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Crop Science Research in Sub-Saharan Africa: A Bibliometric Overview

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SUMMARY

Despite increases in both financial and human resource allocations to national agricultural research systems in sub-Saharan Africa, there has been little evidence of any significant impact on agricultural production over recent years. In order to determine the reasons for this state of affairs, we must obtain a clearer understanding of the effects of government policies on the performance of the various institutions involved in the generation and utilization of agricultural technology. This paper presents a contribution of this study by reporting a bibliometric analysis of publications output, during the period 1973–82. It is concluded that there has been a significant decrease in the number of crop science publications by government researchers during the period studied.

INTRODUCTION

As is now well known, there has occurred a persistent and deep-seated deterioration in the food and agricultural situation in the majority of sub-Saharan African (SSA) countries during the last 20–25 years. This deterioration is most starkly evidenced by the fact that, during the decade 1971–80, the growth of agricultural output *per capita* in SSA as a whole was −1·6 per cent per annum.[3] While a wide variety of causal factors have been advanced in order to explain why agricultural performance in SSA has, in general terms, been so unsatisfactory, most observers, however, have tended to focus on various interventions by central government and other

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public sector agencies which have (or should have) directly or indirectly affected agricultural output. A key intervention has been direct government support for the generation of new agricultural knowledge and technologies via the establishment of specialized agricultural research institutions. Indeed, during much of the same period that *per capita* agricultural production fell so dramatically, public resources devoted to formal agricultural research activities in SSA were significantly increased with the explicit purpose of developing viable agricultural technologies for farmers. More specifically, in human resource terms, the number of agricultural researchers employed by government research departments and institutes in SSA as a whole at least doubled between 1972 and 1983.[1] And, at the regional level, expenditures on agricultural research (measured in constant 1975 US dollar terms) in West and Eastern and Southern Africa increased by 193 per cent and 55 per cent, respectively, between 1971 and 1980.[6]

It is generally accepted that agricultural research will have to play a pivotal role if the current agricultural crisis in Africa is to be overcome. It is essential, therefore, that the past performance of agricultural research institutions in SSA are comprehensively assessed in order that effective research strategies can be formulated for the future development of African agriculture.

The purpose of this paper is to assess the performance of crops research activities in SSA countries with respect to one type of indicator, namely individual publications output during the period 1973–82. The use of publications and publications citation data as measures of scientific performance have been widely utilized in studies of research organizations and national research systems in the developed countries.[5] However, much less analysis has been undertaken of publications outputs of research organizations in the developing country context, especially in SSA.

There are a number of arguments for and against the use of publications as an indicator of the efficacy of the agricultural research effort in developing countries. Arguments against stress that publications outputs, while clearly signifying something about the level of activity by researchers in agricultural research organizations, are likely to be only weakly correlated with any increases in agricultural productivity which may arise as a result of the research effort. (Indeed, in some exceptional cases, the relationship between publications output and agricultural impact could even be negative.) This is because agricultural research in most developing countries must first and foremost be development and client oriented and therefore research priorities and activities must be directly geared to serving the needs of the nation and farmers. In practice, this will require that the bulk of the agricultural research undertaken is mainly adaptive in nature. Since it is well known that adaptive research is much less likely to

lead to publishable results it is argued it would be wholly misleading to rely on publications outputs as a primary indicator of the agricultural research process.

The 'strong' argument in favour of publications as a primary indicator of research output is that publications *per se* are universally considered to be the primary product of all formalized scientific effort, whether in agriculture or any other area, and that major trends in publications outputs over time at both the individual, institutional and country levels convey important indications about the overall efficacy of this research effort. Moreover, publication continues to be the major means of communicating new knowledge, both internally within a country and overseas. The concern expressed by researchers unable to obtain regular access to mainstream journals is palpable evidence of this.

A different line of argument is that, regardless of whether or not publications are a suitable proxy for research efficiency, the fact remains that, among a large majority of agricultural research managers and researchers in SSA, an individual's publication output is still considered to be a major criterion of success, and as such is a key factor in determining career advancement and thus status and material rewards. So long as publications retain this importance, trends in publication output (both in terms of quantity and quality) are likely to be related to changes in the internal efficiency of research organizations.

From the foregoing discussion, it can be concluded that publications outputs should not be adopted as primary indicators of the efficiency of the agricultural research effort in SSA. Having said this, however, given the importance that is attached to publications by agricultural researchers in SSA, trends in publications output over a relatively long time period are still likely to be of considerable interest in any assessment of the productivity and efficiency of agricultural research institutions in SSA during recent decades.

DATA AND METHODOLOGY

The data for this study have been compiled from the Commonwealth Agricultural Bureaux (CAB) computerized bibliographical database. (Searches were carried out online using the Dialog Information Services system.) Comparisons with other agricultural science databases (e.g. AGRICOLA) indicate that the CAB database is currently the most comprehensive for the SSA countries. The earliest complete year of computerized entries is 1973 and, given lengthy publications lags, 1982 has been taken as the final year of analysis. All crop science publications,

except those covering forestry, socio-economics and human nutrition, have been included in the study.

A major drawback in using the CAB database for statistical purposes is the presence of relatively large numbers of duplicate abstracts which, quite apart from seriously overinflating the overall publication totals, also distort the true picture with regard to country, commodity and disciplinary breakdowns. In order to overcome this problem, it was necessary to examine each publication abstract rather than simply relying on gross publication counts obtained via the computer. Given the costs of obtaining full abstracts plus the time-consuming nature of the analysis, it was decided to process only three years of publications data, 1973, 1978 and 1982. Even at this level of disaggregation, there are still some problems involved in classifying precisely the disciplinary breakdown of a publication.

Only publications whose author(s) gave an African address(es) have been selected for analysis. Publications by researchers at the international agricultural research centres have also been excluded since they are not formally part of national agricultural research systems (NARS) in SSA. The main international crops research institutes in SSA are the International Institute of Tropical Agriculture (IITA) headquartered in Ibadan, Nigeria and the West Africa Rice Development Association (WARDA) in Liberia. In addition, other crop research institutes have extensive outreach programs in SSA, most notably the International Maize and Wheat Improvement Center (CIMMYT) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Finally, 'internal' publications and other 'grey literature', such as research station or institute annual reports and mimeographed scientific papers, have been excluded mainly because of their obvious incomplete coverage by the CAB database in many SSA countries. However, papers which have appeared as part of the published proceedings of major conferences, seminars and symposia and also those in national and international research bulletins and newsletters have been included.

PUBLICATION OUTPUT: AN OVERVIEW

The number of crop science publications by agricultural researchers employed by government departments and institutes in SSA countries for the years 1973, 1978 and 1982 are presented in Table 1. This includes all non-university agricultural research institutions with the exception of two special cases in Nigeria: the Institute of Agricultural Research at Samaru and the Institute of Agricultural Research and Training at Ibadan, which are formally part of the Universities of Ahmadu Bello and Ife, respectively, but are funded directly by the Federal Government of Nigeria. It can be

TABLE 1
Crop Science Publications by Researchers Employed at Government Research Institutions in SSA Countries, 1973, 1978 and 1982

	1973	*1978*	*1982*	*1982 as % 1973*
WEST AFRICA				
Burkino Faso	5	2	1	20
Benin	0	1	1	
Chad	6	4	0	0
Cape Verde	0	0	0	0
Gambia	0	0	0	0
Ghana	33	10	7	21
Guinea	0	0	0	0
Ivory Coast	67	84	55	82
Liberia	0	0	1	
Mali	4	5	4	100
Mauritania	0	0	0	0
Niger	0	4	0	0
Nigeria	51	46	37	72
Senegal	36	56	25	69
Sierra Leone	1	0	3	300
Togo	0	3	9	900
CENTRAL AND SOUTHERN AFRICA				
Angola	0	0	0	0
Botswana	0	0	0	0
Cameroon	23	10	12	52
Central African Rep.	0	3	2	
Congo, People's Rep.	3	4	0	0
Gabon	0	6	0	0
Lesotho	0	0	0	0
Madagascar	24	3	0	0
Malawi	12	16	22	183
Mozambique	3	0	1	33
Swaziland	0	1	0	0
Zaire	0	3	7	700
Zambia	7	1	2	28
Zimbabwe	37	47	33	89
EAST AFRICA				
Burundi	0	0	3	300
Djibouti	0	0	0	0
Ethiopia	1	8	4	400
Kenya	48	56	45	94
Rwanda	1	1	5	500
Seychelles	0	0	0	0
Somalia	0	0	0	0
Sudan	20	36	29	145
Tanzania	13	8	13	100
Uganda	5	6	6	120

TABLE 2
Gross Crop Science Publication Outputs from Government Research Institutions in SSA Countries, 1973–1983

Sub-Saharan Africa	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*
Angola	3	0	3	1	0	1	0	0	0	0	0
Benin	0	0	0	3	1	3	1	1	1	2	1
Botswana	0	4	3	3	11	12	8	7	4	6	3
Burundi	0	0	0	0	0	0	1	2	1	3	5
Cameroon	24	16	11	29	24	16	19	12	15	19	2
Central African Rep.	1	5	2	1	4	5	3	0	7	2	1
Chad	7	8	3	4	3	1	6	2	0	0	0
Congo, People's Rep.	3	2	3	7	2	4	0	3	10	3	2
Ethiopia	11	15	22	6	14	35	8	15	8	10	11
Gabon	0	0	0	0	0	2	0	0	0	4	1
Gambia	1	0	4	1	1	0	3	2	0	0	1
Ghana	47	47	53	43	72	22	15	24	22	9	10
Guinea	0	0	0	0	0	0	0	1	1	0	1
Ivory Coast	80	79	104	87	78	100	94	89	72	55	36
Kenya	87	101	99	97	109	101	96	88	70	96	75
Lesotho	0	0	0	3	4	1	1	1	3	0	0
Liberia	0	1	2	3	3	6	11	8	2	5	3

Madagascar	29	26	8	9	3	2	3	3	3	0	3
Malawi	25	25	42	49	29	20	18	22	25	24	14
Mali	7	4	1	8	3	6	3	14	3	6	1
Mauritania	0	0	1	2	1	0	0	1	0	0	2
Mozambique	3	8	0	0	0	2	0	1	0	2	0
Niger	0	6	1	7	3	6	7	3	2	1	3
Nigeria	89	86	126	119	126	97	76	110	87	75	61
Rwanda	1	3	4	0	0	2	3	3	4	6	0
Senegal	43	41	35	44	62	58	55	46	44	31	34
Sierra Leone	3	4	0	0	5	7	11	22	3	3	8
Somalia	0	0	0	0	1	0	1	0	0	0	0
Sudan	40	45	38	18	39	50	35	36	37	40	28
Swaziland	3	1	4	2	4	10	8	1	3	0	4
Tanzania	32	42	32	27	33	19	16	17	13	22	18
Togo	0	2	4	4	0	7	3	3	6	9	4
Uganda	21	24	11	13	13	10	8	7	3	6	4
Upper Volta	5	4	1	3	11	7	3	15	6	3	11
Zaire	0	0	1	2	0	6	6	4	5	7	3
Zambia	17	23	14	8	8	13	7	11	7	5	8
Zimbabwe	53	52	91	46	70	77	55	51	50	51	61
Totals	635	674	723	649	737	708	584	625	517	505	419

observed that while 12 countries registered an increase in publications between 1973 and 1982, these increases were very small in absolute terms so that, with the possible exception of Malawi, total publications outputs remained minimal. In the remaining 28 SSA countries listed, there occurred absolute reductions between 1973 and 1982. At first sight, these declines seem most surprising with regard to countries such as the Ivory Coast, Nigeria and Senegal in West Africa and Kenya in East Africa, all of which had relatively well established agricultural research institutions.

This picture of decline or, at best, stagnation in crop science publications in SSA is also reflected in the annual time series data of gross publications output (see Table 2) although, as mentioned earlier, the overinflation of these estimates (especially during the earlier years) caused by the inclusion of duplicate abstracts is clearly apparent when compared with the adjusted totals in Table 1. It would appear that in many countries there was an upward trend in the annual number of crop science publications up to the mid-late 1970s but a decline thereafter.

As noted earlier, the deterioration in publication performance occurred at a time of relatively rapid growth in the number of agricultural researchers employed by government agricultural research institutions. Comprehensive data on the employment of crop researchers in NARS in SSA prior to the early 1980s are not available but it seems fairly certain that the performance measure, publications per researcher per annum, also fell considerably between 1973 and 1982. In Table 3, it can be observed that publications per crop science researcher in 1982 did not exceed one in any government agricultural research institution and that typically this figure was between 0·0 and 0·2. Only a few SSA countries (Ivory Coast, Malawi and Zimbabwe) were in the range of 0·2–0·3 publications per annum.

Although no detailed abstract analysis of crop science publications authored by members of faculties of agriculture within universities was undertaken, on the basis of gross, unadjusted publication outputs computed from the CAB database, it can be observed in Table 4 that there appears to be a similar pattern of decline and stagnation in crop science publications in the university sector in SSA countries. Publications per university scientist per year, while somewhat higher than for government agricultural researchers (0·16 compared to 0·09), are still very low especially given the generally superior qualification profiles of the former group.[1]

Type of publication

Four types of scientific publications have been delineated for the purpose of this study: national and regional journals, international and other non-African journals, newsletters and bulletins (both national and international) and books and proceedings of conferences, symposia, etc. The

TABLE 3
Publications Per Crop Science Researcher Employed at Government Research Institutions in SSA countries, 1982

	Number crop researchers	*Number publications*	*Publication/ researchers*
WEST AFRICA			
Burkino Faso	101	1	0·01
Benin	52	1	0·02
Chad	8	0	0·00
Cape Verde	9	0	0·00
Gambia	11	0	0·00
Ghana	71[a]	7	0·10
Guinea	22[b]	0	0·00
Ivory Coast	202	55	0·27
Liberia	27[b]	1	0·04
Mali	142	4	0·03
Mauritania	9	0	0·00
Niger	48[b]	0	0·00
Nigeria	704	37	0·05
Senegal	140	25	0·18
Togo	51	9	0·18
CENTRAL AND SOUTHERN AFRICA			
Botswana	47	0	0·00
Cameroon	117	12	0·10
Central African Rep.	26	2	0·08
Congo, People's Rep.	18	0	0·00
Lesotho	15	0	0·00
Madagascar	48	0	0·00
Malawi	84	22	0·26
Mozambique	66	1	0·01
Swaziland	15[b]	0	0·00
Zaire	56	7	0·12
Zambia	177[b]	2	0·01
Zimbabwe	115	33	0·29
EAST AFRICA			
Burundi	4	3	0·75
Djibouti	1	0	0·00
Ethiopia	132	4	0·03
Kenya	428	45	0·10
Rwanda	22	5	0·22
Seychelles	5	0	0·00
Somalia	36	0	0·00
Sudan	242	29	0·11
Tanzania	261	13	0·04
Uganda	103	6	0·06
Totals/aggregate	3615	324	0·09

[a] Nationals only.
[b] All agricultural researchers.

TABLE 4
Crop Science Publications by Members of Faculties of Agriculture in SSA countries 1973–83

Sub-Saharan Africa	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*Public./ Researcher 1982*
Angola	1	1	1	1	0	1	0	0	1	0	0	0·00
Benin	0	0	0	2	4	5	4	2	3	2	1	0·07
Botswana	0	0	0	2	3	3	0	1	1	2	1	
Burundi	0	0	0	0	0	0	0	1	1	1	2	0·10
Cameroon	2	2	0	2	4	3	2	4	1	4	2	0·06
Central African Rep.	0	0	0	0	0	0	0	0	0	0	0	0·00
Chad	0	0	0	0	0	0	0	1	0	0	0	0·00
Congo, People's Rep.	0	0	0	0	0	0	0	0	1	1	0	0·00
Ethiopia	4	3	1	2	0	1	4	5	4	5	4	0·05
Gabon	0	0	0	0	0	0	0	0	0	0	0	0·05
Gambia	0	0	0	0	0	0	0	0	0	0	0	
Ghana	35	31	40	42	66	22	14	13	12	11	5	0·15
Guinea	0	0	0	0	0	0	0	0	0	0	0	0·00
Ivory Coast	3	3	3	8	6	4	2	3	7	5	4	0·09
Kenya	9	8	23	21	35	23	19	36	30	29	25	0·40
Lesotho	0	0	0	1	0	2	1	2	3	4	1	0·08

Liberia	0	0	0	0	0	0	0	0	0	1	0	0·00
Madagascar	1	1	0	0	0	5	1	2	1	2	2	0·05
Malawi	4	16	9	8	5	10	2	3	2	6	2	0·13
Mali	0	0	1	0	4	2	0	1	1	0	0	0·00
Mauritania	0	0	0	0	0	0	0	0	0	0	0	0·00
Mozambique	1	4	1	0	1	0	0	0	2	2	0	0·07
Niger	0	0	0	2	1	0	0	4	1	0	0	0·00
Nigeria	99	113	198	188	233	174	142	161	208	155	199	0·29
Rwanda	0	0	0	0	0	1	2	0	3	0	3	0·00
Senegal	0	1	0	0	4	1	3	1	2	5	7	0·04
Sierra Leone	26	13	10	14	12	11	11	12	12	6	6	0·05
Somalia	0	0	0	0	0	0	3	4	1	1	2	0·03
Sudan	15	32	28	17	12	21	15	4	28	9	17	0·06
Swaziland	0	0	0	2	12	7	1	8	3	2	3	0·17
Tanzania	15	11	15	14	17	13	10	21	17	41	16	0·34
Togo	0	0	0	0	4	2	3	2	1	2	3	0·08
Uganda	24	19	27	19	8	9	3	4	5	3	1	0·08
Upper Volta	0	0	0	0	0	0	1	0	1	0	0	0·00
Zaire	7	2	3	4	2	6	3	5	6	5	7	0·15
Zambia	3	0	0	8	4	7	5	2	3	4	2	0·19
Zimbabwe	16	28	13	19	10	15	8	8	13	6	11	0·26
Totals	265	288	373	376	447	348	259	310	374	314	326	0·16

country level breakdowns of these four types of publication for each of the years under investigation are presented in Tables 5–7. A number of trends can be discerned during the period 1973–82.

There occurred a significant absolute and relative decline in the number of national and regional scientific journals published in SSA. Part of the explanation for this directly concerns the serious physical, logistical and financial problems associated with publishing journals in many SSA countries. In 1973, crop science articles were published in some 20 Africa-based scientific journals but by 1982 the number of journals had fallen to fewer than ten and these were concentrated in just three to four SSA countries (Cameroon, Kenya and Zimbabwe). Indeed, the mid-1970s were crucial for many African publications. Financial support for several journals launched during the colonial or immediate post-independence era ceased; they were supposed to be taken over by the SSA countries themselves, but this never really happened. General financial restraints, which usually affect information systems first, were apparent in many SSA countries, resulting in cutbacks in both journal support and subscriptions placed. In addition, these publications also suffered from demand-related problems. More specifically, the international scientific journal continued to remain the preferred, first choice publication option for the majority of crop researchers in SSA during this period. This is mainly because of the generally held view that articles published in overseas journals are of higher quality (as a result of more rigorous refereeing and competition for acceptance of manuscripts), usually reach a considerably wider scientific audience, and are not subject to lengthy delays before being published. (During this period most SSA-based journals had lengthy backlogs of articles awaiting publication.)

Despite this preference for overseas journals, there was a sizeable absolute and relative decline in the numbers of non-African journal articles by crops researchers working in SSA during the period 1973–82. Unlike with Africa-based journals, this fall cannot be linked to any decline in the opportunity to publish. On the contrary, the number of international journals dealing with the crop sciences continued to grow rapidly during this period. Thus, the main explanation must be specifically related to the agricultural research process in SSA itself. Although the available data are scanty, a major factor was undoubtedly the considerable reduction in the number of foreign crop researchers working in SSA during this period. It is generally recognized that the foreign researcher in SSA usually has a stronger incentive to publish in international journals and other overseas publications than the African researcher, mainly because in this case career advancement is even more dependent on his/her publication record in well-known scientific journals. It is noticeable that over 65 per cent of the

absolute decline in international journal articles between 1973 and 1982 was accounted for by francophone SSA countries, many of which experienced large-scale exoduses of metropolitan researchers.

It is not clear to what extent the reduction in the number of foreign journal articles by crop researchers in SSA is due to an overall fall in articles submitted or an increase in the rate of rejection. The introduction of page charges by many international journals during the 1970s could have deterred developing countries from submitting papers to these journals. In addition, there is some evidence[4] that authors from developing countries experience a far higher rejection rate of scientific articles and that a major explanatory factor is the problems they face in gaining access to up-to-date scientific information. This may well be of considerable significance in many SSA countries where chronic foreign exchange constraints have resulted in the cancellation of subscriptions to scientific books and journals and other types of publications. Furthermore, many articles from developing countries may be deemed to be of local importance, and therefore more suitable for publication in national or regional journals, many of which had ceased to function.

The other major trend was the two-fold increase in the number of articles published in newsletters and bulletins and, more significant still, the five-fold increase in the size of the book/proceedings publication category, from just 14 in 1973 to 72 in 1982. This type of publication tended to be heavily concentrated among national researchers from anglophone SSA countries (accounting for nearly 70 per cent of the total in 1982). Much of the increase can be attributed to the publication of scientific papers as part of the proceedings of conferences, workshops, seminars, etc., sponsored by the international agricultural research centres (most notably, the International Institute of Tropical Agriculture), the International Development Research Centre (IDRC) of Canada and a number of other international organizations concerned with the promotion of agricultural research in SSA. Thus, with the decline in national/regional journal publications, these meetings fulfilled an important role in ensuring the dissemination (in published form) of crop science knowledge and technology produced by national researchers in SSA. However, such symposia only provide a limited outlet because they are held infrequently and cover very specific areas or commodities in the mandates of the international centres.

Authorship

In 1973, over two-thirds of all agricultural research publications in SSA were written by foreign researchers. The corresponding figure for francophone SSA was 94·5 per cent which is a clear indication of the very

TABLE 5
Country Level Crop Science Publications by Type of Publication and Authorship, 1973

	Type of publication				*Totals*	*Authorship*		
	National/ regional journals	*International/ non-African journals*	*Newsletter/ bulletins*	*Book/ proceedings*		*National(s)*	*Foreigner(s)*	*Joint*
Angola	0	0	0	0	0	0	0	0
Benin	0	0	0	0	0	0	0	0
Botswana	0	0	0	0	0	0	0	0
Burundi	0	0	0	0	0	0	0	0
Cameroon	0	23	0	0	23	0	23	0
Central African Rep.	0	0	0	0	0	0	0	0
Chad	0	6	0	0	6	1	5	0
Congo, People's Rep.	0	3	0	0	3	3	0	0
Ethiopia	1	0	0	0	1	1	0	0
Gabon	0	0	0	0	0	0	0	0
Gambia	0	0	0	0	0	0	0	0
Ghana	10	20	1	2	33	19	12	2
Guinea	0	0	0	0	0	0	0	0
Ivory Coast	1	66	0	0	67	0	67	0
Kenya	25	22	0	1	48	16	29	3
Lesotho	0	0	0	0	0	0	0	0

Liberia	0	0	0	0	0	0	0	0
Madagascar	1	23	0	0	24	1	23	0
Malawi	0	9	3	0	12	0	12	0
Mali	0	4	0	0	4	0	3	1
Mauritania	0	0	0	0	0	0	0	0
Mozambique	3	0	0	0	3	0	3	0
Niger	0	0	0	0	0	0	0	0
Nigeria	15	27	5	4	51	29	17	5
Rwanda	0	0	1	0	1	0	1	0
Senegal	0	36	0	0	36	1	34	1
Sierra Leone	0	1	0	0	1	0	1	0
Somalia	0	0	0	0	0	0	0	0
Sudan	0	20	0	0	20	15	3	2
Swaziland	0	0	0	0	0	0	0	0
Tanzania	7	5	0	1	13	3	7	3
Togo	0	0	0	0	0	0	0	0
Uganda	1	4	0	0	5	0	5	0
Upper Volta	1	4	0	0	5	0	5	0
Zaire	0	0	0	0	0	0	0	0
Zambia	3	4	0	0	7	1	4	2
Zimbabwe	18	10	3	6	37	0	37	1
Totals	86	87	13	14	400	90	290	20
Per cent	21·5	71·8	3·2	3·5	100·0	22·5	72·5	5·0

[a] Articles in edited books have been counted as separate publications.

TABLE 6
Country Level Crop Science Publications by Type of Publication and Authorship, 1978

	Type of publication				*Totals*	*Authorship*		
	National/ regional journals	*International/ non-African journals*	*Newsletters/ bulletins*	*Book proceedings*		*National(s)*	*Foreigner(s)*	*Joint*
Angola	0	0	0	0	0	0	0	0
Benin	0	1	0	0	1	0	0	1
Botswana	0	0	0	0	0	0	0	0
Burundi	0	0	0	0	0	0	0	0
Cameroon	0	9	0	1	10	2	7	1
Central African Rep.	0	3	0	0	3	0	3	0
Chad	0	4	0	0	4	0	4	0
Congo, People's Rep.	0	3	0	1	4	0	4	0
Ethiopia	2	5	0	1	8	0	5	3
Gabon	0	3	2	1	6	0	6	0
Gambia	0	0	0	0	0	0	0	0
Ghana	1	5	0	4	10	7	0	3
Guinea	0	0	0	0	0	0	0	0
Ivory Coast	0	59	1	24	84	5	79	0
Kenya	21	22	3	10	56	28	24	4

Lesotho	0	0	0	0	0	0	0	0
Liberia	0	0	0	0	0	0	0	0
Madagascar	0	3	0	0	3	0	3	0
Malawi	0	6	10	0	16	4	10	2
Mali	0	1	0	4	5	3	2	0
Mauritania	0	0	0	0	0	0	0	0
Mozambique	0	0	0	0	0	0	0	0
Niger	0	3	1	0	4	0	4	0
Nigeria	15	18	3	10	46	26	7	13
Rwanda	1	0	0	0	1	0	1	0
Senegal	0	38	0	18	56	0	53	3
Sierra Leone	0	0	0	0	0	0	0	0
Somalia	0	0	0	0	0	0	0	0
Sudan	2	27	0	7	36	32	0	4
Swaziland	0	0	0	1	1	0	1	0
Tanzania	5	2	0	1	8	3	0	5
Togo	0	1	0	2	3	0	1	2
Uganda	2	0	2	2	6	6	0	0
Upper Volta	0	1	0	1	2	0	1	1
Zaire	0	1	0	2	3	1	1	1
Zambia	0	1	0	0	1	0	1	0
Zimbabwe	34	9	2	2	47	2	44	1
Totals	83	225	24	92	424	119	61	44
Per cent	19·6	53·0	5·7	21·7	100·0	8·1	61·5	10·4

TABLE 7
Country Level Crop Science Publications Output by Type of Publication and Authorship, 1982

	Type of publication				*Totals*	*Authorship*		
	National/ regional journals	*International/ non-African journals*	*Newsletters/ bulletins*	*Book proceedings*		*National(s)*	*Foreigner(s)*	*Joint*
Angola	0	0	0	0	0	0	0	0
Benin	0	0	0	1	1	1	0	0
Botswana	0	0	0	0	0	0	0	0
Burundi	0	0	0	3	3	0	3	0
Cameroon	4	5	0	3	12	7	4	1
Central African Rep.	0	2	0	0	2	0	1	1
Chad	0	0	0	0	0	0	0	0
Congo, Peoples Rep.	0	1	0	2	3	0	3	0
Ethiopia	0	3	1	0	4	2	0	2
Gabon	0	0	0	0	0	0	0	0
Gambia	0	0	0	0	0	0	0	0
Ghana	0	6	0	1	7	4	0	3
Guinea	0	0	0	0	0	0	0	0
Ivory Coast	0	45	2	8	55	2	51	2
Kenya	20	18	0	7	45	27	12	6
Lesotho	0	0	0	0	0	0	0	0

Liberia	0	0	0	1	1	1	0	0
Madagascar	0	0	0	0	0	0	0	0
Malawi	0	13	7	2	22	9	11	2
Mali	0	4	0	0	4	0	3	1
Mauritania	0	0	0	0	0	0	0	0
Mozambique	0	1	0	0	1	0	1	0
Niger	0	0	0	0	0	0	0	0
Nigeria	0	23	1	13	37	26	2	9
Reunion	0	1	0	0	1	0	1	0
Rwanda	0	3	0	2	5	2	2	1
Senegal	0	25	0	0	25	1	22	2
Sierra Leone	0	0	3	0	3	0	0	3
Somalia	0	0	0	0	0	0	0	0
Sudan	0	14	8	7	29	27	1	1
Swaziland	0	0	0	0	0	0	0	0
Tanzania	2	7	1	3	13	7	3	3
Togo	0	7	0	2	9	1	8	0
Uganda	1	2	0	3	6	6	0	0
Upper Volta	0	0	1	0	1	0	0	1
Zaire	0	1	0	6	7	2	0	5
Zambia	0	2	0	0	2	1	0	1
Zimbabwe	25	1	0	7	33	1	32	0
Totals	52	184	24	71	331	127	160	44
Percent	15·7	55·6	7·3	21·4	100·0	38·4	48·3	13·3

small numbers of national agricultural researchers in most of these countries even at this relatively late date in the formal decolonization process. Nationality was allocated on a best-guess basis. The relatively large numbers of Asian names in East Africa and a much smaller number of probably anglophone West African names, were assumed to represent national researchers. This implies that the estimates of expatriates may be slightly downwards biased, though this should not significantly affect the general conclusions of the study.

The percentage of total publications authored by nationals was actually lower in percentage terms in 1978 than in 1973 but thereafter increased fairly rapidly reaching 37·9 per cent of the total in 1982. There was some decline in the share of publications written exclusively by foreign researchers but this group still accounted for nearly 50 per cent of the total in 1982 with again a much higher concentration in francophone SSA (79 per cent in 1982).

Joint national-foreigner publications increased from 4·9 per cent of the total in 1973 to 13·9 per cent in 1982. Nevertheless, this is still a surprisingly low figure given that, on paper at least, one of the primary objectives of employing foreign researchers was for them to work collaboratively with their national counterparts. Interestingly, it would appear that where there were relatively few expatriates there was a much greater likelihood that they would publish jointly with national researchers (i.e. Nigeria, Ghana, Kenya and Zaire).

Disciplinary breakdowns

Lack of data on the disciplinary specializations of agricultural researchers in SSA does not allow estimates of publications per researcher disaggregated by discipline to be computed for each of the three years under study. Nevertheless, a number of conclusions can be drawn from the annual publications totals by broad disciplinary areas presented in Table 8. These disciplinary breakdowns have been based on the United Nations Food and Agriculture Organization AGRIS (International Information System for the Agricultural Sciences and Technology) classification. Looking at absolute totals first of all, the very small number of publications throughout this period by researchers specializing in meteorology and climatology, soil resources and management, weeds and the protection of stored products is particularly worrying given the critical importance of these subject areas in SSA. At the other extreme, entomology/nematology and plant pathology had relatively high rates of publication given the likely number of researchers specializing in these areas. Plant breeding and general agronomy were surprisingly low given the relatively high

TABLE 8
Crop Science Publications by Area of Specialization, 1973, 1978 and 1982

Subject area	*AGRIS codes*	*1973*		*1978*		*1982*	
		Number	%	*Number*	%	*Number*	%
Meteorology & Climatology	F10	11	2·6	4	0·9	2	0·6
Soil Science General: Soil Biology, Chemistry and Physics	F20, F21, F22	25	6·0	42	9·7	18	5·3
Soil Classification and Genesis; Soil Surveying and Mapping	F23, F24	1	0·2	4	0·9	3	0·9
Soil Fertility; Fertilizers	F25	53	12·8	36	8·3	26	7·7
Soil Resources and Management; Soil Erosion; Irrigation & Drainage	F26, F28, P10, P12	10	2·4	11	2·5	6	1·8
Soil Cultivation and Cropping Systems: General Agronomy	F27 F01	44	10·6	70	16·2	61	18·0
Plant Breeding	F30	52	12·5	54	12·5	45	13·2
Plant Ecology, Structure, Physiology and Biochemistry	F40, F50, F60	50	12·0	46	10·6	27	7·8
Entomology/Nematology	H10	80	19·3	74	17·4	84	24·8
Plant Pathology	H20	55	13·2	47	10·9	42	12·4
Weed Science	H60	17	4·1	30	6·2	12	3·5
Protection of Stored Products	H70	7	1·7	1	0·2	6	1·7
Others		10	2·4	13	3·0	7	2·0
Totals		415	100·0	432	100·0	339	100·0

proportion of crops researchers in SSA countries working in these disciplines (typically 35–50 per cent). Part of the explanation for this may be that many were mainly involved in adaptive research trials of imported germ plasm and general agronomic practices, the results of which were not particularly publishable.

The most noticeable trends in the percentage disciplinary shares between 1973 and 1982 are the sizeable increases for general agronomy and entomology/nematology and equally sizeable decreases in plant ecology/structure and soil fertility/fertilizers.

Commodity breakdowns

The absolute and relative publication breakdowns on the basis of commodity subject matter are presented in Table 9. It should be pointed

TABLE 9
Breakdown of Publications by Commodity 1973, 1978 and 1982

Commodity	*1973*		*1978*		*1982*	
	Number	*%*	*Number*	*%*	*Number*	*%*
Maize	15	4·2	23	6·7	20	7·6
Millets	0	0·0	5	1·5	0	0·0
Rice	26	7·4	27	7·8	18	6·9
Sorghums	3	0·8	8	2·3	3	1·1
Wheat/barley	4	1·1	4	1·2	2	0·8
Cereals not spec.	17	4·8	13	3·8	5	1·9
Cereals sub-total	65	18·3	80	23·2	48	18·3
Legumes	13	3·7	20	5·8	27	10·3
Root crops	5	1·4	20	5·8	47	17·9
Fruit/nuts	42	11·9	28	8·1	3	1·1
Vegetables	13	3·7	20	5·8	6	2·3
Oil crops	41	11·6	49	14·2	29	11·1
Sugar	11	3·1	14	4·1	6	2·3
Pastures	22	6·2	14	4·1	1	0·4
Food crops sub-total	212	59·9	245	71·2	167	63·7
Cotton	40	11·4	13	3·8	15	5·7
Sisal/fibre crops	0	0·0	3	0·9	1	0·4
Cocoa	46	13·0	16	4·7	22	8·4
Coffee	28	7·9	32	9·3	18	6·9
Tea	15	4·3	28	8·1	19	7·3
Spices/flavourings	2	0·6	0	0·0	2	0·8
Rubber	6	1·7	2	0·6	9	3·4
Tobacco	4	1·2	5	1·4	9	3·4
Export crops sub-total	141	40·1	99	28·8	95	36·3
Grand total	353	100·0	344	100·0	262	100·0

out that there is a group of commodities (including sugar, oil crops), which are produced both as food and export crops. On balance, however, a large and growing proportion of these crops are for domestic food consumption and have therefore been included as food crops.

Between 80 per cent and 85 per cent of the crop science publications contained in the CAB database for the years 1973, 1978 and 1982 has a specific crop (or crops) focus. A definite trend during this period was the steady increase in the relative importance of food crop publications so that by the early 1980s, export crop publications represented only approximately one-third of total (crop identifiable) publications. Thus, at least with regard to publications, crops research in SSA does not appear to be particularly heavily biased in favour of export crops as is sometimes alleged.[2] The same conclusion is true, incidentally, with regard to the relative number of researchers engaged on food and export crops research.[1]

Within the food crops sub-categories, it can be observed that while maize publications increased in relative importance, publications concerned with the major drought-tolerant crops of the semi-arid areas in SSA, namely the sorghums and millets, were insignificant throughout the period. Among the remaining food crops, there was a major increase in the share of legumes and root (mainly cassava) crops—from a combined total of 5·0 per cent in 1973 to 27·1 per cent in 1982. Conversely, there was a sizeable fall in the relative importance of fruits and nuts publications (largely accounted for by a reduction in the number of publications by French researchers working on these crops).

Finally, within the export crop sub-category the most noticeable changes in the relative publication shares of specific crops were the declining importance of cotton and cocoa.

CONCLUSION

The main conclusions to have emerged from this study are that (1) there has been a significant downward trend in the total number of crop science publications that have been written by researchers employed in government research institutes in SSA as a whole during the period 1973–82, and (2) while the total number of crop science publications written (or partly written) by national researchers did increase during this period, when expressed in terms of publications per national researcher, there was also a significant decline in publication output.

It is conceivable that such a decline in publications output may signify relatively little about the effectiveness of agricultural research activities. Of

particular relevance in the SSA context, is the commonly stated view that the fundamental objective of small, resource poor NARS should be to adapt technology developed elsewhere to local agro-economic conditions. However, because such adaptive research is not generally considered to be particularly publishable, publications *per se* cease to be a reliable performance indicator.

While there has occurred some shift in emphasis by some NARS in SSA from applied to adaptive research during the last 5–10 years, it cannot be convincingly argued that this in itself has amounted to such a fundamental change in the nature of the research process as to cause the very sizeable, generalized decline in national crop science publication outputs. Of considerably greater importance has been the role of factors directly linked to the quantity and quality of resources available to NARS in Africa.

Probably the most serious problem has been the pronounced deterioration in the experience and qualification profiles of crop researchers in SSA.[1] This has been mainly due to the fact that most new recruits have tended to be fresh graduates straight from university while at the same time relatively large numbers of expatriate researchers, often with doctorates and/or many years of experience, have departed and have not been replaced. And, with the rapid growth in the number of young researchers, the management and supervisory duties of the relatively small group of experienced researchers have grown as well with the result that they have been less able to devote their time to substantive research activities.

Another issue has been the widespread decline in operating and capital expenditures per crop researcher during the last 15–20 years. As noted in the Introduction, there have been significant increases in both human and financial resources committed to agricultural research efforts in SSA. However, the rate of growth in the size of the professional research cadre has generally outstripped the rate of growth in government financial support. Thus, given this deprivation in the availability of resources per researcher, it is perhaps not surprising that publications output has suffered as much as it has.

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