a cess to either contract research out to NARO or conduct its own research.⁸

We identified two private companies that had active research programs in 2000. Naseco, a seed company employed two part-time research staff to work mainly on maize research. Government-owned Kinyara Sugar Works, which is one of the three large sugar companies in Uganda, had its own research facilities and employed four fte researchers.

There are a few other private companies that have some small-scale research activities. These include the other two large sugar companies, the Sugar Corporation of Uganda and Kakira Sugar Company, which were recently fully repossessed by their original multinational companies. Both companies conduct some varietal testing in Uganda of technologies developed abroad. British American Tobacco also conducts some varietal testing in Uganda but most of its research is conducted in Zimbabwe and Malawi (Cook and Chema 2001).⁹

RESEARCH ORIENTATION

Commodity Focus

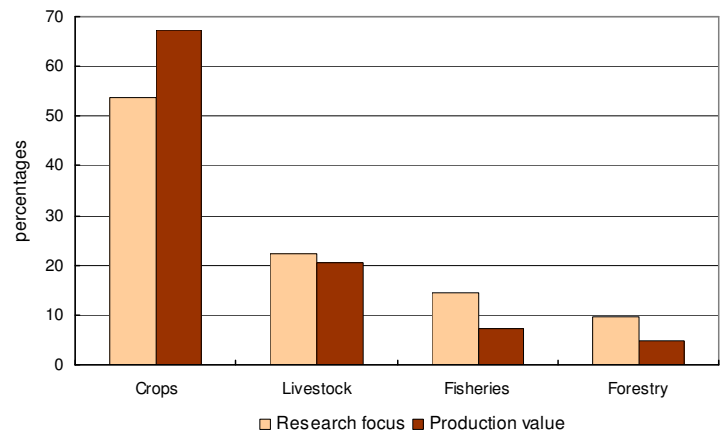
The allocation of resources among various lines of research is a significant policy decision, and so detailed information was collected on the number of fte-researchers working in specific commodity and thematic areas.

The congruence or parity model is a commonly used method of assessing the allocation of research resources. This usually involves allocating funds (or, in this instance research personnel) across research areas in proportion to their corresponding contribution to the value of agricultural production. For example, if the value of rice output were twice that of maize, then congruence would be achieved if research on rice received twice as much funding—or employ twice as many scientists—as maize. Figure 8 shows the shares of crops, livestock, fisheries, and forestry in AgGDP with the corresponding share of research staff in these areas. In 2000, 54 percent of the 201 researchers in this sample undertook crops research—lower than the share of crops in the total value of production. In contrast, the shares of livestock, fisheries and forestry in total fte research staff were higher than the value of these areas in total value of production.

In 2000, more than half the 227 fte researchers in the 6-agency sample conducted crop research. Livestock accounted for 20 percent of the total while fisheries and forestry research accounted for 5 percent each (Figure 8). The major crops were bananas and cassava, which accounted for 20 and 19 percent respectively of total fte crop researchers in our sample. Researchers working on coffee, potatoes, and maize accounted

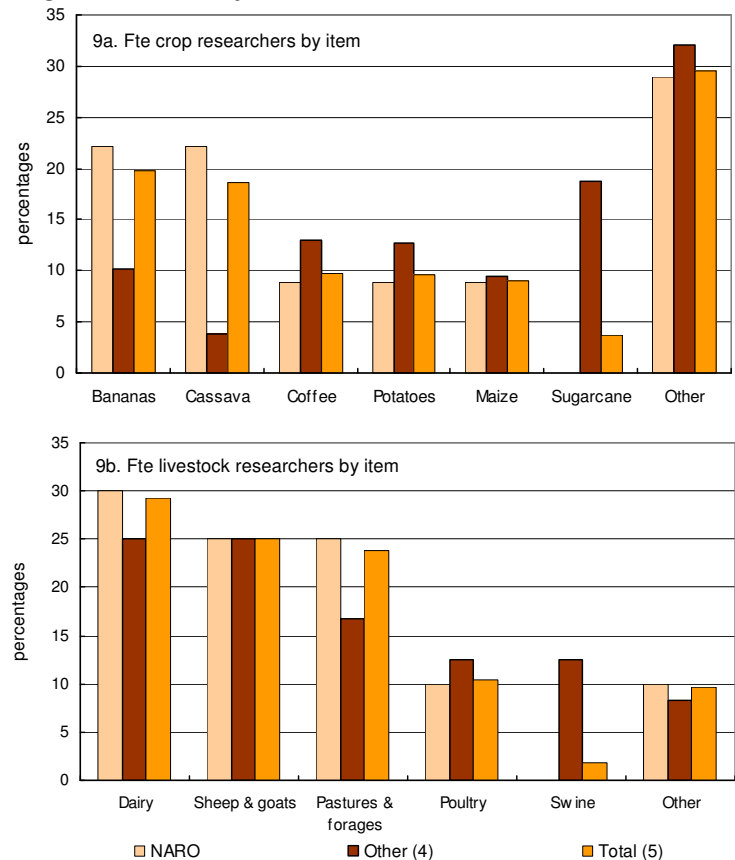
for close to 10 percent each (Figure 9a). Most livestock researchers were conducting research on dairy, sheep, goats, and pastures (Figure 9b).

Figure 8—Major research areas and congruency with production value, 2000



Sources: Compiled by the authors from survey data. GDP by major agricultural area from UBOS 2001.

Figure 9—Commodity focus, 2000



Sources: Compiled by the authors from survey data.

Note: Number of agencies in sample is shown in brackets. "Other" includes UCDA, Makerere University's Faculty of Agriculture, KSR, and Naseco. Figure 9a does not include 26 fte researchers working on natural resources, postharvest or other research areas at the 6 agencies in our sample (11.5 percent of total).

Thematic Focus

In 2000, 30 percent NARO's researchers were working on crop or livestock pest and disease control and 20 percent on crop or livestock genetic improvement (Table 2). Only a small proportion of NARO's researchers were working on natural resources. In contrast, a higher share (28 percent) of the five researchers at the Faculty of Agriculture focused on other themes than crop and livestock such as natural resources and postharvest research.

Table 2—Thematic focus, 2000

	Numbers of researchers		Shares	
	NARO	Faculty of Agriculture	NARO	Faculty of Agriculture
	<i>(in fte's)</i>		<i>(percent)</i>	
Crop genetic improvement	28.8	2.4	15.0	9.0
Crop pest and disease control	38.4	5.1	20.0	19.0
Other crop	38.4	3.8	20.0	14.0
Livestock genetic improvement	9.6	1.6	5.0	6.0
Livestock pest and disease control	19.2	0.8	10.0	3.0
Other livestock	28.8	3.8	15.0	14.0
Soil	1.9	2.4	1.0	9.0
Water	1.0	1.6	0.5	6.0
Other natural resources	—	0.8	—	3.0
Postharvest	5.8	0.8	3.0	3.0
Other	20.2	3.8	10.5	14.0
Total	192.0	27.0	100	100

Source: Compiled by authors from survey data.

CONCLUSION

Following the PMA framework NARO will need to narrow its mandate on noncommercial crops with the private sector becoming responsible for research on commercial crops. Until now, however, the producer organizations have not been very willing to invest in agricultural research.

Uganda's agricultural research is characterized by its high dependence on donor funding, but donor support to NARO is expected to decline substantially in the next few years. Alternative funding sources have to be developed such as income generation and the sale of technologies, and consultancies. However, it is not expected that funds raised through these forms of revenues will be sufficient to counterbalance the decline of donor funding. One serious additional constraint for NARO is the relative low level of salaries it is offering, which has resulted in staff departures and low staff morale. This situation will not improve with lower total funding levels. In addition, funding through the commercialization of research has been limited in part because of the reluctance of existing producer organizations to commit funds to research.

NOTES

1. The authors are grateful to Olympia Icochea for her assistance with the data processing as well as numerous colleagues in Uganda for their time and assistance with the data collection, and thank Derek Byerlee, Simon Bolwig, Peter Hazell, and Johannes Roseboom for their useful comments on previous drafts of this brief.
2. The 14-agency sample consisted of:
 - Four government agencies/units—the National Agricultural Research Organisation (NARO), the National Environmental Management Authority (NEMA), the Uganda Wildlife Authority (UWA), and the Forestry Department's Biomass Project (BF/FD);
 - One nonprofit institution—the Uganda Coffee Development Authority (UCDA);
 - Six higher-education agencies—the Nyabeyya Forestry College and five faculties/departments of the Makerere University (MAK): The faculties of Agriculture (FA), Forestry and Natural Conservation (FFNC), and Veterinary Medicine (FVM), the Faculty of Science's departments of Botany (DB) and Zoology (DZ), and the Institute of Environment and Natural Resources (IENR);
 - Two private enterprises—the Kinyara Sugar Works Ltd and Naseco Ltd.
3. Unless otherwise stated, all data on research expenditures are reported in 1993 prices and in international dollars or in 1999 Ugandan shillings.
4. National science and technology (S&T) policies are coordinated by the Ugandan National Council of Science and Technology (UNCST), which was established in 1990. Formulation and management of sector-specific S&T activities are the responsibility of the respective ministries. In the case of agriculture, NARO, a semi-autonomous body under the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF), has the mandate to undertake and coordinate research and to disseminate technology.

5. Least squares growth rates.
6. This section draws largely on Cook and Chema (2001).
7. R&D investments are measured on a performer basis. The private shares based on funding-by-source figures will be somewhat higher as many private firms contract out research to NARO, other agencies and individuals.
8. In 1980, the Tea Research Institute of East Africa (TRIEA), located in Kenya, collapsed several years after the East African Community. Uganda For some time, the Uganda Tea Authority continued some tea research at TRIEA's former research station in Uganda.
9. Because of the small size of their research activities, these three private companies are not included in the data analysis in this brief.

METHODOLOGY

- Most of the data in this brief are taken from unpublished surveys (IFPRI, ISNAR, and ASARECA 2001-02 and CIFOR 2001) and ACU (various years).
- The data were compiled using internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 1994; UNESCO 1984). We grouped estimates using three major institutional categories—government agencies, higher-education agencies, and business enterprises, the latter comprising the subcategories private enterprises and nonprofit institutions. We defined public agricultural research to include government agencies, higher-education agencies, and nonprofit institutions, thereby excluding private enterprises. Private research includes research performed by private-for-profit enterprises developing pre, on, and postfarm technologies related to agriculture.
- Agricultural research includes crops, livestock, forestry, and fisheries research plus agriculturally related natural resources research, all measured on a performer basis.
- Financial data were converted to 1993 international dollars by deflating current local currency units with a Ugandan GDP deflator of base year 1993 and then converting to U.S. dollars with a 1993 purchasing power parity (ppp) index, both taken from World Bank (2002). Ppp's are synthetic exchange rates used to reflect the purchasing power of currencies, typically comparing prices among a broader range of goods and services than conventional exchange rates.
- The salaries and living expenses of many expatriate researchers working on donor-supported projects are paid directly by the donor agency and are often excluded in the financial reports of the agricultural R&D agencies. These *implicit* costs have been estimated using the average cost per researcher in 1985 to be \$160,000 1993 international dollars and backcasting this figure using the rate of change in real personnel costs per full-time researcher in the US state agricultural experiment station system. This extrapolation procedure has the assumption that the personnel-cost trend for US researchers is a reasonable proxy of the trend in real costs of internationally recruited staff in the agricultural R&D agencies.

See the ASTI website (<http://www.ASTI.cgiar.org>) for more details on methodology.

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