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and
The Second IFARD Global Convention

THE IMPACT OF RESEARCH ON NATIONAL AGRICULTURAL DEVELOPMENT

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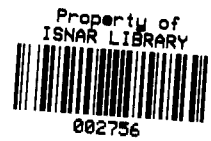

IFARD, International Federation of Agricultural Research Systems for Development
ISNAR, International Service for National Agricultural Research
CTA, Technical Center for Agricultural and Rural Cooperation
EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária

GLOBAL DATA BASES ON NATIONAL AGRICULTURAL RESEARCH SYSTEMS

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Introduction

Research leaders have frequently expressed the need for information which enables them to justify agricultural research to policy makers and to those hard-nosed economists in the Ministry of Planning and Finance who often appear not to understand the special characteristics of agricultural research. They also have expressed the need for norms by which they can compare their own system with other similar systems or trace the evolution of their system through time.

This brief presentation will attempt to situate ISNAR's current efforts to develop a data base on national agricultural research systems in relation to previous works and to report on preliminary results. It is appropriate that this should be the forum for such a report because of the strong support that ISNAR received from the IFARD board when it presented a proposal to its own board for the creation of a global data base on NARS using core funds. Subsequently, it was IFARD that assisted ISNAR's efforts in carrying out a Survey of National Agricultural Research Systems which provided a major input to the data base.

A Brief History of Data Base Activities on NARS

It is fairly easy to provide a list of the major contributions which have constituted our quantitative knowledge of national agricultural research in developing countries. The major works are as follows:

1971 – Evenson, R. and Y. Kislev, "Investment in Agricultural Research and Extension: A Survey of International Data", Yale Economic Growth Center Discussion Paper No. 124.

1975 – Kislev, Y. and R. Evenson, "Investment in Agricultural Research and Extension: An International Survey", *Economic Development and Cultural Change*, Vol. 23, pp. 507-21.

1975 – Boyce, J. and R. Evenson, *Agricultural Research and Extension Programs*, Agricultural Development Council, New York.

1981 – Oram, P. and V. Bindlish, *Resource Allocations to National Agricultural Research: Trends in the 1970s.* ISNAR/IFPRI.

1983 – Judd, A., J. Boyce and R. Evenson, "Investing in Agricultural Supply". (Mimeo).

It is important to note that the major efforts have been relatively sparse, largely individual rather than institutional efforts, and have shown a long gestation from the time of undertaking the initial data collection exercise to the publication of the results.

This long gestation is something that is inherent in serious data base efforts because of the time needed for data verification and cleaning. It is also important to note the debt that each of the successive data base efforts owes to its predecessors. In fact, the primary data base is rather narrow, and successive works have included figures from earlier efforts. In some cases this citation cycle has produced some problems. In some instances we have traced back to primary sources to find that a 15-20-year "time series" for a given country has been based on only one or two documentable sources. The researcher must work with the available data, but unwary users of the data may tend to convert "constructed time series" into "actual time series" in the citation cycle. A major part of ISNAR's effort has gone into reconciling the

figures and documenting every piece of information appearing in its data base.

ISNAR's Data Base Efforts

Formal data base activities were an early undertaking of ISNAR and led to the joint ISNAR/IFPRI publication of Oram and Bindlish in November 1981. The report noted the great variability in the information available from various countries and that in many countries there was little understanding of the level of resources required for effective agricultural research. The assembling of the data was considered only one step on the way to analyzing policies for using those resources more effectively to achieve development objectives. The document was careful to note, however, that it was only a first step towards a continuing effort to upgrade and update the quality of data.

In late 1984, the ISNAR/IFARD Survey of National Agricultural Research Systems was mailed out to 116 developing countries. IFARD representatives, and colleagues in other institutions, aided us in identifying the most appropriate official in each country to which the questionnaires should be sent. Our target was the national agricultural research system as a whole, but the point of entry was usually the publicly funded national agricultural research organization which was requested, in turn, to contact private-sector and university-sector bodies as part of the survey.

The survey was prepared in English, French, and Spanish, with a manual of definitions and examples of completed questionnaires to guide respondents in completing the forms. The questionnaires came in three parts and were color coded to keep them distinct. The three parts were:

System-Level Data

Part A: Current information about the structure, organization, funding, human resources, and research activities of the country's national agricultural research system.

Part B: Historical information about the evolution of the national system.

Institution-Level Data

Part C: Current information about staffing, funding, and research activities of the principal component units of the national system.

The intention of dividing the questionnaires in this way was to permit a respondent to reply with current information (which was likely to be available) and not hold back a response because of the sparseness of historical information. It also allowed us to collect institution-level data which would provide a valuable cross-check on the national-level data.

The initial questionnaire was followed up with a second mailing and a telexed request for assistance with the undertaking. In order to reach the member states of the Arab Organization for Agricultural Development, a similar survey was carried out as the ISNAR/AOAD Survey at the request of the ministers of agriculture constituted as the AOAD board.

ISNAR has received replies from 60 countries which completed questionaires for all or significant parts of their systems. As expected, the historical information was the most difficult to obtain. In many cases, the System-Level data of Part A is identical to the Institution-Level data of Part C, indicating that we failed to capture the contribution of universities and the private sector. Clearly, a special effort will be required to reach these sectors.

A major effort has also gone into obtaining additional data from hundreds of primary and secondary sources. Staff members returning from missions provide information to fill in gaps in our knowledge. For each country, a paper file has been set up which contains a photocopy and complete reference for all data included in the data base.

The data has been coded and entered into computer files. After a substantial job of checking and cleaning, it became part of the ISNAR DATA FILES; a fully sourced and documented data base. The information provided by the ISNAR/IFARD Survey of National Agricultural Research Systems was a most valuable contribution, but in itself did not constitute a "data base". Rather than rush into print with the publication of the "results of a survey", which would tend to add to the confusion of the citation cycle, we decided that the information should be integrated into the other primary and secondary data we held. In this way we could be able to develop a time series of basic indicators and use these *documented, multiple*, historical observations as a basis for substantial cross-checking of the data.

The files are currently maintained in draft form in Lotus 1-2-3 format but will be shifted over to a relational data base (Pace) on ISNAR's mainframe computer so we can

process them into ASCII files and thus be able to service requests by external users for specific outputs or machine readable data.

ISNAR is currently constructing an INDICATOR SERIES of basic agricultural research expenditure and personnel figures. This series synthesizes the ISNAR DATA FILES to produce a fully sourced and documented series. It is the most representative series of basic NARS data that we can construct from the information currently available to us. If we make repeated mention of the "fully sourced and documented" nature of the indicator series it is indicative of the importance we attach to data quality.

The Rationale for a Global Data Base

The ISNAR/IFPRI document clearly pointed to the need for reliable data to be used by national systems, donors, and international agencies in planning their activities. This was evidenced by the widespread use of the results presented in that November 1981 report.

Much of the existing data sources were fragmented in scope and coverage; difficult to access; uneven in quality; and varying in the degree of documentation. The data base effort under way attempts to document the cause of discontinuities in time series or major variations in the data, often due to expanded or reduced coverage of the institutions included or in definition of the data collected. We felt there was a need to work *towards* some standardization in both the data collected and the way it is treated. Of particular importance is the way of treating exchange rates for international comparisons, deflators for figures cited in local currency units, and definitions of expenditure categories.

There was a need to develop an ongoing institutionalized data base effort which capitalized on ISNAR's comparative advantage derived from its relatively frequent system-level contact with NARS and its global mandate to serve NARS. However, it is also clear that ISNAR can work effectively with a network of regionally based organizations, which have direct use for such data, in maintaining the currency and quality of the data in line with the needs of users.

We also saw a need to provide data-based information to assist national research managers through the provision of various agricultural research activity indicators and to assist international agencies and donors to improve their coordination and priority-setting mechanisms. Since the reproduction of series of undigested numbers is not likely to be very helpful for most of our clients, a certain amount of analysis is needed to place the data in the appropriate policy context.

Finally, the data base could be expected to help ISNAR in its own research on problem-oriented issues related to:

- the structure and determinants of support to agricultural research;
- cross-commodity allocations of resources;
- geo-climatic allocation of resources;
- size of system and dispersion of resources;
- factor shares and the evolution of the portion of resources going to salaries, capital investments, and operating expenses over time.

While ISNAR itself will be a prime user of the data base, the goal is to create a public good which can be used freely by interested research groups and NARS scientists. Like any responsible research group, we wish to be sure of the quality of our product before diffusing it widely.

An Overview of ISNAR's Data Base

Figure 1 below describes the ISNAR Database and its expected products. The returns from the ISNAR/IFARD and ISNAR/AOAD surveys are a major input to the ISNAR DATA FILES. Alongside the survey results comes information drawn from a wide variety of primary and secondary sources. At the present time, almost 600 documents are sourced and referenced in the data files.

The ISNAR DATA FILES present multiple observations in a side-by-side format. Each figure has a *source* code and a reference to a "comments file" in which the quality of the figure is described along with its origin and any manipulation to which it has been subjected. The raw numbers by themselves mean very little, and it is the source and comment files which produce a data base which is upgradable and makes institutionalization of the process possible.

To reconcile and synthesize the multiple observations is an extremely time-consuming task. Unfortunately, it is *not* the sort of process where having ten people working on the one data set will get the job completed in one-tenth of the time. Consistency in the processing of the information requires the continued effort of a small and highly qualified team. The output of this effort is an INDICATOR SERIES containing the figures which we believe are the most reliable indicators of research input

or activity, which can be drawn from the information currently available to us.

We are also assembling a set of SUPPLEMENTARY FILES which will include data coming from supplementary sources such as the IMF, the World Bank, FAO and others. These are information in the public domain which are necessary to place the research data in a wider context. They are machine readable files which contain information (usually going back to 1960) on consumer price indexes, wholesale price indexes, implicit GDP deflators and the like. They are necessary when one wishes to adjust country-level information for cross-country comparison or to show the evolution of real expenditures through time within the same country. Since research expenditures are often expressed in indicators such as "Scientific Manyears per 10 M dollars of Agricultural GDP" or in relation to economically active population in agriculture, the Indicator Series also contains such information in easily accessible form.

The Longitudinal Indicator Series

The Longitudinal INDICATOR SERIES contains baseline, system-level personnel and expenditure figures going back to 1960 (wherever possible). First, we have the *Personnel* figures expressed in person years. The figures offer the following breakdown:

Researchers
- Ph.D.
- M.Sc.
- B.Sc.
- Expatriate

- Total:

The researcher figures are net of support personnel such as administrative, technical and support staff.

These figures allow one to track not only the total research personnel commitment by the public sector but also the evolving skill levels of this research staff as indexed by degree status, and the shifts in local versus expatriate staffing patterns.

The Expenditure INDICATOR SERIES records total expenditure figures in current local currency units. Where the source of the data was not in local currency units, we attempted to recover these figures using the procedures used by the various analysts wherever possible. This will allow us to apply a standardized procedure to convert the figures into standardized units. Since the final results are sensitive to the method of standardization, we are currently doing sensitivity analysis on this to determine the most practical yet analytically reasonable procedure available.

The Cross-Sectional Indicator Series

The Cross-Sectional INDICATOR SERIES contains more detailed information (generally for the latest year(s) available) on

- the source of funds (internal sources such as national budgetary allocations, sale of products, earmarked taxes, and external sources);
- the factor mix (capital investments, recurrent costs, including salaries, operating expenses);
- selected institutional-level data (the number and type of institutions in a system, expenditure and personnel data, problems with funding, and the like).

The institution-level data coming from Part C of the ISNAR/IFARD Survey was particularly useful in reconciling the apparent inconsistencies in the aggregate, system-level figures which appear in various sources.

A Preliminary Look at Some Research Indicators

Financial Indicators of Research Activity:

The updating of information which has taken place since the ISNAR/IFPRI publication of 1981 has altered somewhat the optimistic picture of research funding which was presented in that document. Whereas it had shown that research allocations had grown rapidly over the decade of the 1970s, recent information shows a slowing down of the rates of growth of research expenditure. The average yearly growth rate in real research expenditures decreased from 12% in 1970-79 to 6% in 1975-84. Figure 2 shows a significant increase in the proportion of countries demonstrating negative growth rates in the order of zero to minus (-) five percent.

FIGURE 1

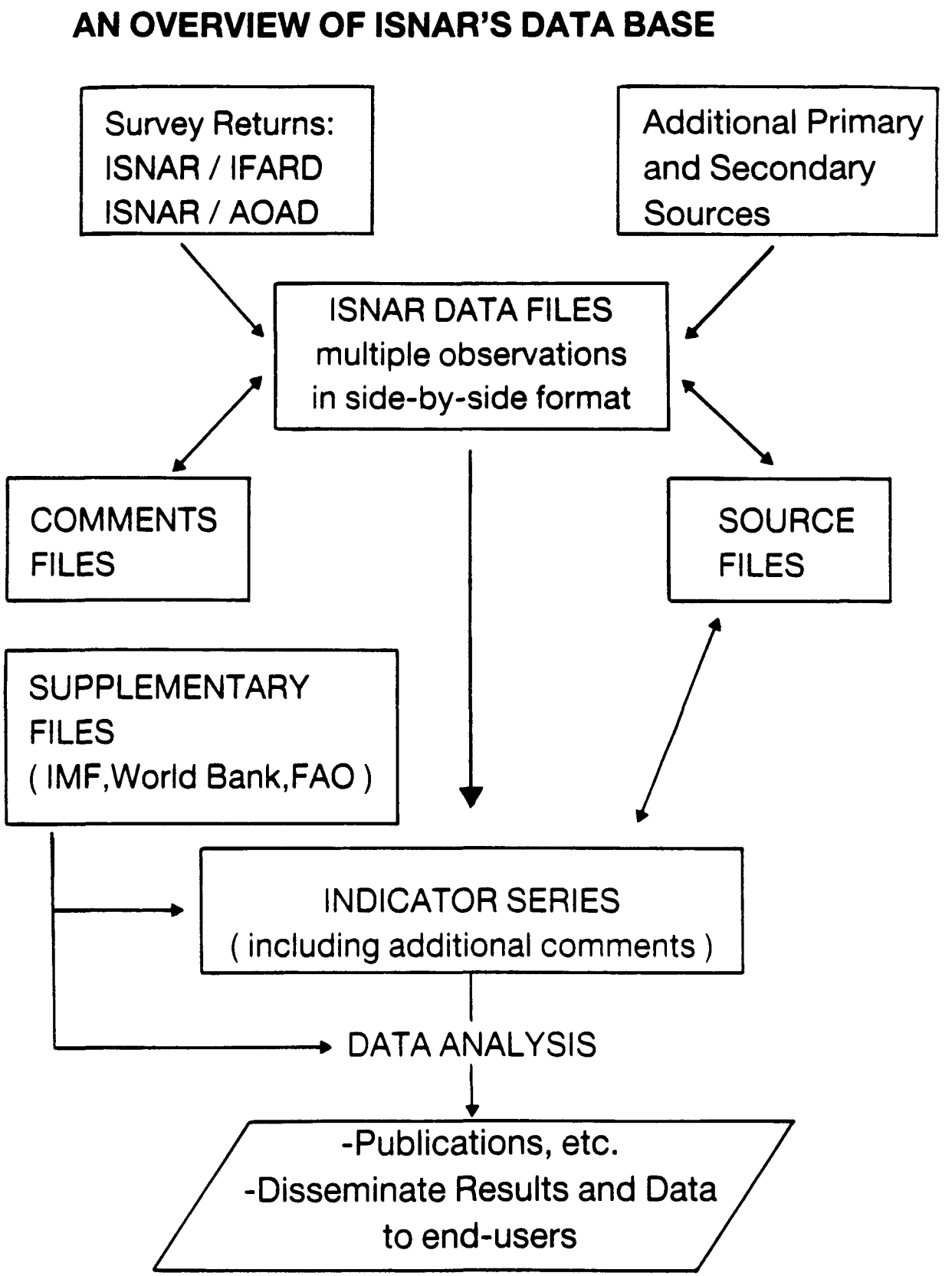
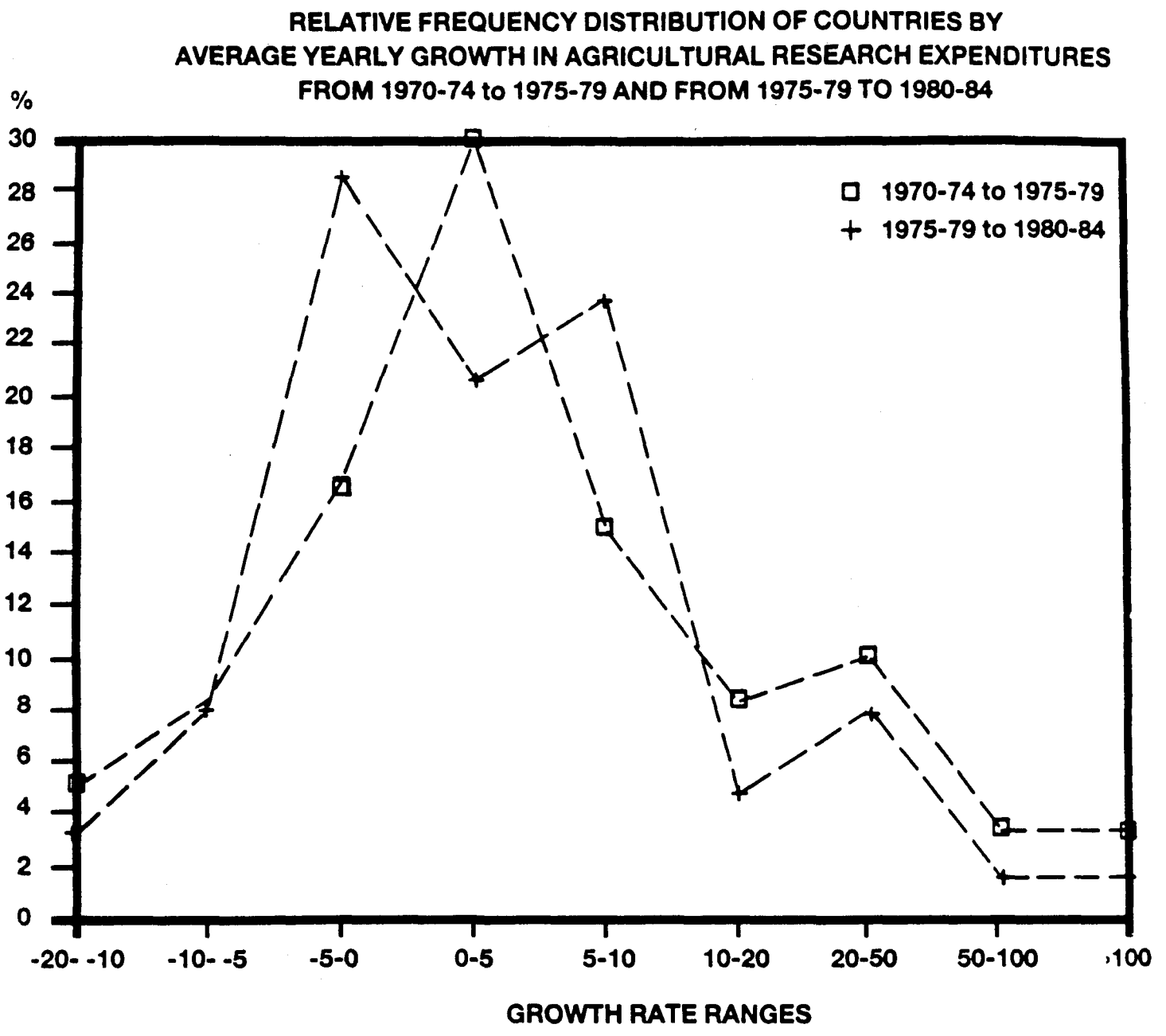

AN OVERVIEW OF ISNAR'S DATA BASE
Survey Returns:
ISNAR / IFARD
ISNAR / AOAD
Additional Primary
and Secondary
Sources
ISNAR DATA FILES
multiple observations
in side-by-side format
COMMENTS
FILES
SOURCE
FILES
SUPPLEMENTARY
FILES
(IMF,World Bank,FAO)
INDICATOR SERIES
(including additional comments)
DATA ANALYSIS
-Publications, etc.
-Disseminate Results and Data
to end-users

FIGURE 2



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

Source: ISNAR Data base

FIGURE 3.

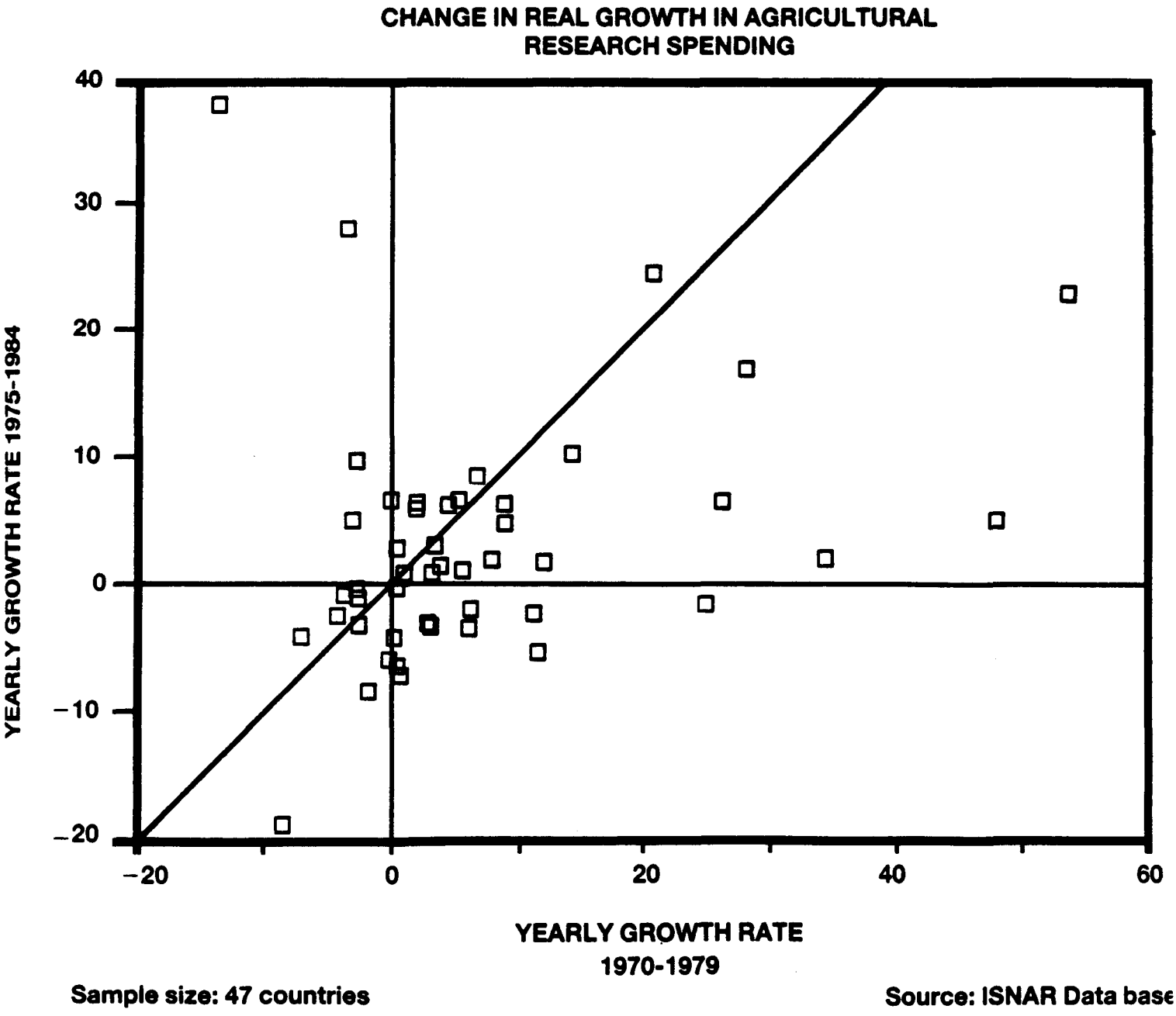
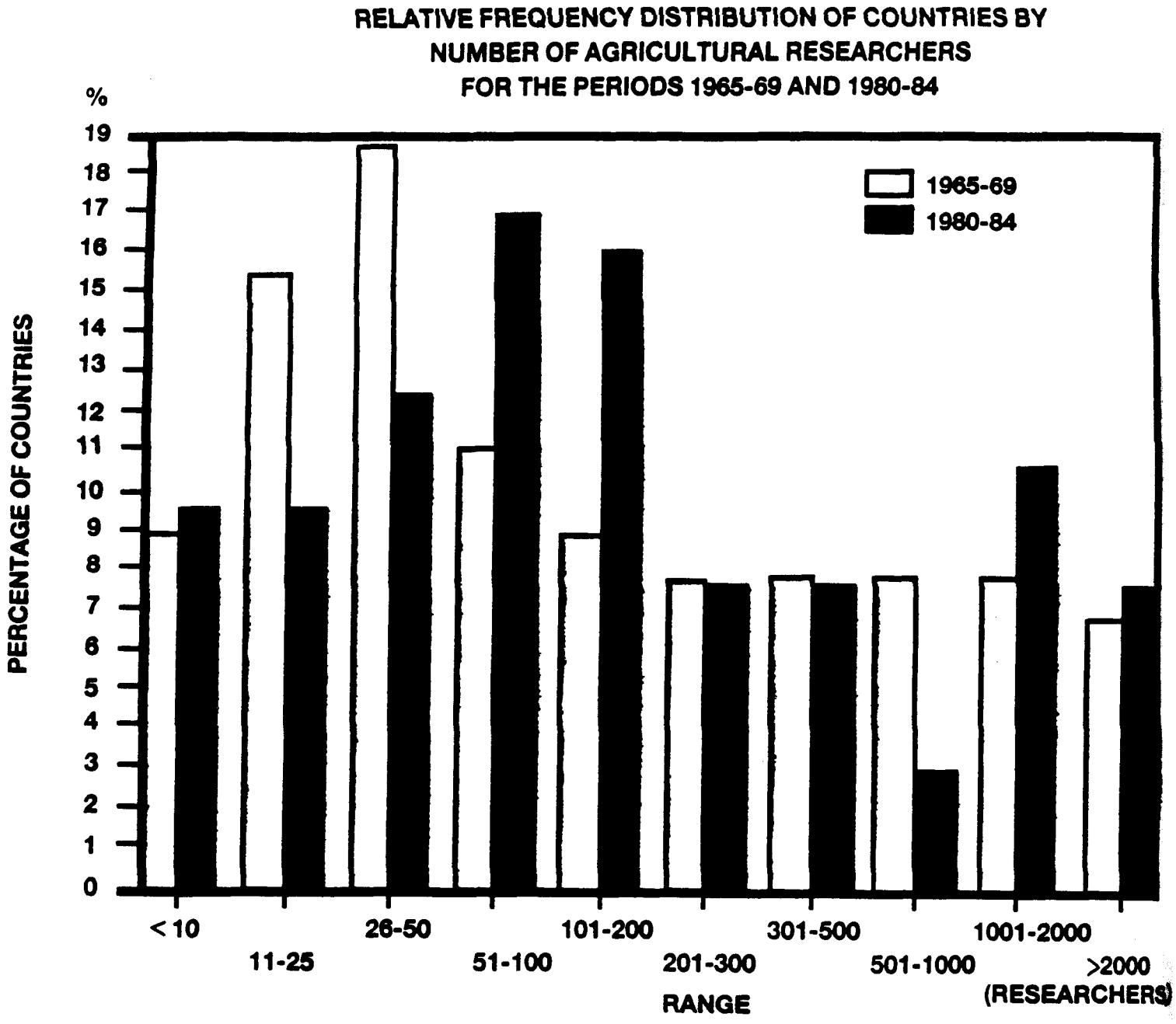

CHANGE IN REAL GROWTH IN AGRICULTURAL RESEARCH SPENDING
YEARLY GROWTH RATE 1975-1984
40
30
20
10
0
-10
-20
-20
0
20
40
60
YEARLY GROWTH RATE 1970-1979
Sample size: 47 countries
Source: ISNAR Data base

FIGURE 4



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

Source: ISNAR Data base

FIGURE 5

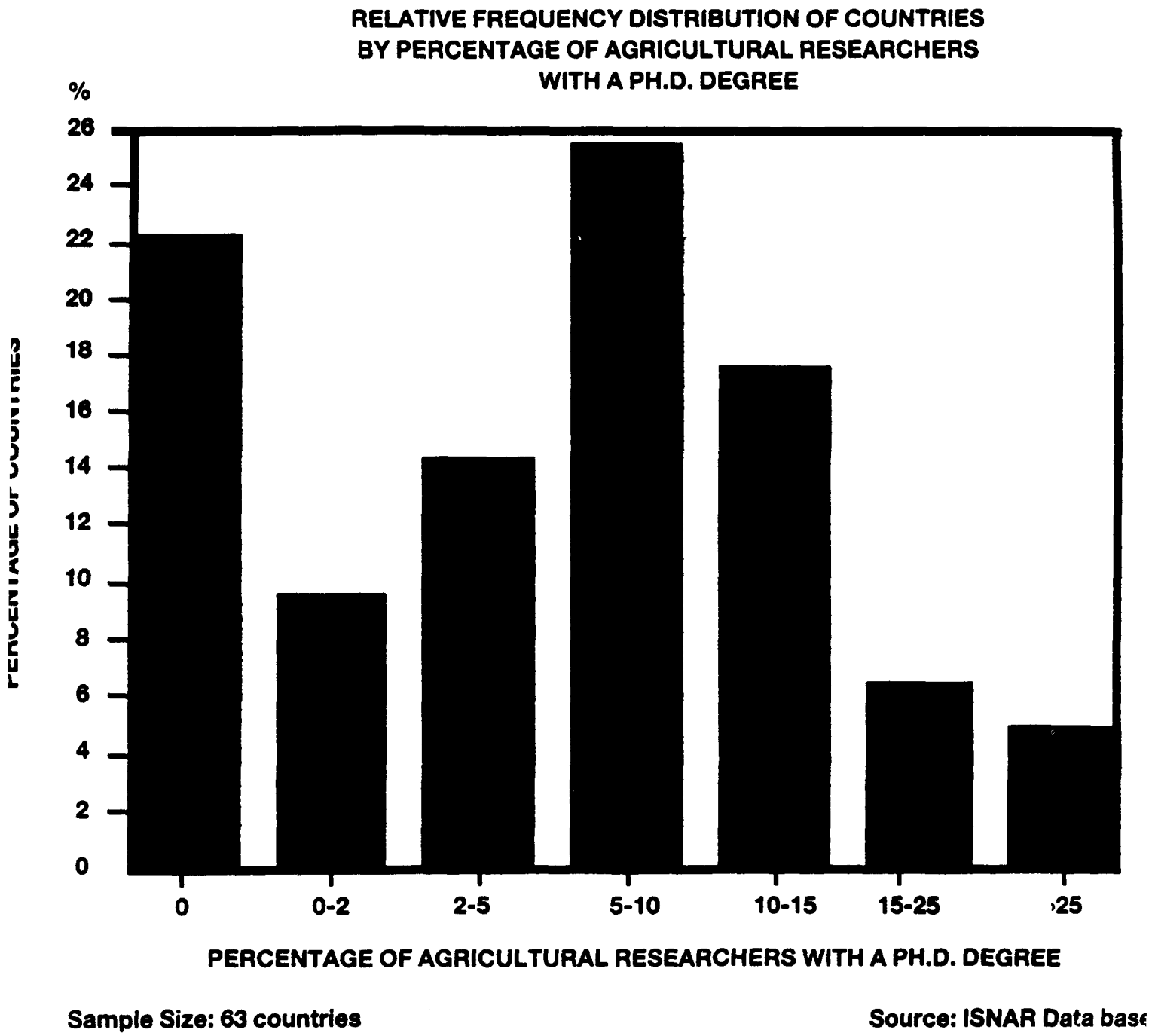

RELATIVE FREQUENCY DISTRIBUTION OF COUNTRIES
BY PERCENTAGE OF AGRICULTURAL RESEARCHERS
WITH A PH.D. DEGREE
%
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
0-2
2-5
5-10
10-15
15-25
›25
PERCENTAGE OF AGRICULTURAL RESEARCHERS WITH A PH.D. DEGREE
Sample Size: 63 countries
Source: ISNAR Data base

FIGURE 6

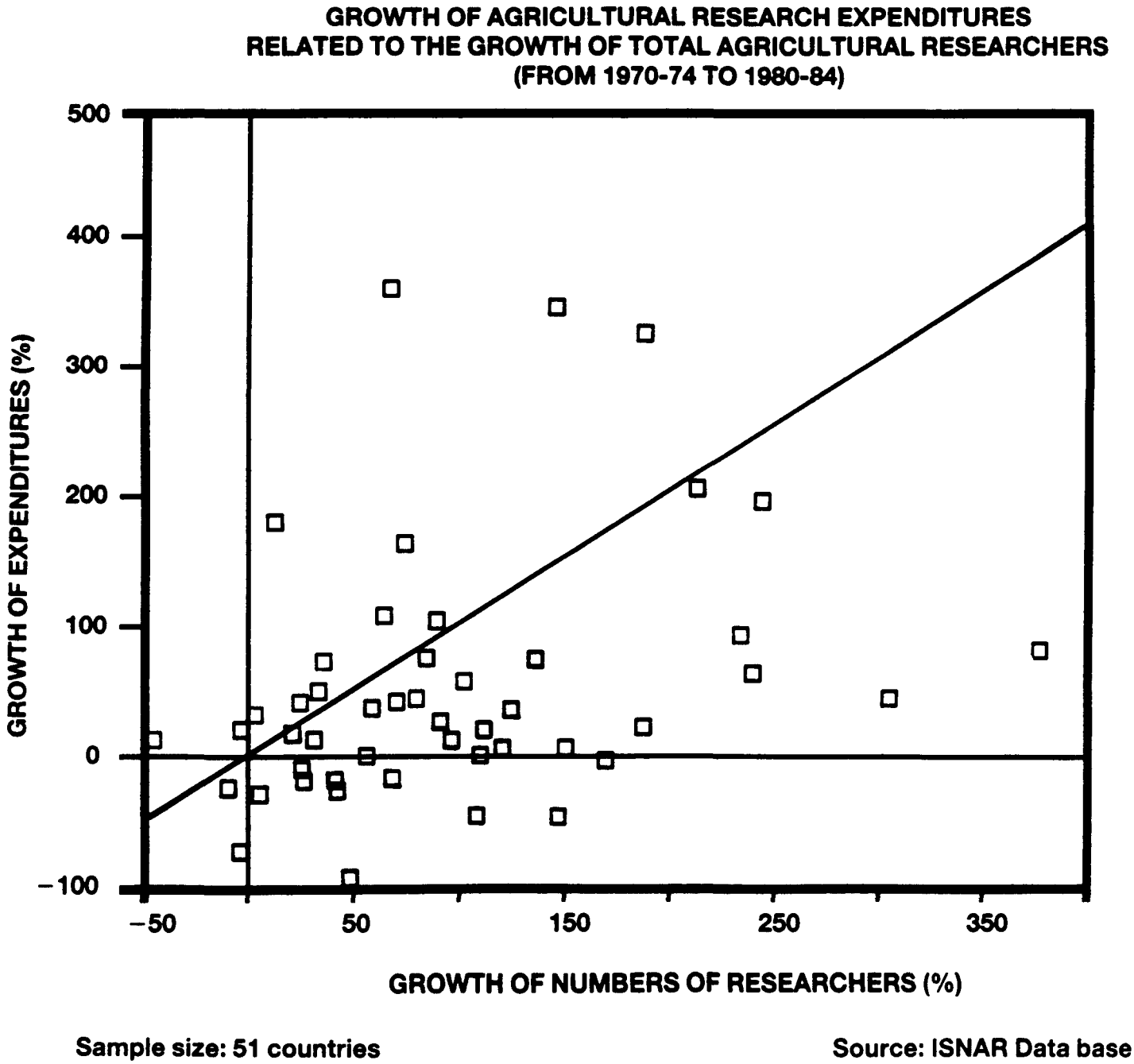

GROWTH OF AGRICULTURAL RESEARCH EXPENDITURES
RELATED TO THE GROWTH OF TOTAL AGRICULTURAL RESEARCHERS
(FROM 1970-74 TO 1980-84)
GROWTH OF EXPENDITURES (%)
500
400
300
200
100
0
-100
-50
50
150
250
350
GROWTH OF NUMBERS OF RESEARCHERS (%)
Sample size: 51 countries
Source: ISNAR Data base

FIGURE 7

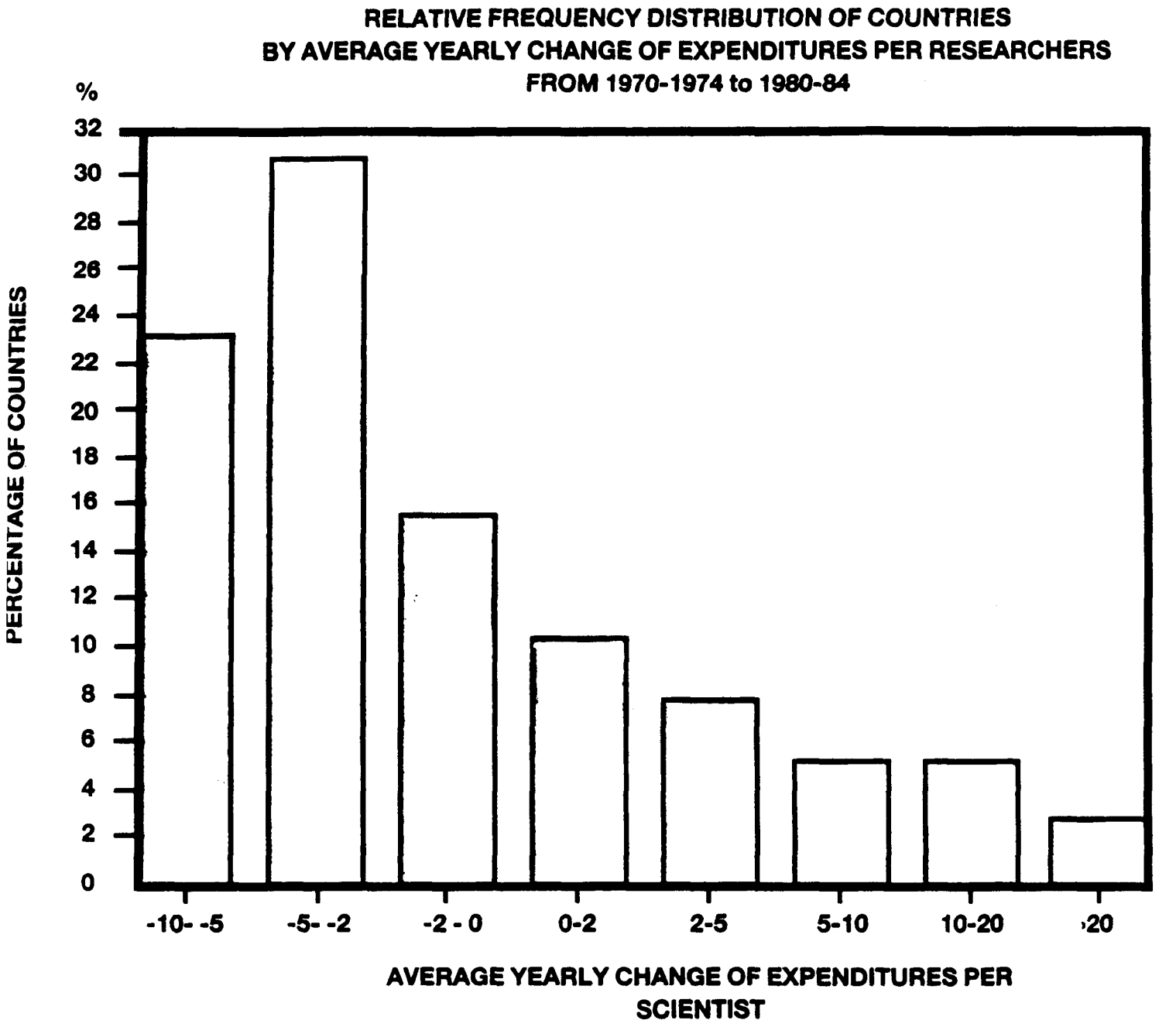

RELATIVE FREQUENCY DISTRIBUTION OF COUNTRIES
BY AVERAGE YEARLY CHANGE OF EXPENDITURES PER RESEARCHERS
FROM 1970-1974 to 1980-84
%
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
PERCENTAGE OF COUNTRIES
-10- -5
-5- -2
-2 - 0
0-2
2-5
5-10
10-20
›20
AVERAGE YEARLY CHANGE OF EXPENDITURES PER SCIENTIST
Sample Size: 51 countries
Source: ISNAR Data bas

FIGURE 8

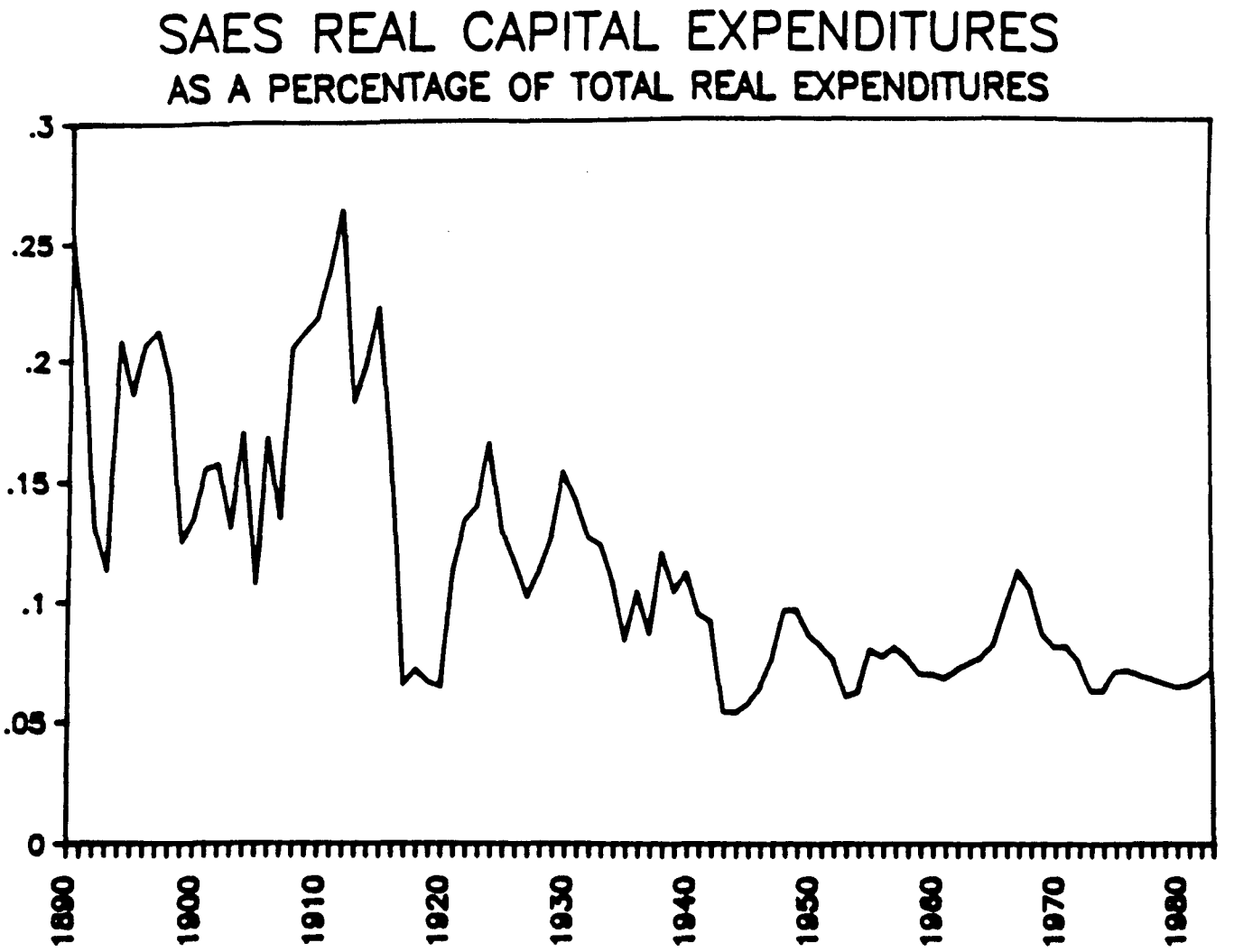
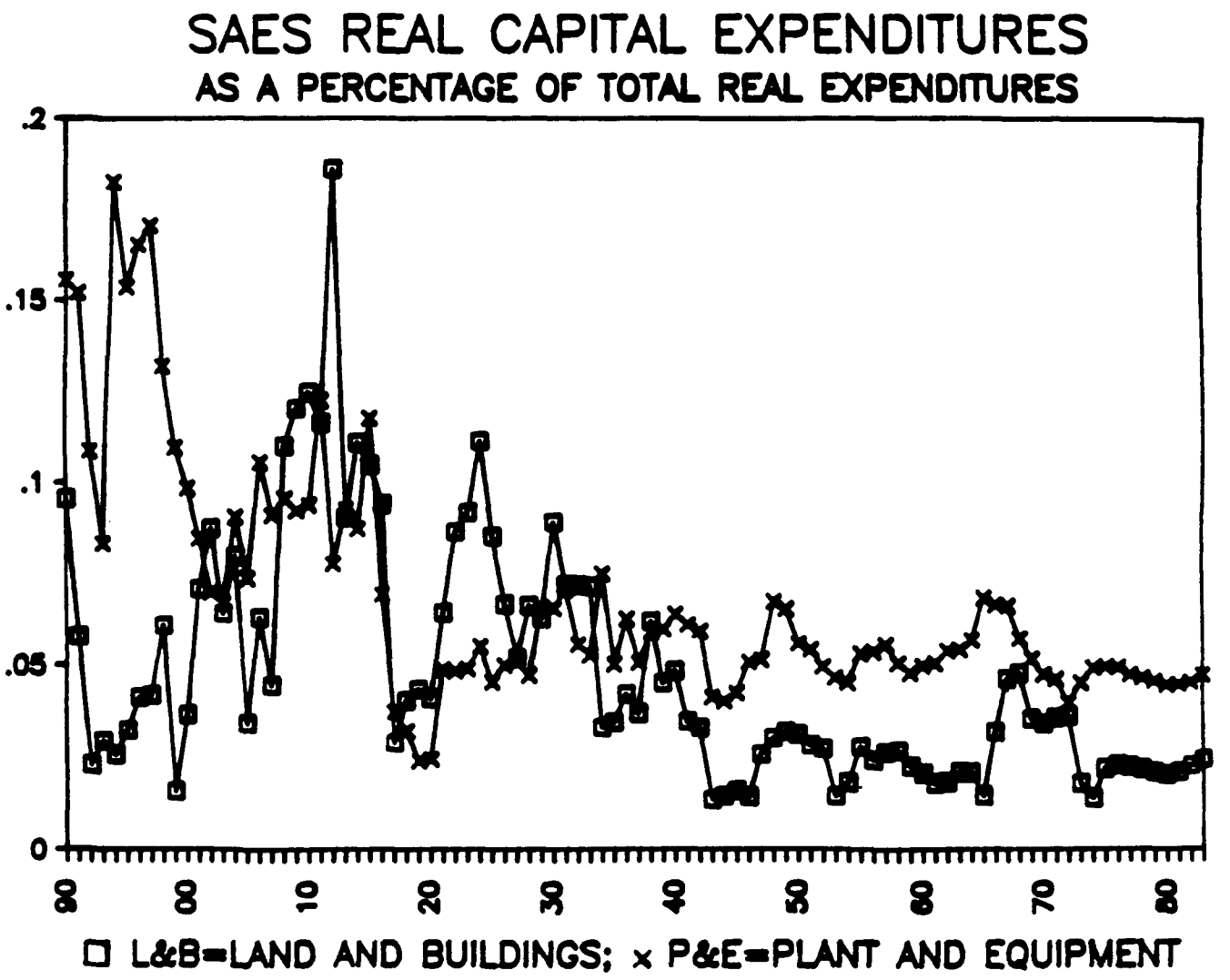

SAES REAL CAPITAL EXPENDITURES
AS A PERCENTAGE OF TOTAL REAL EXPENDITURES
.3
.25
.2
.15
.1
.05
0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980

FIGURE 9


SAES REAL CAPITAL EXPENDITURES
AS A PERCENTAGE OF TOTAL REAL EXPENDITURES
.2
.15
.1
.05
0
60
00
10
20
30
40
50
60
70
80
□ L&B=LAND AND BUILDINGS; x P&E=PLANT AND EQUIPMENT

This proportion rose from 17% of the countries to 29% of the countries in 1975-84.

Figure 3 shows, moreover, that 58% of the countries were growing less rapidly (in terms of agricultural research spending) during 1975-84 compared with 1970-79. The figure plots a country's growth rate during the period 1970-79 on the horizontal axis and its growth rate during the period 1975-84 on the vertical axis. A country which has the same rate of growth during the two time periods would lie on the diagonal line. All countries experiencing slower rates of growth lie below the diagonal line, and some have moved from positive to negative growth.

In a sample of 57 developing countries, approximately one-quarter of them received at least 50% of their financial support from external sources. Approximately a third of these developing countries spent less than 10% of their resources on capital items, while another third of them spent in the 10 to 20% range. This is indicative of the development constraints facing systems in recent years. The few countries showing investment in capital items in the 50 to 60% range are recipients of externally funded investment programs. Obviously, the concentration of resources on a few systems may be related to donors' political as well as research strategies.

Research Personnel Indicators:

Turning to the growth of human resources in national systems, we have data from 91 countries which allow us to compare the 1965-69 average numbers with a 106-country sample for the years 1980-84. Figure 4 shows that:

- over this 15-year period, the mean system has increased by almost 90%, from 254 to 474 researchers; and

- the proportion of countries with a "marginal" research capacity of less than 10 researchers has remained constant at around 9% of the total number of countries.

This growth of research personnel is taking place against a background of reduced growth in funding.

Of critical importance is the level of *qualifications* of these researchers. Figure 5 shows the relative frequency distribution of countries by the percentage of their agricultural researchers holding a Ph.D. degree. Many people might question the use of the Ph.D. as the criterion for comparing countries, but a strong case may be made for the argument that this is the most standardized qualification. The quality and meaning of a master's degree may vary from country to country and from university to university within the same country, whereas the scientists holding the Ph.D. have often studied in the same universities as their developed-country colleagues or have been trained in national-level programs offering an international level of qualification. We find:

- Approximately 50% of the NARS (in our sample of 63 countries) have less than 5% of their research staff holding doctorates.

- Only four countries have more than 20% of their scientists with doctorates.

However, we also believe that the operational effectiveness of an agricultural research system, especially in developing countries, also depends on strength at the middle level. We therefore calculate a postgraduate degree ratio. When we include the total numbers with postgraduate training (M.Sc. plus Ph.D.), then roughly half of the NARS have 40% or more of their personnel in this category.

Personnel-Expenditure Interactions:

In order to get a proper sample of countries for which all the needed information was available, we worked with a 51-country sample over the 1970-74 to 1980-84 period. We observed:

- 67% of the countries experiencing a contraction in their average yearly change in expenditures per scientist; 13% in the zero to -2% range; 31% in the -2 to -5% range; and 23% in the -5 to -10% range.

In Figure 6, this is illustrated by countries falling below the diagonal line. With growth of expenditures on the vertical axis and growth of researchers on the horizontal axis, a country maintaining its expenditure-per-scientist ratio would lie on the diagonal. Those few showing gains lie above the line. Figure 7 shows the relative frequency distribution of the 51 countries by the average yearly change of expenditures per researcher.

We thus observe a general decline in the financial resources available to NARS in more recent years at the same time as there is occurring a substantial increase in the number of research personnel. This suggests that numerous research systems may be experiencing significant distortions in the factor mixes (the relative shares of research labor, capital, and operating expenses)

of their NARS. The contraction of operating budgets per scientist is cited almost universally as a principal constraint facing research today.

It is to be hoped that this is not a permanent trend. In this respect, it is useful to note that historical evidence from the United States suggests that there have been substantial shifts in the factor mix of states within the U.S. system over time, and as yet the impact of these shifts on research productivity is unclear. Research at the University of Minnesota being carried out in association with ISNAR is seeking to generate insights on these issues. One of the goals of this project is to show how a system evolves over a long period and the need for patience on the part of policy makers to gain major impacts on production. Early empirical results from this study suggest that the impact of research expenditures on agricultural output persists for at least 30 years - a lag period which is substantially longer than has been commonly used for agricultural research to date.

This study is also attempting to quantify long-run shifts in expenditure patterns within the research system itself. Figure 8 shows the share of total real capital expenditures of the State Agricultural Experiment Stations (SAES) in total real expenditures. It is evident that there are periods of start-up and periods of reinvestment which appear against a generally downward trend in capital expenditure as a share of the total. Figure 9, showing the breakdown of investment into its components of land and buildings versus plant and equipment, demonstrates that the nature of the capital investment experiences fluctuate as well.

Final Comments

ISNAR is continuing to update and refine the primary ISNAR DATA FILES. We have contacted numerous agencies and individuals who can provide information on national agricultural research systems in the developed countries so that meaningful comparative analysis can be performed.

The construction of the INDICATOR SERIES, based on the current status of the ISNAR DATA FILES, is nearing completion, along with the SUPPLEMENTARY FILES. If the change-over to the new data management system goes smoothly, we anticipate that our initial data analysis will be completed around the middle of 1987, and both the analysis and accompanying data series will be prepared for publication later in 1987.

Considerable effort has now gone into preparing a fully sourced and documented data base which can be used by researchers as a basic reference on the state of national agricultural research. It is hoped that what it lacks in day-to-day management information for leaders of research institutes it will make up for in relevance to the ongoing policy dialogue. We seek your feedback on the nature of other types of information that NARS require to do their job better.

The final question is, "Where do we go once the data have been published?". If we agree that such information is of importance to us all, we see several options:

1. repeat the global survey at periodic intervals by mail survey;

2. regionalize the mail survey exercise in association with appropriate partners and using a standard methodology;

3. identify individuals in each national system who could on a regular basis assist us in maintaining the currency of the information. In many countries, ISNAR would see part of its job to be to assist directly in establishing the procedures and capacity for data collection and reporting.

Everyone agrees on the need for standardization of the information for comparative purposes and on the need for the information to be useful to those who are asked to provide it. We believe that Option 2 probably comes closest to satisfying these criteria in a networking arrangement. As with all networks where the output is a public good, some form of external support will be essential to the task. We actively seek your advice and your collaboration.

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