THE STATE OF NATIONAL AGRICULTURAL RESEARCH

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I. INTRODUCTION

Science and technology began to receive increasing attention as the basic engine for agricultural progress in the developing world only after World War II. There was a growing conviction that the problems resulting from poor agricultural performance -- inability to satisfy national food requirements or provide exportable surpluses -- could be solved through technology. It was believed that the stock of knowledge already available in the developed world was adequate to meet the needs of the developing countries; only appropriate mechanisms for transferring the technologies from donor to recipient countries were needed. This conviction soon proved to be erroneous. It became apparent that if technology was to be a positive force for agricultural development, national institutions capable of carrying out applied research and adapting existing technological knowledge to fit farmers' needs had to be developed.

Beginning in the late 1950s and early 1960s, important efforts have developed from these early views, and national research infrastructures that might eventually provide the technological base necessary for agricultural development were evolved. These efforts concentrated first in the larger countries of Asia and Latin America, but have since spread throughout the developing world.

This paper is an elementary attempt to examine how these national agricultural research systems have evolved since the mid-1960s. Certain issues are raised which, in our opinion, affect their productivity and, consequently, their capacity to contribute to agricultural development. In doing so, the analysis is based on the premise that effective national agricultural research systems (NARS) are not only a function of the quantity of resources they secure, but also of the quality of those resources and how they are used. The analysis is based on an extensive survey of NARS and upon a systematic attempt to incorporate data developed by other researchers and institutions interested in the topic.

The paper is organized in five sections. The second section, following this introduction, is a brief discussion of the state of agriculture and the main indicators of agricultural growth between 1960 and 1984; it gives the background for the evolution of NARS during the period. Section three reviews the database used in the paper, with particular reference to the 1984 ISNAR survey of NARS. Section four summarizes the current and changing state of NARS in the developing world from the perspective of their human and financial resources. Section five presents some concluding thoughts and issues for discussion in relation to the main problems confronting NARS today.

II. THE STATE OF AGRICULTURE

Current projections put world population at around 6 billion by the turn of the century. Providing the increased food and agricultural products demanded by this population will challenge the capacities of existing agricultural production systems. Nevertheless, changes in these systems need to be considered in a much broader context than simply meeting the demand for agricultural products. Sectoral changes in agriculture influence and are influenced by the development paths particular countries follow.

History demonstrates that, as most countries develop, they decline in agricultural output and employment relative to the non-agricultural sector. For instance, by 1980 agriculture's share of the labor force had declined to only one-third of its 1960 level for most developed countries. It dropped to a level which averaged around 6 percent of the total labor force. Nevertheless, for many of these economies agriculture is still an important industry, and the export earnings derived from it are still substantial, although the value added in agriculture tends to shift off-farm into the distribution and processing stages of the production-marketing chain.

In the following paragraphs based on World Bank data we discuss some of the main indicators of the contemporary record of agricultural growth in the developing world.

Figures 1 and 2 present for a 98-country sample the average yearly growth rates in gross agricultural product over the 1960-1984 period at specific per capita income levels. The main observation is the great diversity in yearly growth rates in gross agricultural product and the contrast when performance in the early and latter part of the period is compared.

Figure 1 shows that most of the low-income countries achieved significant rates of growth during the '60s and '70s, while in higher-income countries a relatively high proportion of negative growth rates is observed, reflecting the familiar pattern of agricultural growth.

In a more recent record (1975-1984), as presented in Figure 2, we observe a marked difference in these sector-level figures. There is a substantial decline in the performance of the agricultural sector during this period, with a significant increase in the number of countries experiencing low and negative growth rates in gross agricultural output. Moreover, the phenomenon of negative growth rate is no longer restricted to the high-income countries.

Using the regional figures in Tables 1 and 2, we have a more precise picture of these rather dramatic shifts in the pattern of agricultural growth.

For the earlier period 1960-1979, 15 percent of the countries sampled -- 15 out of 98 -- had negative yearly growth rates. This was clearly influenced by the high-income countries of Europe and North America, with 8 percent of the African countries -- 4 out of 49 -- having negative growth rates as well. As a group, the Asian and Latin American countries performed quite well during this period, with the majority of the

countries in both regions showing, on average, a growth rate of over 2 percent per annum.

The figures in Table 2 reveal the extent of the deterioration in the agricultural sectors during the late '70s and early '80s. Roughly half of the countries experienced declines in their real agricultural output, with nearly 50 percent of the African, 32 percent of the Asian, and 40 percent of the Latin American countries experiencing negative rates of growth. The number of countries with growth rates in excess of 2 percent has been reduced by more than half since 1967, to only 29 of the 98 countries in the sample. The drop has been most dramatic in Asia and Latin America, where the numbers went from 20 to 8 and from 14 to 5, respectively.

Figure 3 summarizes the shifts which have occured in the agricultural sectors of 98 countries over the last 20 to 25 years. The horizontal axis measures yearly rates of increase in real agricultural output for the earlier 1960-79 period, and the vertical axis measures the yearly rates of increase over the more recent 1975-1984 period. The countries above the dotted line experienced an improvement in their agricultural output growth rates over the two periods, and those below the dotted line fared somewhat worse in the later period than in the earlier period.

Although the discussion so far relates to changes in the level of gross agricultural output, FAO recently presented figures showing that the picture concerning food production alone is equally disturbing, with per capita food production in 28 countries declining in the decade from the early '70s to the early '80s.

Clearly, economic progress in the agricultural sectors of numerous countries has been undercut by factors such as the oil shocks of the '70s and associated structural adjustments, extensive droughts (particularly in the Sahel, and southern and eastern Africa, during the '80s) and constraints imposed by the unprecedented external indebtedness that emerged for several countries (especially in Latin America) in the late '70s and early '80s.

Nevertheless, the shifting patterns of these long-term growth averages suggest that some alternative deep-seated structural issues may also be operating here. Sustained discrimination against the agricultural sector through persistently overvalued exchange rates and/or direct interventions to maintain low agricultural prices (in support of 'cheap food' policies) has been documented in numerous countries and would account, in part at least, for the declines in agricultural output noted earlier.

Limited access to, and use of, both private and public agricultural technology is also likely to be relevant in explaining the situation. However, throughout the 1970s significant efforts were made to strengthen national agricultural research and technology-generation capacities. The pertinent question to ask is why these efforts have not been reflected in agricultural performance. In this context we would like to sketch the state of national agricultural research systems as they have evolved over the last 20 or so years, with special focus on resources available to national public-sector agricultural research.

III. ISNAR's DATA BASE EFFORTS: (An Aside)

Before doing so, however, let us briefly mention ISNAR's ongoing efforts to construct a data base on national agricultural research systems. Our activities in this area date back to a joint ISNAR/IFPRI report compiled by Oram and Bindlish in October 1981 (1). More recently, in October 1984 ISNAR mailed a questionnaire in English, French, or Spanish to approximately 116 countries, requesting data on their agricultural research systems. The survey was in three parts:

Part A - current information about the structure, organization, and activities of the country's national agricultural research system;

Part B - historical information about the evolution of the national system;

Part C - current information about staffing, funding, and activities of the principal component units of the national system.

A companion survey was also sent to the member countries of the Arab Organization for Agricultural Development in late December 1984.

Around 60 countries have returned completed questionaires for all or major parts of their systems. This information, along with a variety of other secondary and internal sources -- including various mimeos and reports, some of which may have had only limited circulation -- has been used to restructure and substantially update the previous data compilations which are available. The results presented here today should definitely be considered preliminary and will no doubt be subject to modification, but, following some additional data gathering, cleaning, and formating, we hope to be able to release these data a little later in the year.

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(1) Oram, P.A., and Bindlish, V. Resource Allocations to National Agricultural Research: Trends in the 1970s (A Review of Third World Systems).

IV. THE STATE OF NARS IN THE DEVELOPING WORLD

Higher research productivity is not necessarily a direct consequence of increased resources. Quality and functional issues are of special importance in the research process. These include the intrinsic characteristics of resources -- particularly human resources -- and resource mixes and how these resources are used. In the following paragraphs we attempt to summarize the current and changing state of NARS based on an analysis of research personnel and expenditure data.

1. Availability of scientific personnel

Figure 4 shows the development over time of scientific manpower. It uses data concerning the two periods covered in the survey (1965-69, 1980-84) and presents frequency distributions for two samples of countries on the basis of the total number of researchers working in the national system. Both samples are fairly comprehensive; for the late '60s we include 91 countries and for the early '80s 106 countries. The main fact emerging from these figures is the growth in the average size of the research systems. Across countries over this 15-year period, the mean system size has increased by almost 90%, from 254 to 474 researchers. However, the proportion of countries with a marginal research capacity of less than 10 researchers has remained relatively constant at around 9 percent. There has been a definite growth in the small to medium-size systems, with a sizeable shift from the 11-50-researcher range into the 51-200-researcher range. We observe little change in the number of countries with medium-sized systems of around 200-500 researchers. The mean size of the systems in this range also remains unchanged. In the 500-1000-researcher range, however, several countries have moved into the 1000+ size.

When analyzing the level of human resources on the basis of the evidence collected in the ISNAR survey, we find that a significantly large number of NARS are staffed by relatively few researchers with doctoral training. This is highlighted in Figure 5, which shows a frequency distribution of the percentage of agricultural researchers who hold a Ph.D. (or equivalent) qualification. For the countries for which there are 1983-84 data, nearly 50 percent of the NARS have less than 5 percent of their research staff holding doctorates, and only four countries show a figure over 20 percent. If the analysis is done just for personnel holding some sort of postgraduate degree (either master's or doctorates), the situation improves substantially, with roughly half of the countries in the sample having 40 percent or more of their research personnel in this category.

Another factor which bears directly on the performance of the national research systems is the low level of experience of research personnel. There is a lack of information on these factors, but partial evidence concerning the NARS of Sub-Saharan Africa highlights their importance. In Kenya in the early '80s, 76 percent of research personnel had less than 5 years' work experience, 46 percent in Nigeria, 69 percent in Senegal, and 67 percent in Zimbabwe. Furthermore, the situation has a tendency to deteriorate as a consequence of the continuing decline in real incomes, which in many of these NARS makes it difficult to retain staff to work full-time within the research system.

Clearly, much still needs to be done to assist NARS in developing institutional and incentive structures which enable them to build and maintain a cadre of qualified research scientists.

2. Financial Resources

We now turn to research expenditures. Figure 6 shows the situation during the 1970-1984 period. According to this information, there is a minor change in the distribution pattern of the global resources (in real terms) spent on public-sector agricultural research away from the high-income countries of Europe, and Canada and Japan, toward the lower-income countries over the 1970-1984 period. We should caution, however, that the changes indicated by these regional totals may be somewhat distorted, because they only reflect the spending totals in 58 countries, for which we have reliable time-series research-expenditure data.

Looking at the frequency distributions of rates of growth in expenditure -- see Figure 7 -- we observe that 30 percent of the countries in the sample experienced rates of growth in real expenditure in the order of 0 to 5 percent during the 1970-79 period. The average yearly growth rate decreased from 12 percent in the 1970-1979 period to 6 percent for the 1975-84 period. The shifts in research spending clearly indicate a greater diversity of research investment behavior. There is an increase in the proportion of countries which show negative growth rates and of countries with annual growth rates in excess of 5 percent. Those countries experiencing declines on the order of 0 to 5 percent increased from 17 to 29 percent; those experiencing positive rates of growth in the 5 to 10 percent range increased from 15 to 24 percent.

Figure 8 shows country-specific performances with regard to growths in real research spending. The horizontal axis represents average yearly growth rates over the 1970-79 period, and the vertical axis measures the growth over the 1975-84 period. Once again, those countries which appear above the dotted line have enhanced their growth rates in the later compared with the earlier period, while those below the line have lost some ground. As we would expect from the earlier figures, most of the countries lie in the plus to minus 10 percent range, but, significantly, around 58 percent of the countries in the sample have research systems which are currently growing less rapidly in real spending terms than they were during the 1970s. A closer look at the figures indicates that 11 of the 13 countries experiencing declines in real spending during the 1970s are currently doing somewhat better, inasmuch as their real spending is still declining but at a slower rate than during the 1970s.

3. The resource mix: human and financial resources

The rather disappointing growth recently in real spending on agricultural research which the above figures portray is even more alarming when coupled with the increased research personnel resources mentioned earlier. Available data suggest that many research systems present severe distortions in their factor mixes.

Although at present no detailed figures on the proportion of resources devoted to operating expenses in support of research scientists are available for many countries, existing information does suggest that many

systems are currently under extreme pressure to maintain an 'appropriate' mix in their research spending portfolios. According to the results of the ISNAR survey, in 13 countries out of the 48 for which there is reasonably accurate information, the proportion of resources going to finance operating costs is less than 20 percent; and as little as 5-6 percent in some instances. Capital spending is another important item, particularly if we consider that many of the NARS in the sample are still in the early stages of development and, consequently, face heavy investment and infrastructure needs. It is also another shortage item, with more than 15 countries in the sample spending less than 10 percent on capital investment.

A concommitant issue is the high year-to-year variability in research spending. This variability is an especially worrying aspect, given the long-term nature of research programs and, thus, their inflexibility for abrupt or short-term adjustments. Again, detailed information is very limited, but a study by Trigo and Piñeiro for the countries in Latin America and the Caribbean for the 1970-80 period shows that monetary allocations for any given country were highly unstable, often revealing year-to-year variations in excess of 50 percent (2). ISNAR experience in other parts of the world suggests that this phenomenon is not confined to Latin America and the Caribbean.

Another dimension of the resource mix, and perhaps more indicative of the seriousness of the situation, is the evolution of budgetary support per scientist. Figure 9 shows expenditures per scientist for the early 1970s and the early 1980s. It is evident that in many countries support per scientist has changed quite dramatically since the early 1970s. In this 51-country sample we observe that 67 percent of the countries fall below the dotted line, indicating a decline in real financial support per scientist for these NARS. The frequency distribution in Figure 10 shows the magnitude of this decline. Notice that 23 percent of the countries had declining expenditures per scientist in the order of -5 to -10 percent, while nearly 31 percent of the countries fell into the -2 to -5 percent range.

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(2) Trigo, E., and Piñeiro, M. (editors). Selected Issues in Agricultural Research in Latin America. ISNAR, IFARD, IICA, Spanish Government. Madrid, Spain, March 1984.

V. SOME CONCLUDING THOUGHTS AND ISSUES FOR DISCUSSION

Agricultural growth is essential for economic and social development and maintaining food supply in balance with population growth. Research is a critical element for creating the new technologies needed to bring about this growth. Strong and highly productive national agricultural research systems are necessary if research is to contribute effectively to the development process.

A major proportion of development assistance in the last 20-25 years went to support agricultural projects in general and agricultural research efforts in particular. The result was a rapidly developing international research network in which national, regional, and international components interacted to produce the needed technologies. Out of these efforts grew what has become known as the Green Revolution and a number of other success stories in specific crops.

The figures we have presented in this paper show for the more recent period a somewhat different picture. Agriculture is not growing, and research systems are faced with increasing restrictions on the human and financial resources being made available to them. We have seen a decline rather than an improvement in the growth of the agricultural sectors of many countries during the late '70s early '80s as compared with their growth performance over the preceding decade. Moreover, a significant number of countries experienced shrinking agricultural sectors in absolute, not just relative, terms. This is cause for grave concern, given the population pressures faced by many food-deficit countries and a decline in their ability to import agricultural products because of increased indebtedness.

In considering the state of NARS, there is no cause for complacency here either. We observe declining rates of growth in total support for many countries both in absolute terms and relative to their levels of support during the 1960s and early 1970s. The number of scientists in many countries is still increasing. However, the poor quality of scientific staff and the associated problems of declining real incomes, plus the institutional environment within which their scientific endeavors are carried out, appear to be in need of serious attention.

Given the relatively long time-lags in the agricultural research-agricultural output process, it is clear that decisions taken today concerning NARS will bear costs or benefits in the decades to come. For this reason it is important that we discuss the issues involved and try to find courses of action that contribute to improving the situation.

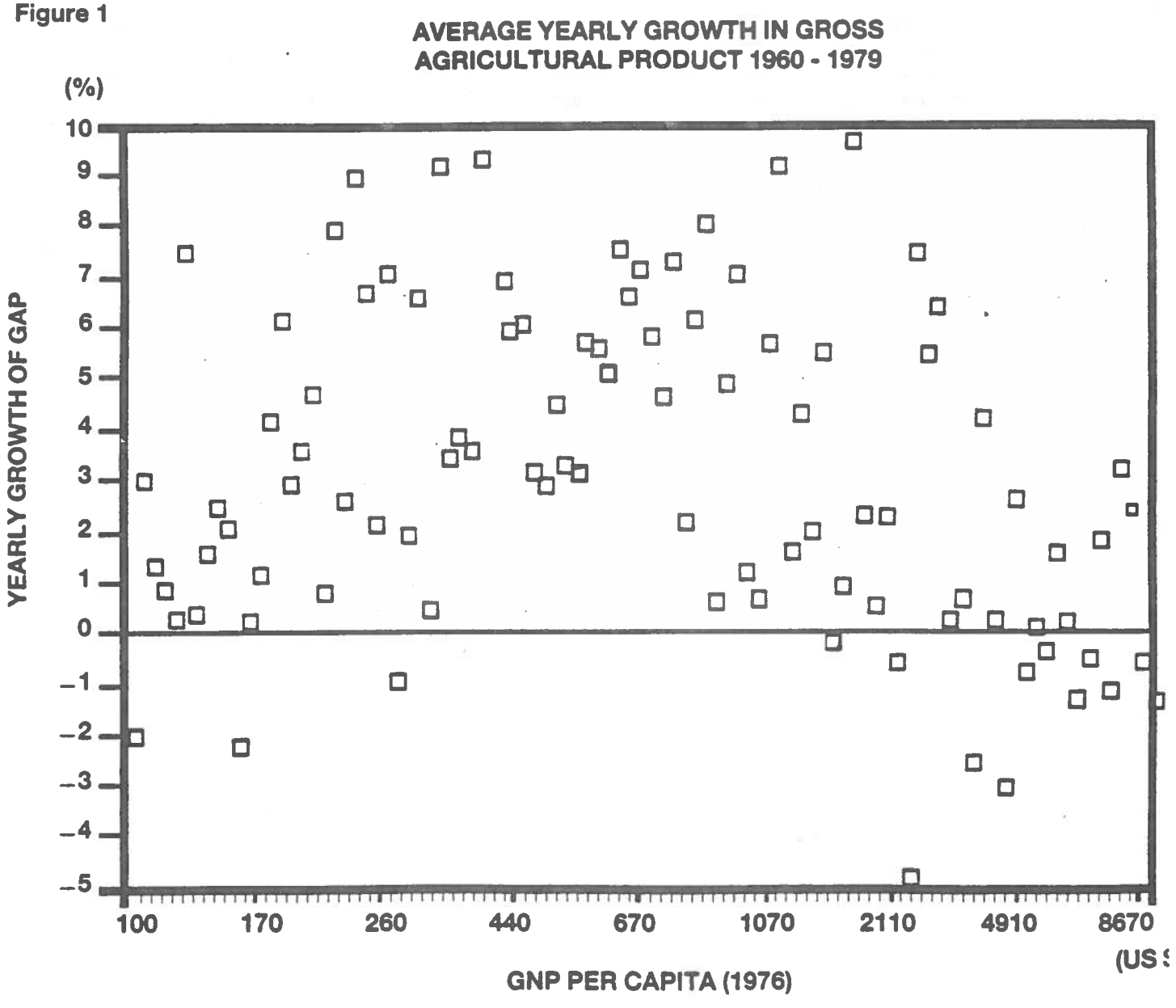
A first topic relates to the relationship between research and agricultural growth. Does the decline in growth rates imply a weaker linkage than we have assumed in the past? We are convinced that it does not. It does imply, however, that research is not enough. Research, at best, can produce the necessary knowledge to improve production conditions; but, for that knowledge to affect production, it must be transformed into technology, and technology must be adopted by the farmers. This requires a whole set of policies and complementary actions which, if not present, render the most potent research useless. ISNAR has found this to be a key problem in almost every country it has worked in during the last five years.

Appropriate policies are not important solely in facilitating the adoption of the newly produced technologies. They must also constitute a key element to help guide the use of research resources in the right direction. There have been many formal national statements on the importance of agriculture and of agricultural technology for development; yet implemented policies have run counter to those statements. What can be done to improve these situations?

A second set of issues relates more directly to the research systems themselves. Financial resources are not growing. A number of countries are actually experiencing reductions in available resources in absolute terms. Given the overall economic situation with which many of these countries are confronted, this trend cannot be taken as a temporary phenomenon. The need for more effective use of available resources is urgent.

Improved management is an ever-present objective. In the face of shrinking and unstable resources it becomes even more important. Better overall management will allow research to remain focussed on the more pressing needs and high-impact areas and will result in increased research productivity. This will in turn help improve the chances of obtaining more resources for research activities. The areas in need of improvement are varied, and may include priority setting and program formulation; resource management (human, physical, and financial); the monitoring and evaluation of research activities; and the development and management of linkages between research organizations and with the research clintele and policy-makers. ISNAR has found all of these to be areas where further work is needed and is strengthening its program to offer NARS in the developing world improved methodologies and approaches which take into consideration the specific conditions and resource constraints that confront them.

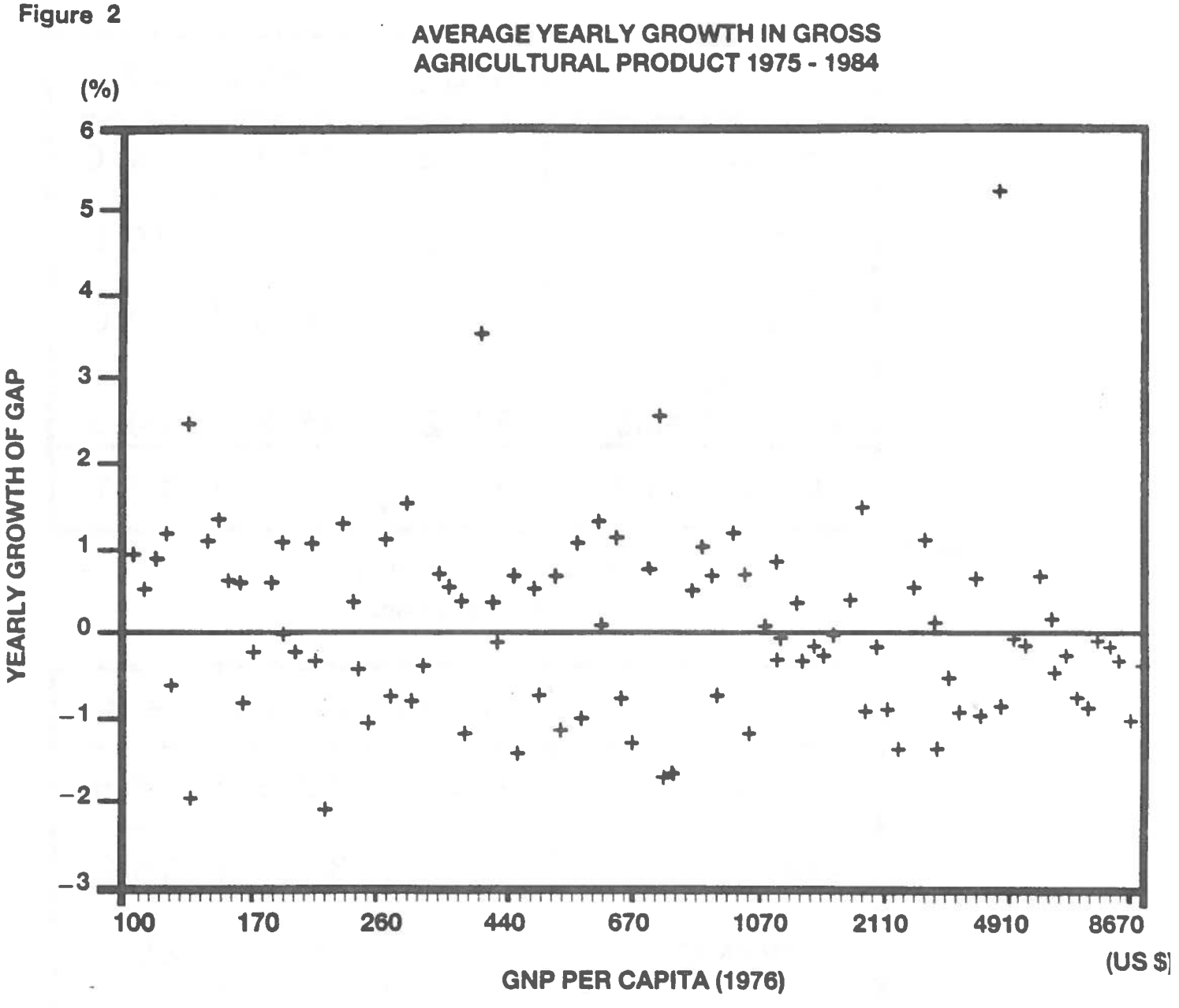
Figure 1



Sample size: 98 countries

Source: WORLD BANK Tables

Figure 2



Sample size: 98 countries

Source: WORLD BANK Tables

Table 1

AGRICULTURAL GROWTH RATES
1960 - 79 Average

	-5 to 0%	0 to 2%	>2%
AFRICA	10.8	35.1	54.0
ASIA	9.1	0	90.8
LATIN AMERICA	10.0	20.0	70.0
EUROPE & NORTH AMERICA	35.2	35.3	29.5
ALL COUNTRIES	15.3	24.5	67.1

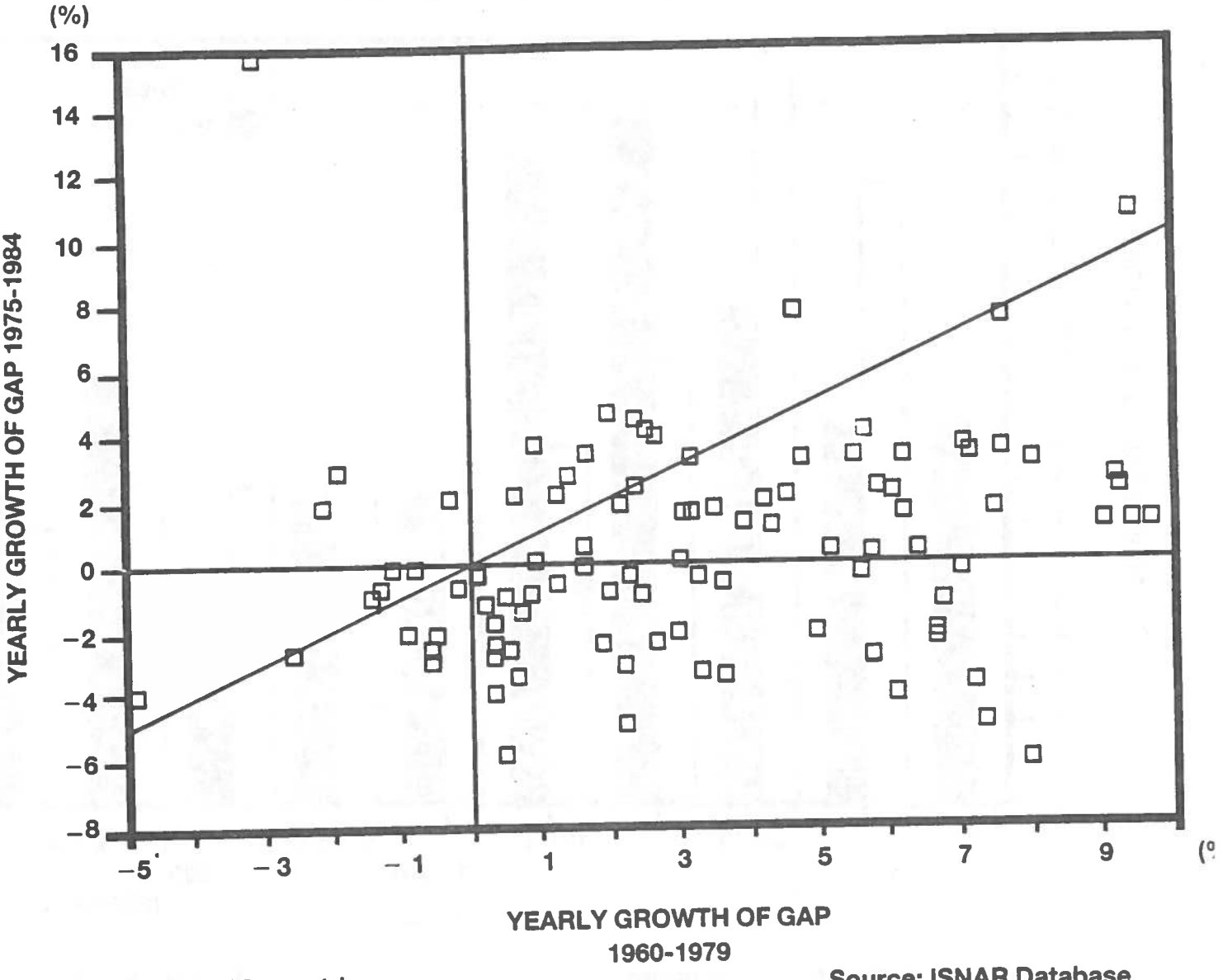
Table 2

AGRICULTURAL GROWTH RATES
1975 - 84 Average

	-5 to 0%	0 to 2%	>2%
AFRICA	48.6	13.5	37.8
ASIA	31.7	31.7	36.3
LATIN AMERICA	40.0	35.0	25.0
EUROPE & NORTH AMERICA	82.3	5.0	11.8
ALL COUNTRIES	49.1	21.4	29.5

Figure 3

CHANGE OF GROWTH IN GROSS AGRICULTURAL PRODUCT

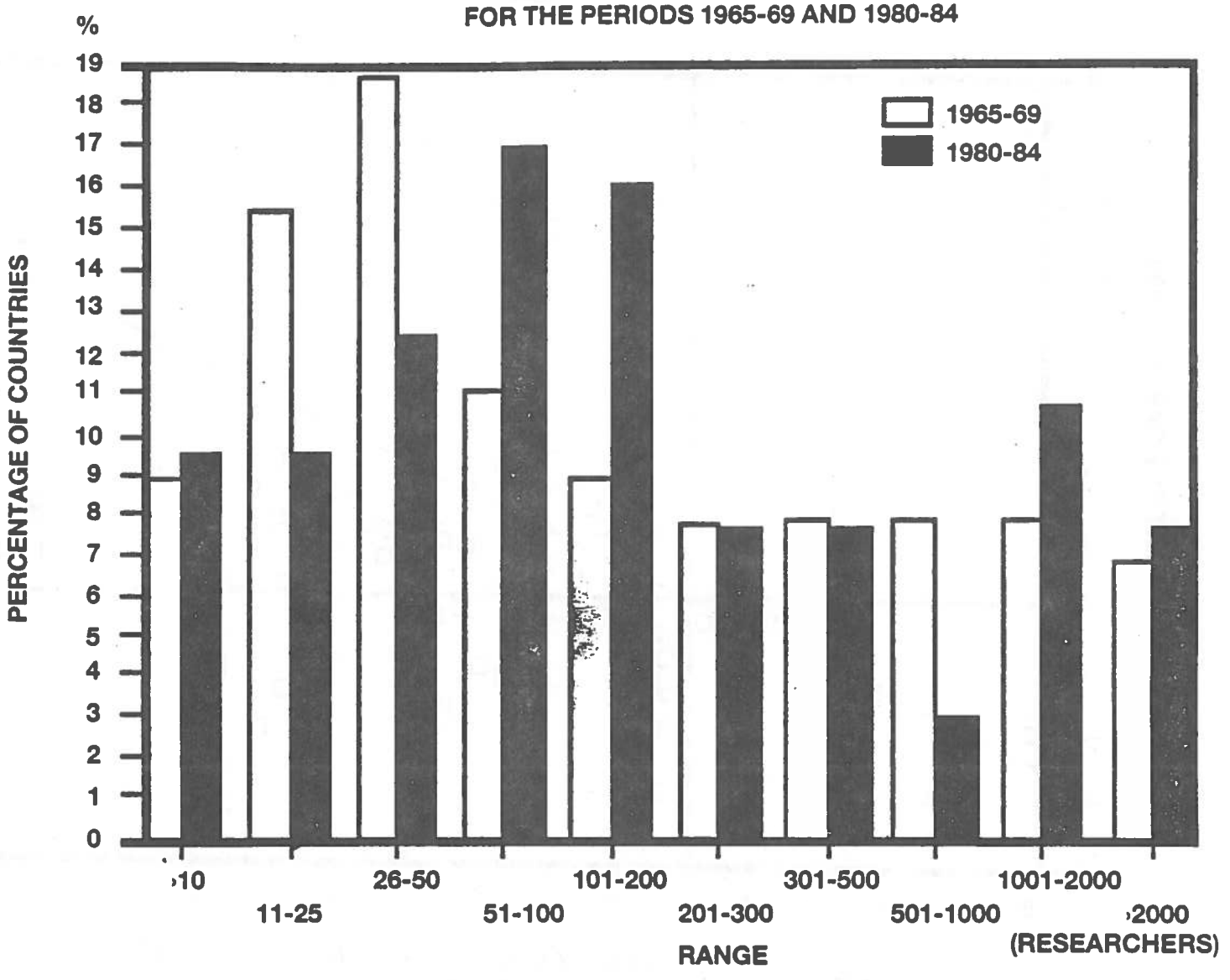


Sample size: 98 countries

Source: ISNAR Database

Figure 4

RELATIVE FREQUENCY DISTRIBUTION OF COUNTRIES BY NUMBER OF AGRICULTURAL RESEARCHERS FOR THE PERIODS 1965-69 AND 1980-84

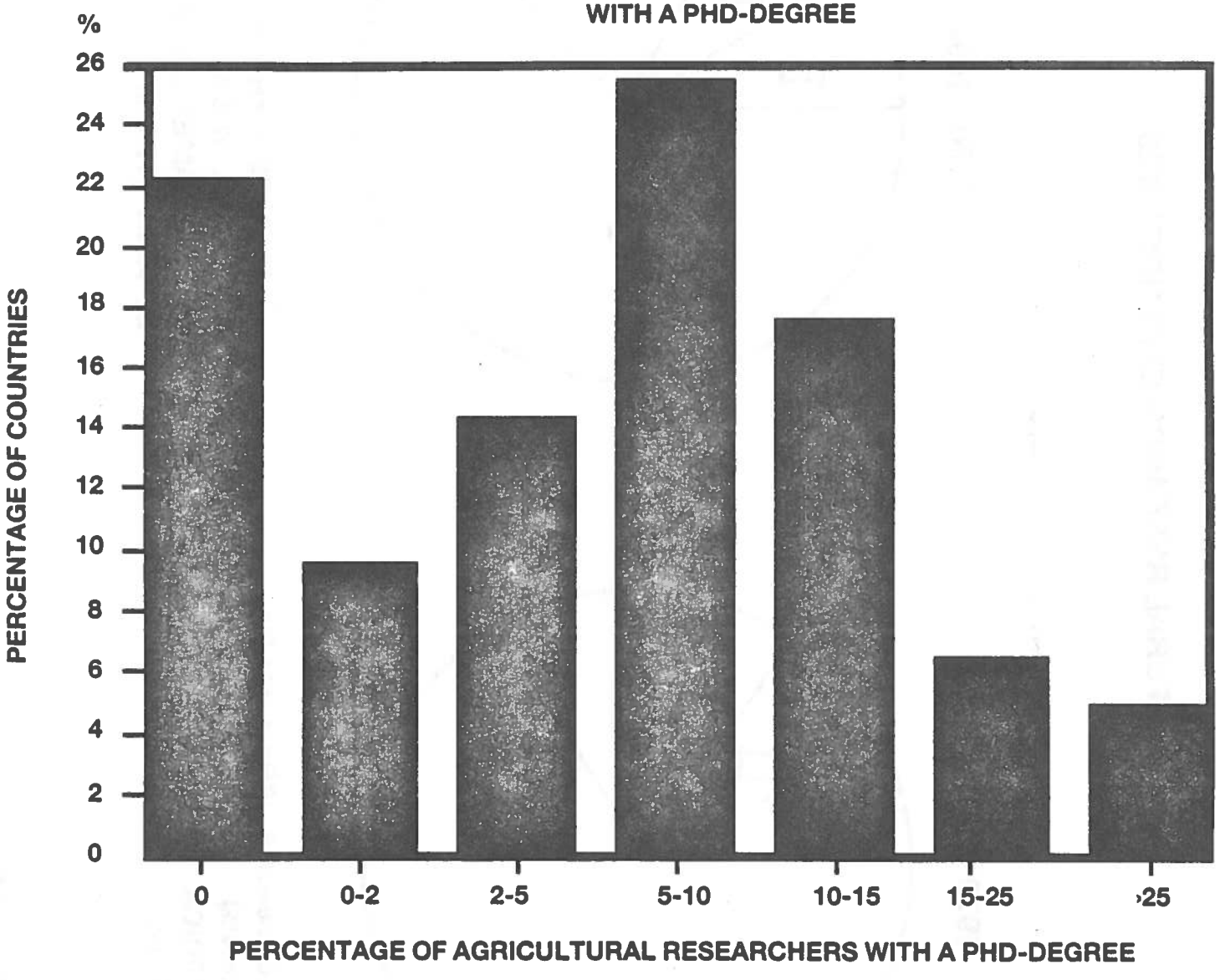


Sample Size: 1965-1969: 91 countries
1980-1984: 106 countries

Source: ISNAR Database

Figure 5

RELATIVE FREQUENCY DISTRIBUTION OF COUNTRIES BY PERCENTAGE OF AGRICULTURAL RESEARCHERS WITH A PHD-DEGREE

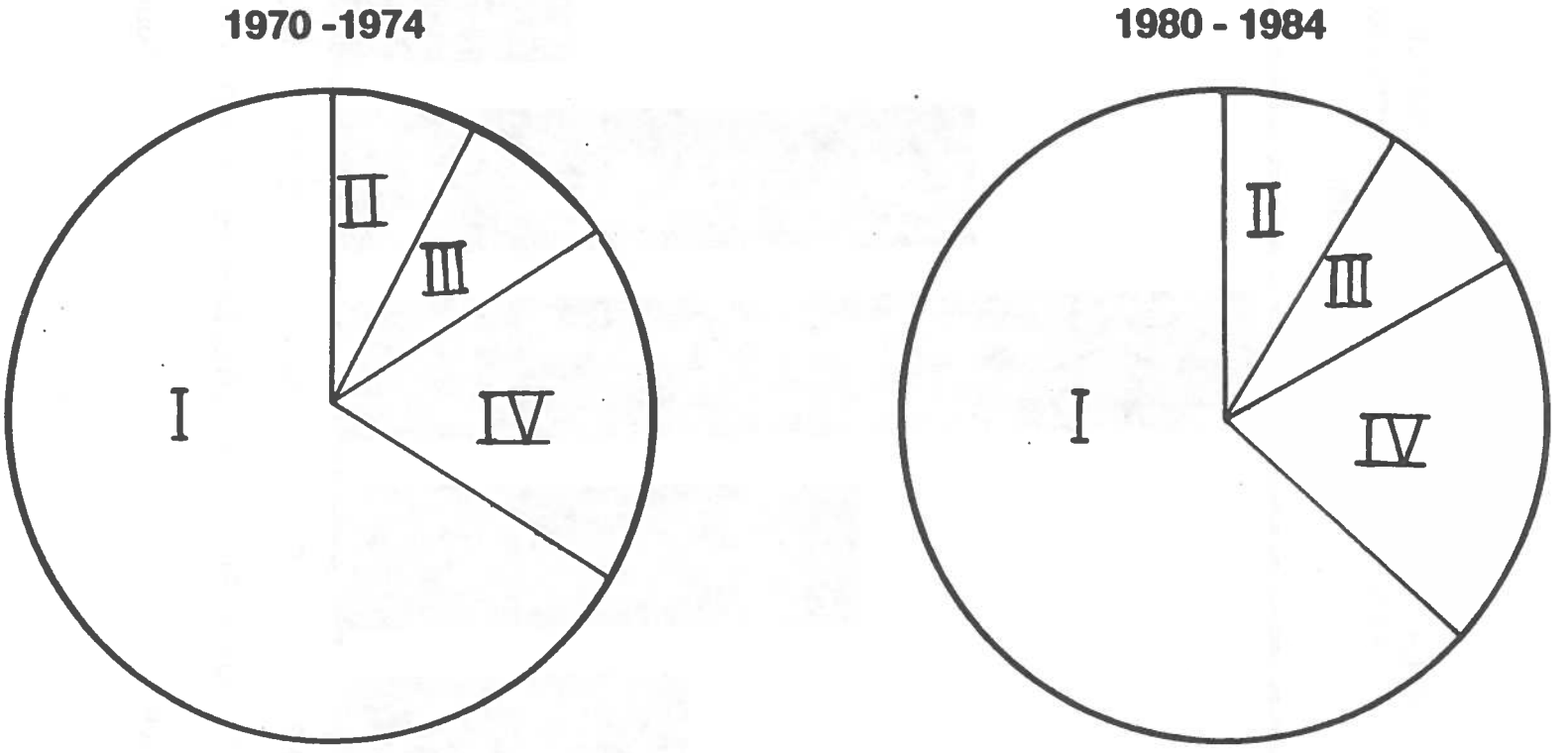


Sample Size: 63 countries

Source: ISNAR Database

Fig.6

AGRICULTURAL RESEARCH EXPENDITURES

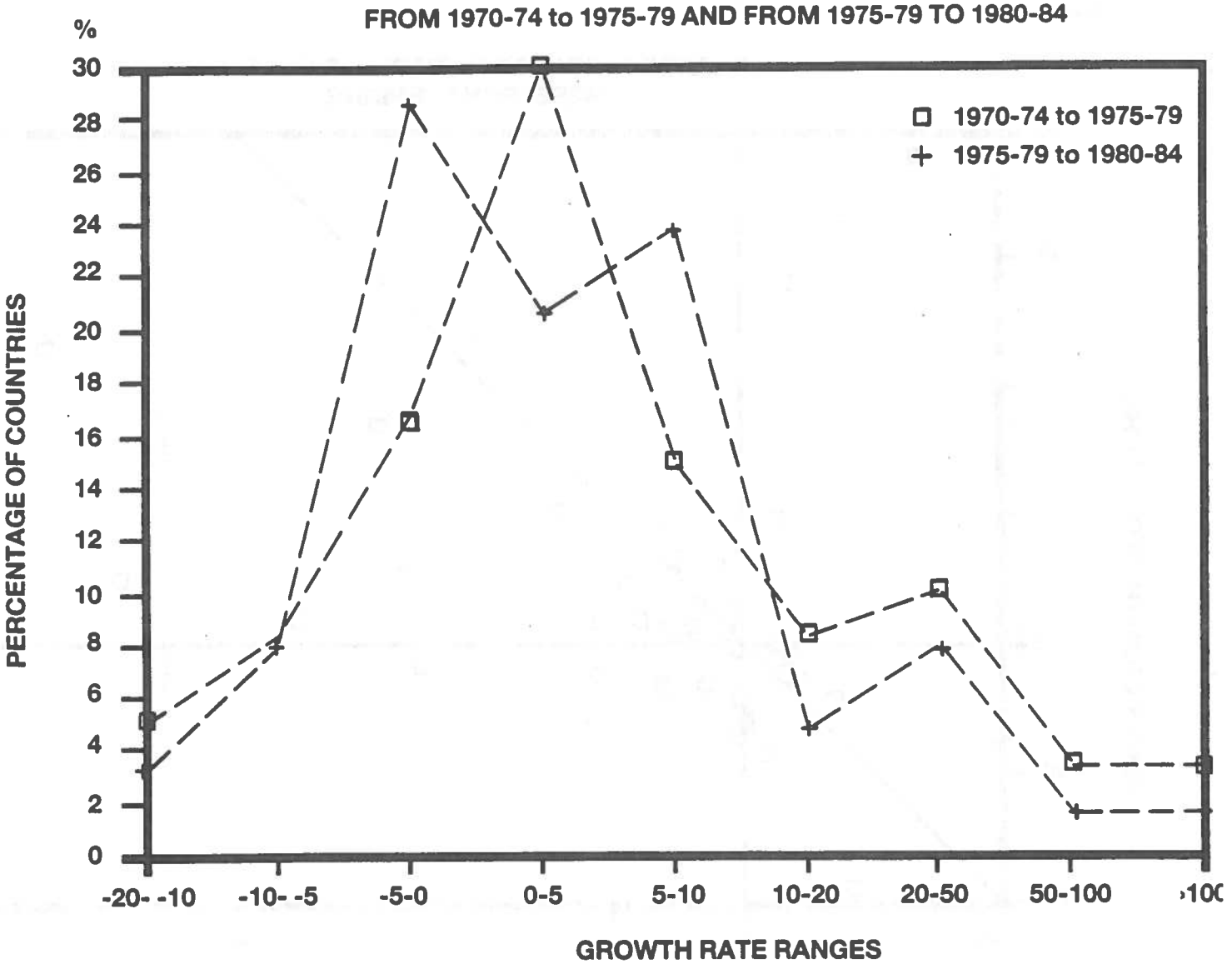


Sample Size: 58 countries

Source: ISNAR Database

Figure 7

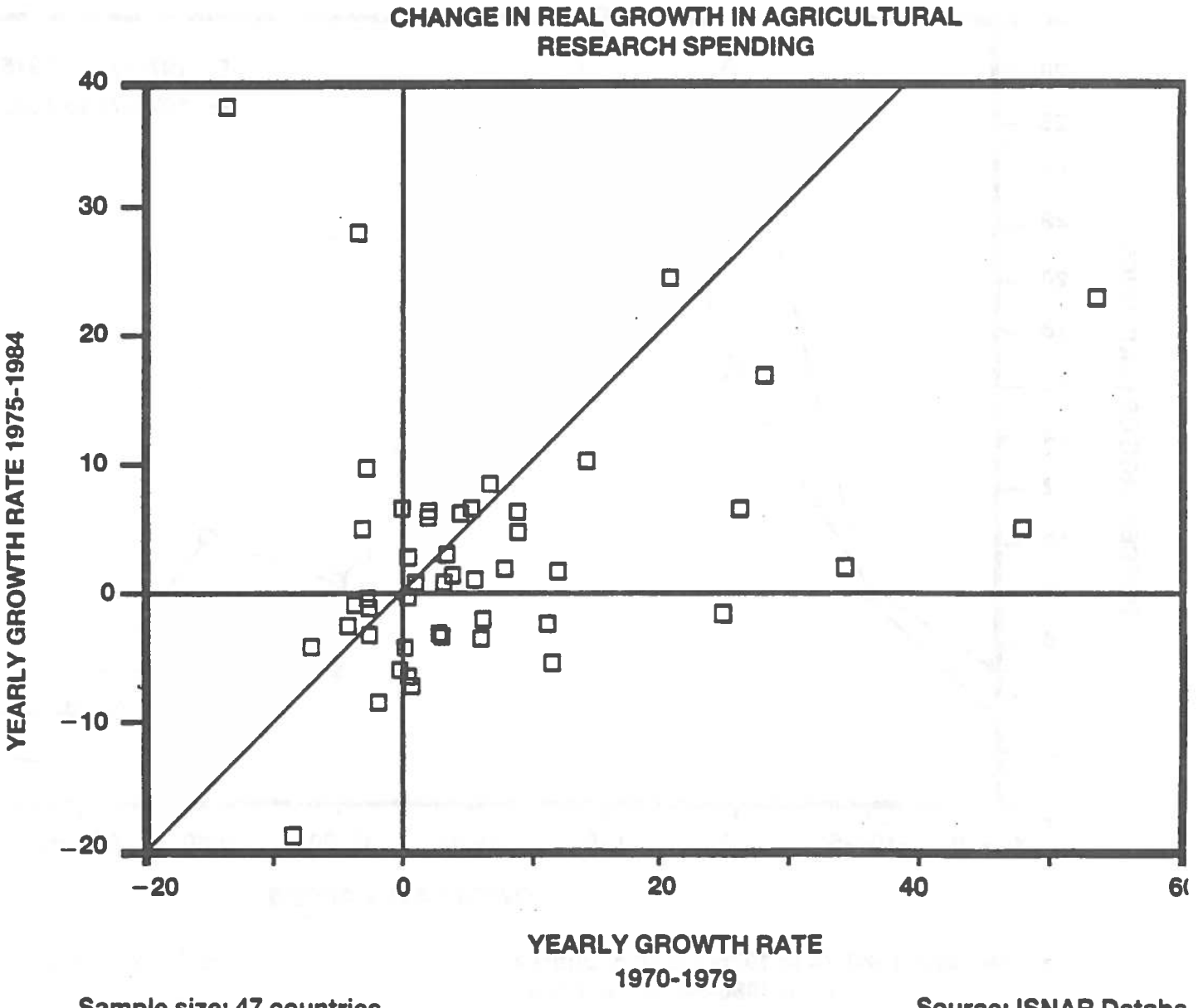
RELATIVE FREQUENCY DISTRIBUTION OF COUNTRIES BY AVERAGE YEARLY GROWTH IN AGRICULTURAL RESEARCH EXPENDITURES FROM 1970-74 to 1975-79 AND FROM 1975-79 TO 1980-84



Sample Size: 1970-74 to 1975-79: 60 countries
1975-79 to 1980-84: 63 countries

Source: ISNAR Databas

Figure 8

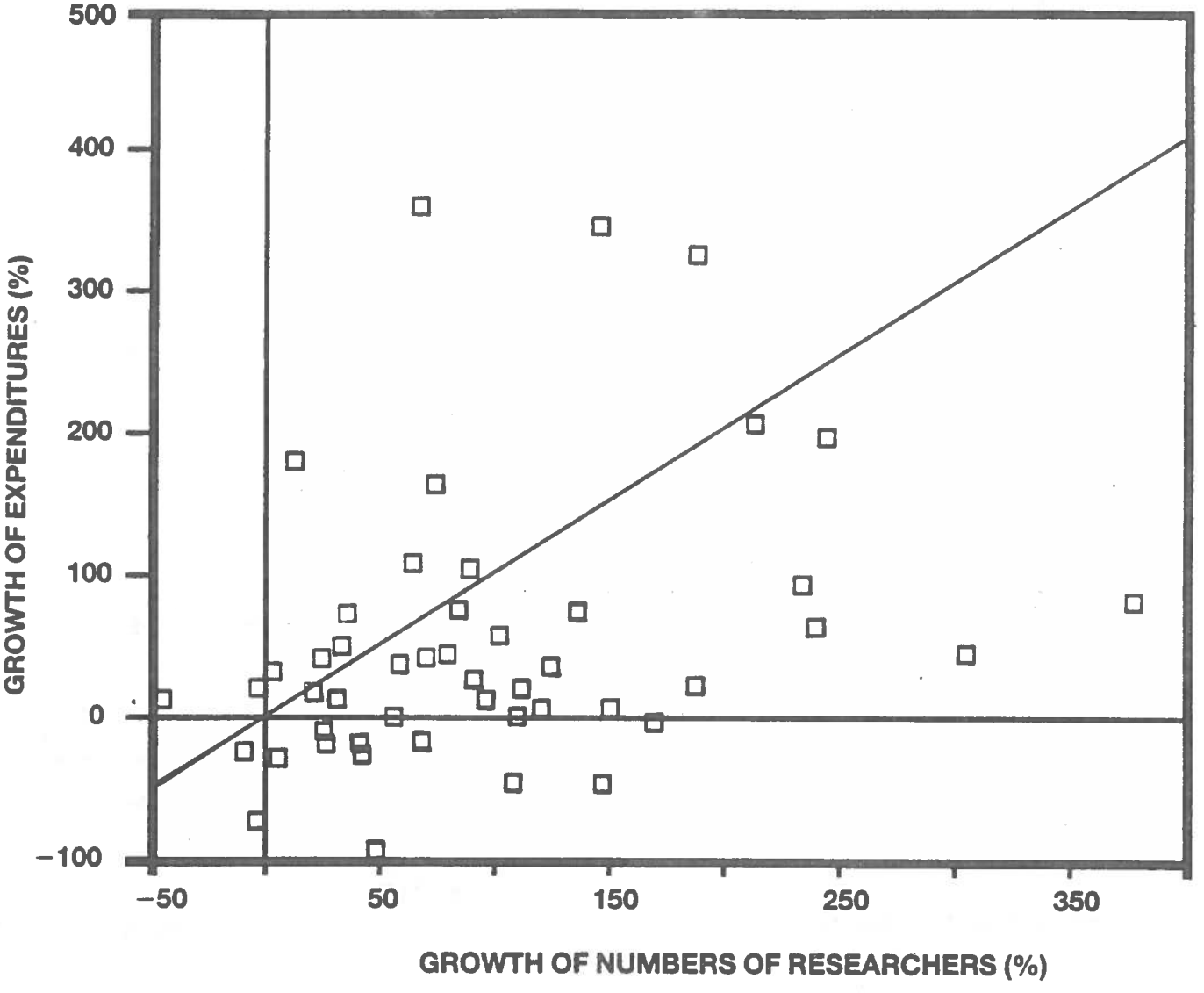


Sample size: 47 countries

Source: ISNAR Databa

Figure 9

GROWTH OF AGRICULTURAL RESEARCH EXPENDITURES
RELATED TO THE GROWTH OF TOTAL AGRICULTURAL RESEARCHERS
(FROM 1970-74 TO 1980-84)

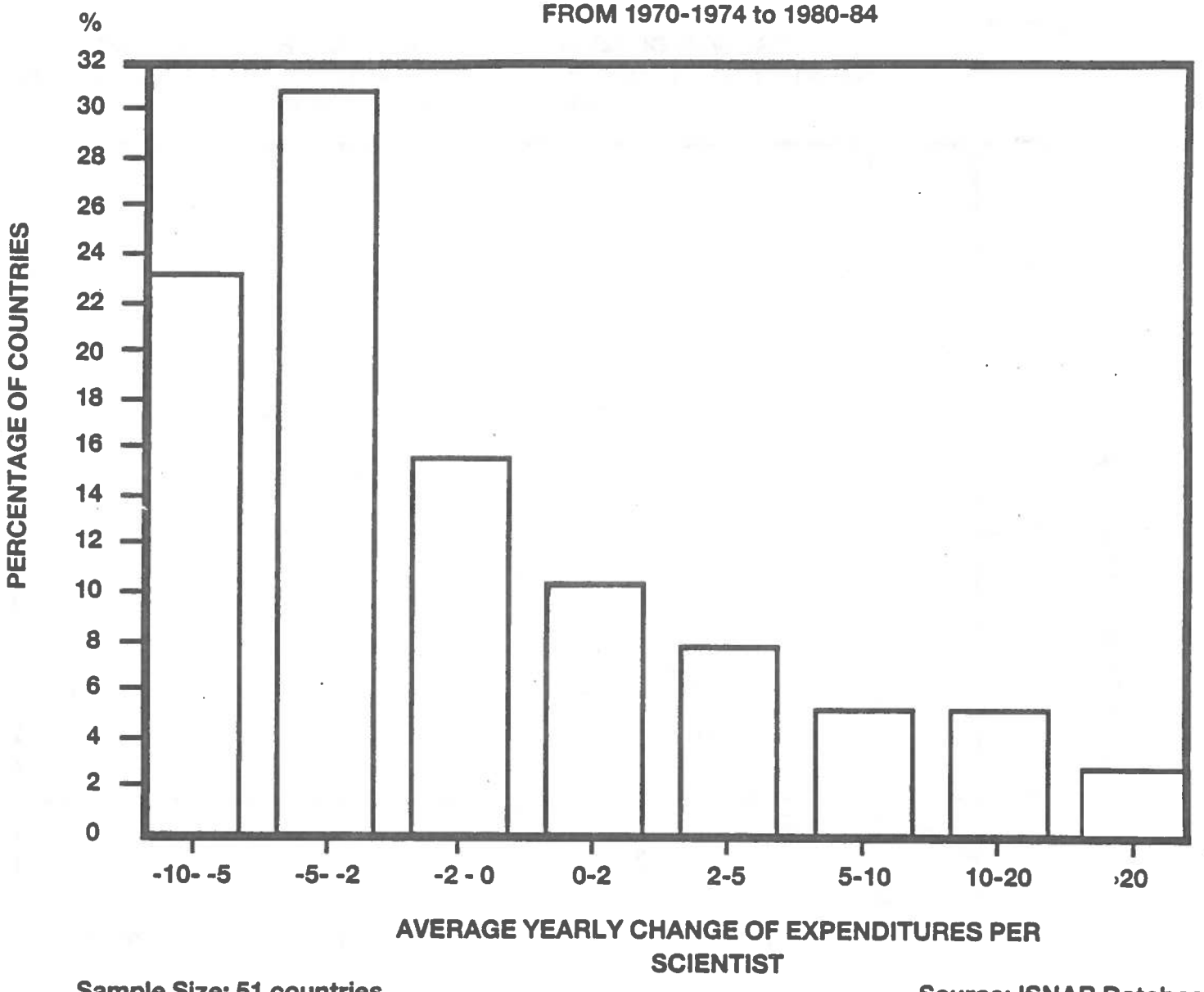


Sample size: 51 countries

Source: ISNAR Database

Figure 10

RELATIVE FREQUENCY DISTRIBUTION OF COUNTRIES
BY AVERAGE YEARLY CHANGE OF EXPENDITURES PER RESEARCHERS
FROM 1970-1974 to 1980-84



Sample Size: 51 countries

Source: ISNAR Databas