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**Statistical Brief on the National Agricultural Research System**  
**of**  
**SWAZILAND**

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ISNAR INDICATOR SERIES PROJECT: PHASE II  
International Service for National Agricultural Research  
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## ISNAR INDICATOR SERIES PROJECT PHASE II

Decision making in the agricultural research policy area in either domestic, regional, or international fora can only be aided by access to reliable and comprehensive data on these systems. It is for this reason that ISNAR initiated its Indicator Series Project in 1986. The major objective of this project is to collect, process, and analyze reliable and comprehensive time-series data on national agricultural research systems (NARSs) throughout the world in order to identify and report on major trends and emerging policy issues with regard to the development of NARSs. To this end a database has been developed that contains time-series data on agricultural research expenditures and personnel for more than 150 developing and developed countries. These data provide a quantitative basis for more in-depth research policy studies by ISNAR and others.

During the first phase of the project (1986-91), the Indicator Series project team produced two major publications published by Cambridge University Press, namely:

Pardey, P.G., and J. Roseboom. (1989) *ISNAR Agricultural Research Indicator Series: A Global Data Base on National Agricultural Research Systems*, 547 pp.; and

Pardey, P.G., J. Roseboom, and J.R. Anderson, eds. (1991) *Agricultural Research Policy: International Quantitative Perspectives*, 462 pp..

The first publication is a statistical reference volume that provides system-level data on agricultural research personnel and expenditures for 154 countries. The second publication draws on the database to report on the major policy dimensions of agricultural research, with a primary focus on less-developed countries.

Phase II of the Indicator Series Project was initiated in 1992 and seeks to update the database and the policy analyses that accompany it. New ISNAR survey data are being used in conjunction with a large variety of published and "informal" reports in order to produce reliable as well as up-to-date information and statistics about the NARSs.

The country-level data are being published in a series of NARS Statistical Briefs. These briefs include more detailed descriptive information about the institutional structure of the NARS as well as a more comprehensive set of statistics than were reported in the 1989 Indicator Series volume. It is envisaged the country-level data will be assembled and analyzed in a series of regional research reports.

These statistical briefs are not official ISNAR publications; they are not edited or reviewed by ISNAR. The information and data presented have been collected and compiled with due care and all reasonable efforts have been made to ensure their accuracy. Comments, corrections, and additions to the material reported in this brief are welcomed. These briefs may be cited with due acknowledgment.

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## Acronyms

ARD	Agricultural Research Division	OECD	Organization for Economic Co-operation and Development
CGIAR	Consultative Group on International Agricultural Research	PPP	Purchasing Power Parity
CSRETP	Cropping Systems Research and Extension Training Project	SACU	Southern African Customs Union
EPAS	Economic Planning and Analysis Section	SCB	Swaziland Cotton Board
FA	Faculty of Agriculture	SNL	Swazi Nation Land
FAO	Food and Agriculture Organization	SSRU	Social Science Research Unit
FTE	Full-time Equivalent	UBLS	University of Botswana, Lesotho, and Swaziland
FS	Faculty of Science	UNISWA	University of Swaziland
ISNAR	International Service for National Agricultural Research	USAID	United States Agency for International Development
ITDL	Individual Title Deed Land	VDL	Veterinary Diagnostic Laboratory
MOAC	Ministry of Agriculture and Cooperatives		
NARS	National Agricultural Research System		
ODA	Overseas Development Administration		

## 1. Introduction

The primary purpose of this brief is to provide various statistical and institutional details on the development and current status of the public agricultural research system in Swaziland. This information has been collected and presented in a systematic way in order to inform and thereby improve research policy formulation with regard to the Swaziland NARS. Most importantly, these data are assembled and reported in a way that makes them directly comparable with the data presented in the other country briefs in this series. And because institutions take time to develop and there are often considerable lags in the agricultural research process, it is necessary for many analytical and policy purposes to have access to longer-run series of data.

NARSs vary markedly in their institutional structure and these institutional aspects can have a substantial and direct effect on their research performance. To provide a basis for analysis and cross-country, over-time comparisons, the various research agencies in a country have been grouped into five general categories; government, semi-public, private, academic, and supranational. A description of these categories is provided in table 1.

Table 1: *Institutional Categories*

Category	Description	Examples
Government	Agencies directly administered by government.	Research department within a ministry
Semi-public	Agencies not directly controlled by government and with no explicit profit making objective.	Research institute under a commodity board
Private	Agencies whose primary activity is the production of goods and services for profit.	Agricultural machinery or chemical company
Academic	Agencies that combine university-level education with research.	Faculty of agriculture
Supranational	Agencies whose mandate covers more than one country.	CGIAR institutes

*Note:* Adapted from OECD (1981).

The concept of a NARS used throughout this report includes only those institutes that can be classified as government, semi-public, and academic agencies. Where it is useful to do so, private and supranational research agencies have been discussed, but for reasons of comparability they are not included in the NARS data reported here. More detailed information on the definitions and concepts used in this brief is provided in appendix 2.

Section 2 provides a brief description of the institutional development and current structure of the NARS. Section 3 presents a statistical overview of the longer-run investment trends in agricultural research along with a more detailed look at contemporary investment orientations. The appendices provide further descriptive details and present the basic research personnel and expenditure data in disaggregated fashion. For general background information and statistics on Swaziland we refer to appendix 1.

## 2. Agricultural Research Institutions

### 2.1 Historical Evolution<sup>1</sup>

In 1894 Great Britain signed an agreement with the Transvaal Republic that recognized the Republic's independence as well as that of neighboring Swaziland. From 1895 until the Anglo-Boer War in 1902 Swaziland was administered by the Transvaal Republic. Beginning in 1902 Swaziland was a British colony and remained so until the country gained its political independence in 1968. Following independence Swaziland's economy developed close links with the South African economy. For example, the nation's currency, the Emulangi, was pegged at parity within the South African Rand during the period 1974-86, Swaziland was a member of the Southern African Customs Union, and South African companies made significant investments in Swaziland.

Agricultural research in Swaziland began in 1959, relatively late by the standards of the region. Prior to that date only some informal research designed to improve crop yields was conducted on the commercial farms that were owned mostly by Europeans. In 1959 the Ministry of Agriculture and Cooperatives (MOAC) established an Agricultural Research Division (ARD) and in 1962 a central station was set up at Malkerns. Substations were subsequently established at Big Bend and Nhlanguano, and research plots at Luve, Vuvulane, Mangangco, and, in 1969, at Hebron. In 1971 administrative responsibility for ARD was transferred from MOAC to the College of Agriculture of the University of Botswana, Lesotho, and Swaziland (UBLS) with the intent of strengthening the relationship between research and education. In 1975 the research plot at Vuvulane was transferred to the Swaziland Irrigation Scheme.

The administrative responsibility for ARD was transferred back to MOAC in 1978 but was subject to some criticism because its research, which at the time was carried out exclusively by expatriates, focused mainly on cash crops grown by the large estates. Shortly thereafter all of the expatriate researchers who worked for ARD left the Division. Unfortunately, no local replacements were immediately available although some nationals were undergoing training abroad. The Division's program of research effectively came to a standstill. In 1981 research was reactivated with the assistance of FAO who made an agronomist available to ARD. With the substantial financial support of USAID, the Swaziland Cropping Systems Research and Extension Training Project (CSRETP) was also set up. CSRETP focused primarily on the problems and needs of the large number of small farmers operating on Swazi Nation Land. The project was initially scheduled to end in 1987, but continued operating through to early 1992. By 1991 all the expatriates who worked on CSRETP had left ARD. During the 1980s cotton research at ARD received technical assistance from South Africa and ODA.

Tertiary education in Swaziland began in 1964 with the establishment of the University of Basutholand (today's Botswana), Bechuanaland (today's Lesotho), and Swaziland. In 1966 Botswana and Lesotho gained their political independence and the university was renamed the University of Botswana, Lesotho, and Swaziland (UBLS). Funding for UBLS was shared equally by the three governments although the university had a limited presence in Botswana and Swaziland until the early 1970s. The exception was the Faculty of Agriculture at Luyengo in Swaziland. The Faculty was formed in 1972 out of the Swaziland Agricultural College which

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1 The material presented in this section draws largely from Buckham, Dlamini, and Nkwanyana (1985), ARD (Annual Report, various issues), and Mavuso and Ballantyne (1992).

began operating in 1966. In the early 1970s UBLS established two additional campuses, one at Gaborone in Botswana and the other at Kwaluseni in Swaziland. In 1975 the Roma campus in Lesotho was detached from UBLS and became the National University of Lesotho. The two remaining colleges continued as the University of Botswana and Swaziland until July 1976. In that year the university was partitioned into two separate national universities.

## **2.2 Present Structure**

As background to a description of the present structure of Swaziland's agricultural research system this section begins with a brief overview of contemporary developments in the country's agriculture sector. About 81% of Swaziland is suitable for agriculture, but only 15% of this agricultural land is cropped, the remaining 85% is pastureland. Of the cropped land 30% is irrigated.

Swaziland's agriculture has a dualistic character. About 60% of the land in the country is Swazi Nation Land (SNL) on which subsistence farming practices predominate. SNL is a common property resource held in trust by the Ngwenyama (the King) with use rights allocated to farmers by the chiefs of the communities. About 10% of SNL is used for crop production, the main crops being maize, beans, sorghum, vegetables, cotton, and tobacco. The remaining 90% of the land is used to graze livestock, particularly cattle, sheep, and goats. The country's large cattle population reflects the national tradition of holding wealth in the form of livestock. Swaziland has the highest number of cattle per unit of land in Africa (FAO 1988) and there are significant land degradation problems due to overstocking. Most (rural) households are partially supported by the remittances of family members who work as migrant labor in South Africa.

The remaining 40% of the country consists of Individual Title Deed Land (ITDL), which is nearly all owned by expatriates who operate large commercial farms. The main cash crop on ITDL is sugar. Other crops include pineapples, citrus fruits, and roundwood. Large ranches also engage in commercial livestock production.

The dual nature of Swaziland's agricultural sector has a counterpart in the country's agricultural research system. Research that focuses on the problems of the SNL farmers is conducted by the government while the private sector funds and conducts research on the cash and export crops grown on ITDL.

The Agricultural Research Division (ARD) of the Ministry of Agriculture and Cooperatives (MOAC) is the country's principal agricultural research agency. Nowadays ARD's research focuses mainly on foodcrops like maize, beans, cowpeas, fruit, groundnuts, and sorghum, as well as on livestock (mainly pastures and forage). Cotton and tobacco are important traditional cash crops for the farmers in SNL areas and also the subject of ARD's research. Since 1987 ARD has received technical assistance from the Tobacco and Cotton Research Institute of the Republic of South Africa. ARD is headquartered at Malkerns with an experiment station at Big Bend, an experimental farm at Nhlanguano, and experimental plots at Mangcongco, Luve, and Skupheleni. The Lowveld Experiment Station at Big Bend mainly conducts research on cotton, in particular on cotton breeding and entomology. Most of the recurrent costs of this station are provided by the Swaziland Cotton Board (SCB), which raises funds for research by a tax on cotton production. MOAC matches SCB's funds by providing personnel, offices, and infrastructure. Nowadays SCB also funds the research staff for the Lowveld Experiment Station.

Although livestock plays an important role in Swaziland's agricultural sector, there is comparatively little livestock research. What livestock research is done is carried out by three different agencies: a) the Veterinary Diagnostic Laboratory (VDL) of the Department of Veterinary Services of MOAC, which mostly provides veterinary services such as the diagnosis of diseases, vaccine production, and so on; b) research on animal nutrition and pastures is conducted by a special section within ARD, which evaluates grasses, legumes, browse, and other fodder crops; and c) the Faculty of Agriculture of the University of Swaziland recently initiated research on beef cattle.

The Economic Planning and Analysis Section (EPAS) of MOAC conducts research on socioeconomic issues, provides agricultural policy information, and assesses and supervises projects and programs. In 1991, two EPAS staff members were seconded to ARD to conduct socioeconomic and rural sociology work. MOAC also has forestry and fishery sections, but neither of these sections do any research. Forestry research in Swaziland is undertaken by the private sector. To date no fisheries research has been conducted in Swaziland, a landlocked country.

The University of Swaziland (UNISWA) provides training to certificate, diploma, and BSc levels. The Faculty of Agriculture, the Faculty of Science, and the Social Science Research Unit (SSRU) conduct agricultural and related research, but most of the staff's time is spent on teaching. Collaboration between the university and MOAC is done mainly on an informal basis. Most of the research conducted by the Faculty of Agriculture is devoted to major staple crops and to a lesser extent to livestock. Faculty staff also do some work in the areas of home economics, nutrition, and agricultural mechanization. The faculty does not undertake any field work. The present organizational structure of the Faculty of Agriculture is provided in diagrammatic form in appendix 3. The Faculty of Science conducts research on soil degradation and erosion, which are serious problems in Swaziland where overstocking and overgrazing are prevalent. At present the faculty carries out a project, which is funded by the European Economic Community, to compile basic information on Swaziland's soils and soil erosion. SSRU conducts socio-economic research related to agricultural issues.

Swaziland participates in all the regional SACCAR research projects. Much of their research involves varietal testing as part of the networks sponsored through SACCAR.

The large commercial estates and other private companies finance and conduct their own programs of agricultural research. The work is problem-oriented and focuses mainly on testing and adapting technologies that are relevant for the major export and cash crops they produce.

Sugar production is the principle crop grown on the ITDL lands and accounts for about 60% of total agricultural exports (by value) and 75% of ITDL's crop production (by quantity). Most of the large sugar estates conduct their own agronomic and plant protection research (e.g., Simunye Sugar Co, Mhlume Sugar Co, Ubombo Ranch, and the Inyoni Yami Swaziland Irrigation Scheme). Together they employed some 10 researchers cum technical advisors in 1991. The sugar estates also financially support the Swaziland Sugar Association, which conducts research and does marketing activities on their behalf.

Research on pineapples and citrus fruit crops, primarily grown on commercial farms, is conducted by Swazican (which employed one agronomist working on pineapples in 1991) and the Inyoni Yami Swaziland Irrigation Scheme (which conducts some research on citrus diseases).

Table 2: Overview of Present Structure of NARS, 1992

Institutional category	Supervising agency		Executing agency		Research focus	Staffed research sites <sup>d</sup>	Number of researchers			FTE
	Name	Acronym	Name	Acronym			National	Expats	Total	
Public	Ministry of Agriculture and Cooperatives	ARD	Department of Research and Planning, Agricultural Research Division	ARD	crop and livestock	6 (2)	12	2	14	14.0 <sup>b</sup>
		EPAS	Department of Research and Planning, Economic Planning and Analysis Section	EPAS	socio-economics	1 (1)	3	[0]	[3]	[3.0]
		VDL	Department of Veterinary Services, Veterinary Diagnostic Laboratory	VDL	animal health	1 (1)	1	0	1	1.0
Academic	University of Swaziland	FA/UNISWA	Faculty of Agriculture	FA/UNISWA	crops, livestock, socio-economics	1 (1)	38	19	57	5.7
		FS/UNISWA	Faculty of Science	FS/UNISWA	soil erosion	1 (1)	na	na	16	1.6
		SSRU <sup>c</sup>	Social Science Research Unit	SSRU <sup>c</sup>	socio-economics	1 (1)	na	na	2	2.0
<i>Total</i>						<i>11 (7)</i>	<i>na</i>	<i>na</i>	<i>na</i>	<i>27.3</i>

Note: Most of the information in this table refers to 1992. The numbers in square brackets are estimated by the authors.

<sup>a</sup> Staffed with researchers and/or technicians. Bracketed sites are permanently staffed with researchers.

<sup>b</sup> Includes staff seconded from EPAS.

<sup>c</sup> SSRU was disbanded recently.

Private commercial forestry companies such as the Usuthu Pulp Company and the Shiselweni Forestry Company engage in forestry research. Usuthu focuses its research on breeding fast growing conifers that are used mainly for pulp and undertakes fieldwork related to site classification and improvement and plant protection. It does research in collaboration with its parent company in South Africa and other institutions in South Africa and the United Kingdom. Research at the Shiselweni Forestry Company focuses on breeding timber species, oil-bearing tree species, and seed production.

When it was initially established it was envisaged that ARD's facilities and staff would undertake privately sponsored agricultural research. But over time the private (largely estate-crop) sector developed its own programs of research rather than channel their funds through ARD. ARD's Chief Research Officer is currently a member of the research advisory boards and committees of almost all of the privately managed and funded research organizations in Swaziland. This helps to maintain contact with the private sector research organizations and keep up to date with all agricultural research conducted in Swaziland.

The private sector research agencies are not included in this statistical overview primarily because of lack of data.

### **3. NARS Statistics**

Questionnaire responses were received from ARD and the Faculty of Agriculture of the University of Swaziland. For EPAS, VDL, the Faculty of Science, and SSRU insufficient data were available to enable credible time series estimates to be constructed. Therefore they are excluded from the data that follow.

The expenditure data presented in this brief are based on the actual expenditures as reported by ARD and the Faculty of Agriculture of the University of Swaziland. However, institutes systematically underestimate the degree of donor support because they only have information about the donor support that is channeled through their accounting system. Most importantly they often underreport or fail to report the salaries and supplements paid directly to expatriate researchers by the donors. Donor funding information, including salaries of expatriates, is available for the period 1982-91 (CSRETP), but to correct for its omission from the available ARD-related data prior to 1982, we constructed an implicit cost series for expatriate researchers (see appendix 2) and where necessary added this to the available expenditure estimates.

#### **3.1 Long-Term Development**

In the early 1960s Swaziland employed 49 FTE researchers per million economically active agricultural population, which was over three times higher than the sub-Saharan African average of that period. This ratio climbed to 78 during the early 1970s, but after the exodus of expatriates during the late 1970s it dropped to 56. The ratio recovered rapidly during the early 1980s (averaging 100 for the first half of this decade, more than double the contemporary sub-Saharan African average) due largely to ARD's new staff hired for CSRETP. In 1991, the year that CSRETP ended, the ratio again declined substantially.

Table 3: *Researcher and Expenditure Series, 1961-92*

	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	1991	1992	annual growth rate <sup>a</sup>
Researchers (FTEs)	7.2	9.6	12.7	9.8	18.8	21.4	19.9	18.9	3.7
Expenditures <sup>b</sup> (millions 1985 Emulangi per year)	0.770	1.180	1.298	1.129	4.953	3.896	3.114	2.647	6.4
Expenditures (millions 1985 PPP dollars <sup>c</sup> per year)	1.456	2.231	2.453	2.133	9.360	7.364	5.885	5.003	6.4
Expenditures per researcher (1985 PPP dollars <sup>c</sup> per year)	202,000	232,000	193,000	218,000	499,000	344,000	296,000	265,000	2.6
Economically active agricultural population (millions)	0.147	0.154	0.162	0.175	0.188	0.202	0.211	0.214	1.3
Researchers per million economically active agricultural population	48.9	62.4	78.4	55.8	99.6	105.9	94.4	88.4	2.4
AgGDP (million 1985 PPP dollars <sup>c</sup> )	114	136	209	236	246	289	327	251	3.6
Expenditures as a % of AgGDP	1.03	1.30	0.89	0.80	4.03	2.78	2.15	2.44	4.2

*Source:* See appendices 5 and 6.

*Note:* Data only include ARD and the Faculty of Agriculture of the University of Swaziland.

<sup>a</sup> Least squares growth rate for the 1961-92 period.

<sup>b</sup> ARD's expenditures include only government contributions and USAID financial support on CSRETP. Other donor contributions are excluded.

<sup>c</sup> For information about "PPP dollars" see appendix 2.

Over the past few decades agricultural research expenditures grew faster than the number of research staff, which is uncharacteristic of developments throughout much of sub-Saharan Africa. For the period 1961-92 the number of FTE researchers grew at an annual rate of 3.7%, substantial lower than the corresponding annual rate of 6.8% for sub-Saharan Africa. Expenditures grew at a comparatively rapid annual rate of 6.4%, reflecting the substantial financial support ARD received for CSRETP. Spending per scientist was relatively stable at around 190,000 to 230,000 US dollars per researcher in the 1960s and 1970s, but was more than double that level during the 1980s. Contemporary expenditure per researcher levels are high in comparison with other sub-Saharan African countries, in part reflecting an especially intensive capital investment program by ARD during the past few years.

In the early 1960s agricultural research expenditures expressed as a share of agricultural GDP averaged 1.03% compared with a weighted average for sub-Saharan Africa of 0.26%. In the early 1980s with substantial donor support to CSRETP this ratio grew to 4.03%, almost eight times higher than the corresponding regional average. In the late 1980s and 1991 the intensity ratio dropped to 2.78% and 2.15%, respectively (with a small increase to 2.44% in 1992). This is still considerably higher than the prevailing regional average, but as Pardey, Roseboom and Anderson (1991) note it is not unusual for small countries, especially those in sub-Saharan Africa, to have higher than average research intensity ratios.

### 3.2 Human Resources

#### *Degree and Nationality Status of Researchers*

A detailed breakdown of the educational status of the research staff of ARD and the Faculty of Agriculture is presented in table 4. The first national scientist began working for ARD in 1979 and thereafter the share of nationals in the Division's total staff grew substantially. In 1991 most of the expatriates working with ARD left when the CSRETP ended and no follow-on projects were forthcoming.

Table 4: *Educational and Nationality Status of Researchers*

Institutional category	Researcher status	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	1991	1992
<i>(full-time equivalents)</i>									
ARD	Nationals								
	PhD	0	0	0	0	0	0	0	1.0
	MSc	0	0	0	0.4	3.0	7.6	9.0	9.0
	BSc	0	0	0	0.8	5.8	1.2	3.0	2.0
	Subtotal	0	0	0	1.2	8.8	8.8	12.0	12.0
	Expat	7.2	9.4	12.0	7.2	6.8	8.6	2.0	1.0
	<i>Total</i>	<i>7.2</i>	<i>9.4</i>	<i>12.0</i>	<i>8.4</i>	<i>15.6</i>	<i>17.4</i>	<i>14.0</i>	<i>13.0</i>
FA/UNISWA	Nationals								
	PhD	—	0	0	0.1	0.1	0.4	1.7	2.8
	MSc	—	0	0.1	0.3	0.8	1.4	2.1	1.0
	BSc	—	0	0.1	0.1	0.4	0.3	0.2	0
	Subtotal	—	0	0.2	0.5	1.3	2.1	4.0	3.8
	Expat	—	0.2	0.5	0.9	1.9	1.9	1.9	1.9
	<i>Total</i>	<i>—</i>	<i>0.2</i>	<i>0.7</i>	<i>1.4</i>	<i>3.2</i>	<i>4.0</i>	<i>5.9</i>	<i>5.7</i>

Source: See appendices 5 and 6.

During the period 1961-91 none of ARD's national researchers held a PhD degree. Since the mid-1970s at least one member of the Faculty of Agriculture did have a PhD and did engage in some research. The data reflect a gradual strengthening of the faculty's staff. In the early 1970s about 50% of the faculty had postgraduate training and by 1991, 95% of the staff was so trained.

### *Gender*

In 1991, 17% of the national professional staff at ARD were female. No information was available on the gender composition of the expatriate staff. The share of female professional staff working for ARD declined substantially in the past few years from 50% (4 FTE researchers) in 1985 to 17% (2 FTE researchers) in 1991. In 1991 one third of the faculty staff of the Faculty of Agriculture were female.

### *Staff Composition*

Table 5 details the composition of ARD's total permanent staff. The number of technicians and administrative support staff remained fairly constant, while the number of "other" support staff increased by 38% between 1985 and 1992. At the same time the number of researchers declined. As a result, the number of technicians per researcher increased from 1.6 to 2.5 since 1985 and the number of total support staff per researcher also grew from 8.2 to 17.1.

Table 5: *Staffing Structure for ARD*

Staff category	1985	1986	1987	1988	1989	1990	1991	1992
	<i>(number of personnel)</i>							
Research	20	22	20	15	16	17	12	12
Support								
Technical	32	32	32	32	31	33	31	30
Administrative	18	18	18	18	18	18	18	18
Other	114	130	130	131	141	152	157	157
Subtotal	164	180	180	181	190	203	206	205
<i>Total</i>	<i>184</i>	<i>202</i>	<i>200</i>	<i>196</i>	<i>206</i>	<i>220</i>	<i>218</i>	<i>217</i>

Source: 0999.

### 3.3 Financial Resources

#### *Factor Mix*

Table 6 describes recent trends in the cost structure of ARD and the Faculty of Agriculture of the University of Swaziland. Corresponding cost data for funds received from USAID sources and other donors were unavailable. Since 1985 personnel costs have usually accounted for well over two thirds of government-sourced expenditures, except for 1991 and 1992 when significant capital expenditures from government-sourced funds saw the personnel cost share drop to less than one third of the corresponding total. This recent development may simply reflect the likelihood that much of the Division's capital costs prior to 1991 were financed from USAID-sourced funds.

The Faculty of Agriculture spent between 69% and 75% of their expenditures on personnel costs, except for 1990 (93%).

#### *Sources of Funds*

Table 6: *Cost Categories for ARD*

Institute	Cost category	1986	1987	1988	1989	1990	1991	1992
		<i>(percentages)</i>						
ARD	Personnel	77.0	72.5	61.9	59.4	71.9	28.1	29.0
	Operating <sup>a</sup>	21.0	19.8	34.9	26.9	26.0	11.9	15.5
	Maintenance	2.0	3.4	1.1	1.0	1.3	0.5	0.4
	Capital <sup>b</sup>	0	4.4	2.1	12.7	0.8	59.6	55.1
	<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
FA/UNISWA	Personnel	72.1	72.3	69.8	72.2	93.3	69.1	74.7
	Other	27.9	27.7	30.2	27.8	6.7	30.9	25.3
	<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

Source: 0999.

Notes: Data only include government contributions. Expenditures for training are paid by the Ministry of Labor and Public Service and are not included in these data.

<sup>a</sup> Operating costs include transport, travelling allowance, and consumable goods.

<sup>b</sup> Capital costs include stores which fall under recurrent costs and funds for capital projects.

During the period 1982-91 most of ARD's funding came from USAID via CSRETP. From 1982 onwards the government contributions to ARD steadily declined until 1991 and 1992 when, following the end of CSRETP, they again increased. During the period 1986-90 USAID funds accounted for 71-83% of ARD's total expenditures, but this share dropped precipitously after CSRETP was wound up in 1991 (table 7). There are apparently no significant donor funds currently being invested in agricultural R&D in Swaziland.

Table 7: *Source of Funding for ARD*

	1986	1987	1988	1989	1990	1991	1992
	<i>(percentages)</i>						
Government	17.2	19.8	24.8	28.0	28.8	78.7	100
Donors <sup>a</sup>	82.8	80.2	75.2	72.0	71.2	21.3	0
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

Source: 0999.

Notes: No own income was reported. The donor-sourced expenditures series was estimated by prorating the CSRETP total over the duration of the project and then adjusting for inflation. The CSRETP total also includes the contributions to the extension component of the project.

<sup>a</sup> Donor funds only include the USAID support to CSRETP. Data on funds received from the Swaziland Cotton Board and other donors were unavailable.

### 3.4 Research Focus

About half of researchers work on crop research (table 8). About 9% of their time is spent doing research on natural resource issues and 6% of their time goes to livestock research. The remaining 38% of ARD's researchers were classified in the "other" category, which includes research on farming-systems and pest management, and research related to socioeconomic issues.

The Faculty of Agriculture spent about one fifth of their research time on crop research. Natural resources and livestock research accounted for 18% and 16%, respectively. Fisheries research accounted for 3%. About 40% of the faculty's total research time was spent on research that could not be readily allocated to a particular commodity. These include topics such as economics and management.

Neither ARD or the Faculty of Agriculture conduct any forestry research. Forestry research in Swaziland is conducted by private commercial forestry companies (e.g., Usuthu Pulp Company and the Shiselweni Forestry Company) for which relevant data were unavailable. In 1992, only one faculty staff member spent some time on fisheries research.

Table 8: *Research Focus, 1992*<sup>a</sup>

	ARD		Faculty of Agriculture		Total	
	FTE	Share %	FTE	Share %	FTE	Share %
Crops	6.2	47.7	0.9	23.7	7.1	42.3
Livestock	0.7	5.7	0.6	15.8	1.3	8.0
Forestry	0	0	0	0	0	0
Fisheries	0	0	0.1	2.6	0.1	0.6
Natural resources	1.2	9.1	0.7	18.4	1.9	11.2
Other	4.9	37.5	1.5	39.5	6.4	37.9
<i>Total</i>	<i>13</i>	<i>100</i>	<i>3.8</i>	<i>100</i>	<i>16.9</i>	<i>100</i>

Source: 0999.

Note: The “natural resources” and “other” categories include research that could not otherwise be allocated to a specific commodity or commodity group. The natural resource category refers to unallocatable soils, land use, and water research.

<sup>a</sup> Data exclude expatriate staff.

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This bibliography comprises three different sets of references. The “references” section relates to references cited in the text, the “data sources” to references from which data have been extracted to construct the time series (see appendices 5 and 6), and “other references” to references that have been consulted in the process of data collection but not used explicitly.

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## Appendix 1: Country background information



### Geography

Area: 1.7 million ha

Location: land-locked country in southern Africa, bordered by South Africa on the north, west and south and by Mozambique on the east.

Agroecological features: the country can be divided into 4 regions from west to east: The Highveld, the Middle Veld, the Lowveld or Bushveld and the Lubombo Escarpment. The major rivers flow through all regions in an easterly direction and provide irrigation for the large estates of sugarcane and citrus fruits in the drier Middle Veld and Lowveld. In the east the climate is subtropical with an average of 750-1300 mm annual rainfall. The hilly west has a temperate climate with annual rainfall of 1000-1300 mm. Grasslands flourish on the higher western parts and the lower areas of the east are dominated by dry woodland savannah. Large areas in the Highland have been planted with pine and eucalyptus trees.

### Population

Total (1991): 0.8 million

Annual growth rate (1981-90)<sup>a</sup>: 3.6%

Literacy (1990): 72%

Life expectancy (1991): 57 years

### Economy (values reported in 1985 PPP dollars)

Gross Domestic Product (1989): 2,077 million dollars

Per capita GDP (1989): 2,711 dollars

Agricultural GDP (1989): 321 million dollars  
Share of agriculture in GDP (1989): 15.4%

Annual growth rates (1981-89)<sup>a</sup>

GDP: 6.2%

GDP per capita: 2.6%

AgGDP: 3.1%

### Trade (values reported in current dollars)

Net surplus total trade (1991): -155 million dollars

Net surplus agricultural trade: 267 million dollars

Percentage of agricultural imports in total imports: 7.7%

Percentage of agricultural exports in total exports: 56.3%

Major agricultural import commodities (1991)<sup>b</sup>: wheat flour (34%), fresh milk (14%), maize (8%), beef & veal (7%), and eggs (5%).

Major agricultural export commodities (1991)<sup>b</sup>: raw sugar (60%), forestry products (24%), canned pineapples (3%), and oranges (2%).

### Agriculture

Agricultural land (1990): 1.4 million ha

Annual growth rate (1981-90)<sup>a</sup>: 1.1%

Percentage arable: 14.4%

Percentage permanent crop: 0.3%

Percentage permanent pastures: 85.3%

Percentage irrigated arable and permanent cropland: 30.4%

Economically active agricultural population (1991): 0.2 million

Annual growth rate (1981-90)<sup>a</sup>: 1.4%

Percentage in total economically active population: 65.4%

Fertilizer use per hectare arable land (1990): 36.8 kg

Annual growth rate (1981-90)<sup>a</sup>: -12.2%

Major crops (in decreasing order of value of production): sugar cane, cotton lint, grapefruit and pomelos, centrifugal sugar, and oranges.

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Sources: Europa Publications (1992), FAO (1993), and World Bank (1993).

<sup>a</sup> Least squares growth rate.

<sup>b</sup> Bracketed percentages represent value share of the respective total.

## Appendix 2: Definitions and concepts

### NARS

The construction of quantitative and internationally comparable expenditure, personnel, and related measures of a national agricultural research system (NARS) requires a precise idea of what, in fact, is being measured. Since the term NARS is subject to a variety of interpretations, it is necessary to define rather precisely the NARS concept used here. Our approach adheres, wherever possible, to the internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 1981 and UNESCO 1984). For statistical purposes a NARS is defined in terms of the following characteristics:

(a) *National*. The concept of a “national” system used in this report refers to domestically targeted research activities funded and/or executed by the *public* sector of a particular country. A relatively broad concept of the public sector is taken to include government, semi-public, and academic research institutes. However, private, for-profit research as well as the research activities of supranational research agencies that are not executed through national institutes are excluded. Also excluded is research undertaken by short-term development projects.

(b) *Agricultural*. Agricultural research, as defined here, includes crop, livestock, forestry, and fisheries research, as well as research on agricultural inputs, the natural resource base, and socio-economic aspects of primary agricultural production. It excludes, where possible, research concerning the off-farm storage and processing of agricultural products, commonly referred to as post-harvest research and food-processing research. This delineation corresponds with the national accounts definition of the agricultural sector.

(c) *Research*. Research is often performed in conjunction with other activities such as extension, education, and production. To the extent possible, research activities (in terms of expenditures and staff) are differentiated from these other activities. However, if non-research activities were an integral part of an institute’s research activities and accounted for less than 20% of the resources of the institute, it was expedient to classify all the activities of the institute as being research-related.

### Full-Time Equivalent (FTE)

A full-time equivalent researcher year is taken to be a person who holds a full-time position as a researcher during the whole year. Adjustments to full-time equivalents have only been made when: (a) a research position was part-time; (b) a research position was not filled for the whole year; and (c) if the position explicitly in-

involved tasks other than agricultural research. In the latter case an estimate was made of the time spent on agricultural research. No adjustments were made, however, for vacation or sick leave nor for time spent on administration, meetings, travel or other activities that form part of the normal duties required to support a research endeavor. Following this line of reasoning, professional staff in management positions were classified as researchers.

The degree status of researchers is determined on the following basis: 3-4 years full-time university education (BSc), 5-6 years (MSc), and more than 6 years plus doctorate thesis (PhD).

### Expatriate Researcher Costs

Many expatriate researchers working on donor-supported projects in NARSs are paid their salaries and living expenses directly by the donor agency. All (or some substantial fraction) of these costs do not get included in the financial reports of the agricultural research organizations. To calculate these *implicit* costs we took the average cost per researcher in 1985 to be 120,000 “1985 PPP dollars” and backcast this figure using the rate of change in real personnel costs per FTE researcher in the US state agricultural experiment station system. This extrapolation procedure makes the assumption that the personnel-cost trend for US researchers is a reasonable proxy of the trend in real costs of internationally recruited staff working in NARSs. Unless otherwise stated FTE expatriate researchers have been costed at \$80,000 “1985 PPP dollars” per researcher for the 1961-65 period, \$85,000 per researcher for 1966-70, \$90,000 per researcher for 1971-75, \$110,000 per researcher for 1976-80, and \$120,000 per researcher for 1981-91.

### Deflators and Exchange Rates

All expenditure figures were first compiled in current local currency units (appendix 5). In order to facilitate comparisons over time and across countries these figures are deflated with a local GDP deflator to base year 1985, and then converted to a common currency (US dollars) using the 1985 Purchasing Power Parity (PPP) over GDP. PPPs are synthetic exchange rates that attempt to reflect the purchasing power of a country’s currency. The PPPs used here are derived from the Penn World Table (Mark 5), which is based on the benchmark studies of the International Comparison Project (Summers and Heston 1991). For additional information on currency conversion methods in this context see Pardey, Roseboom, and Craig (1992).

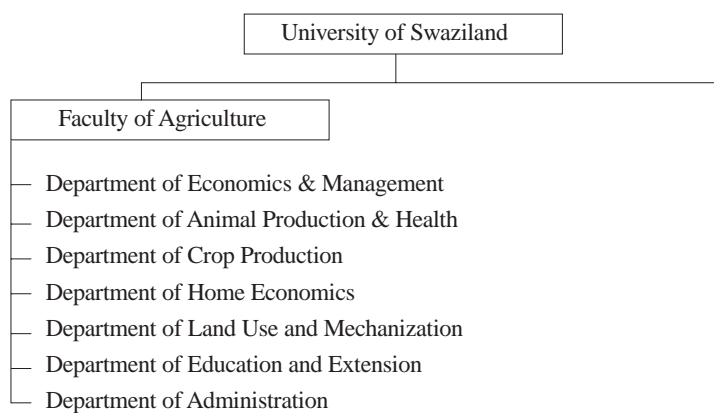
*Nomenclature for tables in text*

A zero indicates an actual observation of zero, a dash indicates an observation is not relevant (due to institutional mergers, closures, and so on), while “na” indicates an observation that is not available.

In the text we note any marked deviations from these data compilation norms and include points of clarification if warranted.

### Appendix 3: Organizational charts of the agricultural research institutes

#### *Faculty of Agriculture, University of Swaziland (1992)*



#### **Appendix 4: Addresses of the agricultural research institutes**

Chief Research Officer  
Agricultural Research Division  
Department of Research and Planning  
Ministry of Agriculture and Cooperatives  
Malkerns Research Station  
P.O. Box 4  
Malkerns  
SWAZILAND

Director  
Economic Planning and Analysis Section (EPAS)  
Department of Research and Planning  
Ministry of Agriculture and Cooperatives  
P.O. Box 162  
Mbabane  
SWAZILAND

Director  
Veterinary Diagnostic Laboratory (VDL)  
Department of Veterinary Services  
Ministry of Agriculture and Cooperatives  
P.O. Box 162  
Mbabane  
SWAZILAND

Dean  
Faculty of Agriculture  
University of Swaziland  
Luyengo Campus  
P.O. Luyengo  
SWAZILAND

Dean  
Faculty of Science  
University of Swaziland  
Kwaluseni Campus  
P.O. Kwaluseni  
SWAZILAND

## Appendix 5: Researcher and research expenditure totals, 1961-92

### Total Number of FTE Researchers

Category	Name institute	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Public	ARD	6	6.6	7.2	7.8	8.4	9	11	10	9	8	12	12	12.0	12.0	12.0	12
	FA/UNISWA	—	—	—	—	—	0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.7	0.9	1.1	1.2
TOTAL		6.0	6.6	7.2	7.8	8.4	9.1	11.1	10.2	9.3	8.3	12.4	12.6	12.7	12.9	13.1	13.2
Sources:		10					10	10			17	17/589;	17				17

Category	Name institute	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Public	ARD	12	12	4	2	3	18	18	19	20	22	17	15	16	17	14	13
	FA/UNISWA	1.4	0.9	1.4	1.9	2.4	3.1	3.3	3.4	3.6	3.3	3.6	3.9	4.3	4.8	5.9	5.9
TOTAL		13.4	12.9	5.4	3.9	5.4	21.1	21.3	22.4	23.6	25.3	20.6	18.9	20.3	21.8	19.9	18.9
Sources:		17; 1000	17; 1000	17	17	17; 1000	17; 979	17		999	999	999	999	999	999	999	999

Note: Italicized figures represent data that are either constructed or interpolated. VRL, Faculty of Science, and SSRU are excluded.

### Total Research Expenditures

Category	Name institute	Currency: million Maloti																
		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	
Public	ARD	0.097	0.116	0.138	0.166	0.196	0.220	0.275	0.255	0.236	0.219	0.354	0.347	0.352	0.371	0.391	0.394	
	FA/UNISWA	—	—	—	—	—	0.000	0.001	0.001	0.001	0.002	0.003	0.004	0.005	0.008	0.011	0.014	
Total (current LCU)		0.097	0.116	0.138	0.166	0.196	0.221	0.275	0.256	0.238	0.221	0.357	0.350	0.358	0.379	0.402	0.408	
GDP deflator (1985=100)		17.5	17.7	18.1	18.9	19.6	19.5	19.9	20.4	21.1	22.0	23.5	24.9	27.6	31.9	37.3	42.1	
Total (constant 1985 Maloti)		0.557	0.656	0.762	0.877	0.999	1.132	1.381	1.295	1.130	1.005	1.517	1.407	1.298	1.188	1.079	0.969	
Total (constant 1985 PPP dollars)		1.052	1.239	1.441	1.657	1.889	2.139	2.611	2.372	2.135	1.898	2.867	2.660	2.453	2.246	2.039	1.832	
Sources:		10									17	17					17	

Category	Name institute	Currency: million Maloti																
		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
Public	ARD	0.595	0.752	0.500	0.620	1.265	4.649	5.314	5.364	4.968	4.920	5.550	5.632	6.280	5.892	6.610	6.263	
	FA/UNISWA	0.017	0.012	0.022	0.035	0.045	0.068	0.074	0.097	0.096	0.099	0.127	0.160	0.188	0.185	0.334	0.339	
Total (current LCU)		0.612	0.764	0.522	0.655	1.310	4.717	5.388	5.451	5.064	5.020	5.677	5.792	6.468	6.077	6.944	6.602	
GDP deflator (1985=100)		46.5	50.4	58.3	69.3	70.2	82.0	85.1	94.8	100.0	112.3	129.5	152.8	170.3	200.0	223.0	249.4	
Total (constant 1985 Emulangezi)		1.317	1.516	0.895	0.945	1.866	5.752	6.334	5.748	5.064	4.469	4.384	3.791	3.799	3.039	3.114	2.647	
Total (constant 1985 PPP dollars)		2.488	2.866	1.692	1.787	3.526	10.870	11.970	10.864	9.571	8.445	8.286	7.165	7.179	5.744	5.885	5.003	
Sources:		17	17	17	17	17	17/999	17/999	999	999	999	999	999	999	999	999	999	

Note: Italicized figures present data that are either constructed or interpolated. VRL, Faculty of Science, and SSRU are excluded in table.

### Appendix 6: Research staff development by institute 1961-92

Agricultural Research Division (ARD)	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Nationals																
PhD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BSc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expatriates	6	6.6	7.2	7.8	8.4	9	11	10.0	9.0	8	12	12	12.0	12.0	12.0	12
Total	6	6.6	7.2	7.8	8.4	9	11	10.0	9.0	8	12	12	12.0	12.0	12.0	12
Source:	10					10	10			17	17/569	17				17
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Nationals																
PhD	0	0				0	0	0	0	0	0	0	0	0	0	1
MSc	0	0				2.0	2	4.0	6	6	7	7	8	10	9	9
BSc	0	0				10.0	10	6.0	2	6	0	0	0	0	0	2
Subtotal	0	0	4.0	2.0	2.0	12.0	12	10.0	8	12	7	7	8	10	12	12
Expatriates	12	12	0.0	0.0	1.0	6.0	6	9.0	12	10	10	8	8	7	2	1
Total	12	12	4	2	3	18	18	19.0	20	22	17	15	16	17	14	13
Source:	17	17	17	17	17	17	17		999	999	999	999	999	999	999	999

Faculty of Agriculture, University of Swaziland (FA/JUNISWA)	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Nationals																
PhD											0	0.2	0.3	0.5	0.7	0.8
MSc											0	0.3	0.7	1.0	1.3	1.7
BSc											0	0.5	1.0	1.5	2.0	2.5
Subtotal							0	0	0	0	0	1.0	2.0	3.0	4.0	5.0
Expatriates						0.7	1.3	2.0	2.7	3.3	4	4.7	5.3	6.0	6.7	7.3
Total						0.7	1.3	2.0	2.7	3.3	4	5.7	7.3	9.0	10.7	12.3
FTE Research						0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.7	0.9	1.1	1.2
Source:										1000						
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Nationals																
PhD	1	1	1.3	1.7	2	1	1.0	1.0	1	1	3	4	4	7	17	28
MSc	2	2	3.0	4.0	5	6	7.7	9.3	11	10	10	14	17	20	21	10
BSc	3	0	0.3	0.7	1	4	4.3	4.7	5	3	4	2	3	2	2	0
Subtotal	6	3	4.7	6.3	8	11	13.0	15.0	17	14	17	20	24	29	40	38
Expatriates	8	6	9.3	12.7	16	20	19.7	19.3	19.3	19	19	19	19	19	19	19.0
Total	14	9	14.0	19.0	24	31	32.7	34.3	36	33	36	39	43	48	59	57.0
FTE Research	1.4	0.9	1.4	1.9	2.4	3.1	3.3	3.4	3.6	3.3	3.6	3.9	4.3	4.8	5.9	5.9
Source:	1000	1000			1000	979			999	999	999	999	999	999	999/1156	999

Notes: The time spent on research by the Faculty of Agriculture has been estimated at 10%. Expatriate staff members are Africans.



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