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Philippine National Agricultural and Natural Resources Research System: Resource Allocation Issues and Directions for Reform*

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Introduction

The performance of the agricultural sector is a key determinant of the Philippine overall economic growth and its people's food security. Agriculture continues to be a major source of gross domestic product, total employment, and livelihood of the rural sector. It is also the major source of livelihood of the country's poor households suffering most from food insecurity.

Unfortunately, the agricultural sector has performed poorly since the 1980's as growth rates of agricultural gross value added (including fishery and forestry) and exports were much lower than other developing Asian countries (Table 1). Indeed, except for livestock, poultry, and a few major crops such as rice and mangoes, gross value added of most crops and fisheries grew at a rate below the growth of population (Table 2). Measures of revealed comparative advantage for agriculture as a whole and for most major agricultural exports indicated a declining trend since the 1980's (Table 3). These trends are consistent with the stagnation of agricultural labor productivity and the slower growth in land productivity per hectare in comparison with the 1960's and 1970's (Table 4).

David (1998) argued that the poor performance of the agricultural sector has been caused by increasing price distortions, weak property rights structure, and inadequate public support services particularly in agricultural research and development. The agricultural research system

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has been severely underfunded with public expenditures in the early 1980s representing only 0.3% of agricultural gross value added, in contrast to an average of 1% among developing countries and 2-3% among developed countries (Table 5). In fact, only 5% of total public expenditures for agriculture have been allocated for agricultural research; whereas the ratio of budgetary outlay for rice price stabilization programs alone was in the range of 10% over the past decade (Table 6). The opportunity cost of under-investing in public agricultural research and development in the sector is high as reviews of social rates of return estimates worldwide report this to be in the order of 40-60% (Table 7).

With continued population growth, limited land supply, and rapid degradation of soil, water, fishery, and forestry resources, sustainable growth of the agricultural sector may be achieved primarily by increasing land and labor productivity and preserving the quality of the environment through technological change and efficient policy and institutional frameworks. Because agricultural technology development and dissemination, as well as social science research on policy, regulatory, institutional issues related to agriculture, natural resources, and the environment often have public good attributes; are characterized by externalities, economies of scale and scope, long gestation period; and subject to risks and uncertainties, the private sector will underinvest in such activities.

The private sector will invest only in the development of technologies where it can capture sufficient economic returns from its research investments. These are technologies which may be embodied in purchased inputs and/or where ownership of the new technology can be effectively protected by intellectual property rights[1] such as farm machineries, pesticides, and fertilizers. There are also technologies where benefits from research can naturally be appropriated by the

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[1]Includes trade secrets, invention or petty patents, plant patent and variety protection.

developers such as the hybrids of cross-pollinated crops (corn, vegetables, etc) because they cannot be easily duplicated and the market is ensured as farmers must buy the seed every growing season to maximize yields. However, the private sector will not invest in a wide range of biological technologies such as high-yielding, open-pollinated or self-pollinated cultivars, improved farm management, integrated pest management, and so forth, where their use cannot be effectively limited to those who pay for them. It will also refrain from investing in basic and strategic research that do not directly produce a technology which can be marketed, although these are crucial inputs in expanding the opportunities for technological development. Neither will it invest in social science research to analyze policy and institutional issues and to evaluate the impacts of new technologies on efficiency, equity, and the environment.

Moreover, agricultural technologies are highly location-specific; relatively little can be directly borrowed from abroad without some testing and adaptation. Appropriate policies, regulations, and institutions are likewise largely specific to the particular socio-political and economic milieu. Unlike in industry, therefore, where new technologies can be largely imported, or developed by the private sector, the public sector will have to take the leading role in agriculture technology generation and social science research and dissemination. This may be accomplished directly by producing new technologies and related social science studies and/or indirectly by funding non-governmental institutions or individuals to conduct such work, and providing the appropriate incentive structures for the private sector to invest in technology development.

The problem of underfunding of the Philippine public agricultural research system has long been raised in the literature and various policy fora (DA 1986; David et al 1993). The problem, however, is not only with the low level of public expenditure, but equally important are the inefficiencies caused by the misallocation of research resources within the sector (e.g., across research program areas, and ecological regions) and weaknesses in the institutional framework of the research system including the organizational structure, lack of accountability, fragmentation of research, incentive problems, instability in leadership, and weak linkage between research and extension.

The Commission on Agricultural Modernization has recently passed the Agriculture and Forestry Modernization Act (R.A. No), which obligates the government to substantially raise public expenditures for research and development up to par with our Asian neighbors. It should be emphasized, however, that unless weaknesses in the allocation decisions and institutional structure are addressed, the wisdom of reallocating scarce budgetary resources in favor of agricultural research investments at the expense of equally needed increases in public expenditure for market infrastructure, education, and health should be seriously evaluated particularly with the current financial crisis faced by the country.

Objectives

The purpose of this study is to explore improvements in the allocation of public expenditures and institutional reforms that will raise the efficiency of the public agricultural research system. Specifically, we propose the use of an economic framework (or principles) in developing strategic research resource allocation decisions. This study focuses on the research allocation/priorities at a strategic level across commodities and/or broad program areas, and not at a project or disciplinary level. As Alston et al. (1995) argued, prioritization at the project or disciplinary level within commodity or broad research program area is best undertaken through technical committees using client's perceptions of problems and potential solutions including scientist judgments on the probability of success, for a number of reasons: First, the benefits of evaluating a large number of potential projects may not warrant the high cost of quantification. Second, the priorities at the project level may be influenced more by technical questions rather than economic ones, such as the constraints to higher productivity and potentials for scientific success which are even more difficult to quantify at a project level but for which scientists and farmers would have reliable qualitative judgements. Finally, too much reliance on formal procedures for research allocation and priority setting may stifle ingenuity, serendipity, and scientific entrepreneurship.

The first section presents the conceptual framework for determining optimal research resource allocation. In the second section, the institutional characteristics of the research system including the organizational structure, funding arrangements, incentive and leadership problems, and coordination issues within research and between research and extension are characterized. The third section quantifies the recent allocation (1992-1997) of research resources across agencies, source of funds, type of expenditure, and commodities and evaluates this relative to an indicative optimal allocation. The fourth section analyzes the quantity, the quality, and the distribution of manpower resources across agencies and disciplinary areas. In the final section, the institutional, resource allocation, and manpower issues raised in the previous three sections are summarized and directions of research policy and institutional reforms are proposed.

The Data

Our inventory of research expenditures and technical manpower resources covers all public agencies mandated to conduct and/or coordinate agricultural research and development (R&D) at the Department of Agriculture (DA), Department of Environment and Natural Resources (DENR), Department of Science and Technology (DOST), and selected state colleges and universities (SCU's) under the Commission on Higher Education (CHED), as well as the SEAFDEC Aquaculture Department for which the country has an international commitment to support. Expenditure data refer to direct budgetary support from 1992-1997 classified by purpose, i.e., personnel, maintenance and operations, and capital outlay, as well as to external grants classified by specific sources, i.e. other government agencies, private sector, and foreign donors. Over 95% of research expenditure data inventoried refer to actual expenditure; only the research budgets for the smaller universities (accounting for at most 3% of the total R&D budget) are based on the General Appropriations Act (GAA). It was not possible to document the budgetary outlay allocated to individual researchers/ consultants or institutions not specifically identified as specializing in agriculture and natural resources but this would constitute a very small proportion say 3-5% of the total. These researches would mostly be foreign-funded and in the nature of socio-economic and other types of research not requiring laboratories or experimental farms, or basic science research related to agriculture but conducted by general science departments in universities.

With the exception of the smaller universities, the manpower database developed in this study is a complete directory of technical manpower resources as of early 1998, including their names, agency and unit where they are employed, designation, gender, age, final degree, year and school obtained and field of specialization. For the University of the Philippines at Los Baños (UPLB) and a few other SCUs, data on time allocation of technical staff across research, teaching, extension, and administration were obtained. In addition, an inventory of administrative and support service staff (in terms of number and their terms of employment) of DA, DENR and DOST-related agencies was made.

Both the research expenditure and manpower database were based on primary data obtained directly from the various government agencies and SCUs. The Bureau of Agricultural Research facilitated the collection of data for the DA-related agencies. Data-gathering on the physical infrastructure was initiated, but this could not be completed within the time and budget constraint of the current study.

Because the information about the distribution of research resources by commodity and other program areas, discipline, and level of research (basic, strategic, applied, and adaptive research) is central to the evaluation of efficiency in resource allocation, we have tried to develop an understanding of recent past allocations by examining the work and financial plans supposed to be approved by the DOST and the listing of projects obtained from a number of SCU's, PCARRD, and PCAMRD.

None of these sources of information provides a complete picture. The DOST does not have a complete set of work and financial plans in its data file. Neither do BAR (for DA agencies), PCARRD and PCAMRD (for their mandated coverage) have complete information that will allow such analysis. Budgets are reported by projects often extending beyond a year; and data on annual disbursements are seldom reported.

The Office of the Director of Research of the UPLB has the most organized and accessible database, but its information also refer only to budgetary allocation by projects, without any detail on their annual disbursement. Nonetheless, the information we were able to obtain directly from the agencies concerned or indirectly from offices undertaking some monitoring of R&D provided some important insights about the nature of research being conducted, the misallocation of resources across program areas, and the fragmentation of research efforts across agencies. At the very least, our efforts highlight the weaknesses in the monitoring, evaluation and prioritization in the research system. They have also provided some insights about directions for improving agricultural research related data collection and analysis to better guide research policy-making.

Although the budgets proposed in the work and financial plans are not actually approved, these at least represent the intended allocations with respect to core budgets of research organizations. At this time, it is not possible to collect a consistent series of actual expenditure data by commodity and program area because the accounting system of most agencies does not provide for such breakdowns, though some indicative figures are estimated in this study based on fragmented reports in order to have some comparison between intended and actual allocations.

Conceptual Framework

A key research policy issue relates to resource allocation questions at various levels: What is the appropriate total public expenditure for agricultural (and natural resource) research and development? Who and through what mechanism should it be funded? What should be the allocation across commodity and cross-commodity research programs, across levels of research -- basic, strategic, applied, and adaptive research -- and across disciplinary components within research program areas? What should be the appropriate input mix in research, i.e., budgetary allocations across personnel services, operation and maintenance, capital outlay, and manpower development? How should regional and ecosystem characteristics be considered in research allocation?

Past Research Prioritization

The appropriate research resource allocation depends fundamentally on the goals and objectives of agricultural research. Since the early 1970's, when formal research planning and prioritization was initiated with the establishment of the Philippine Council for Agricultural Research (PCAR), agricultural research and development has historically been aimed at achieving a multiple of objectives. Typically, these objectives would include the following: improve food security and nutrition, increase farmers’ income, generate foreign exchange, reduce imports through import substitution, generate employment opportunities, alleviate poverty, preserve the environment and maintain ecological balance.

Goals and objectives were determined through stakeholder consultations, together with the identification of priority commodities and program areas. For example in the late 1980's, PCAR which was later renamed Philippine Council of Agricultural Resource and Research Development (PCARRD) grouped commodities and research program areas into three. Nineteen commodities and cross-commodity program areas were classified as Priority I, 10 as Priority II, and another 5 as Priority III (Appendix Table 1). It has also been arbitrarily decided that 80% of funding would be allocated to Priority I commodities, 10% for Priority II, and 3% for Priority III.

A scoring approach was used to develop priority commodities by the Science and Technology Coordinating Council in 1989 where the results and methodology are presented in Appendix Table 2. The Science and Technology Agenda for National Development (STAND) also drew another list, which refocused the earlier priorities developed in the Science and Technology Master Plan (STMP). Again, multiple criteria were used to identify STAND priority areas classified into the coconut industry, export winners -- including 4 marine products, and 5 fruit crops and ornamental horticulture products--and basic domestic needs which included essentially all other major commodity groups and a number of environment-related program areas (Appendix Table 3).

There are at least three major problems with the above approaches. There is no clear analytical framework that links the objectives with the set of priority commodities. Even if a scoring method was adopted, any detailed commodity rankings derived would strictly be ordinal, with no implications for optimal decision about resource allocation (Alston et al. 1995).[2] In the actual budgetary allocation process, it is extremely difficult to influence overall allocation because of the highly fragmented institutional structure of the research system. Although in principle, the DOST approval of research budgets of all the government agencies is required by the Department

[2] According to Alston et al (1995), the rankings from scoring models may be wrong sometimes because the units in scoring procedures are incompatible with economic surplus measures from which efficient research priority ranking, as well as resource allocation are derived.

of Budget and Management (DBM), that process does not start with some priori notion of the desirable distribution of research resources across commodity and cross-commodity program areas which can provide an overall guide to program and project formulation, as well as in later evaluations. Even for the relatively small share of the research budget being administered by the DOST agricultural councils, the actual allocation would be largely dependent on the quantity and quality of project proposals submitted for each program area, though to some extent the priority areas influence those submissions.

Objectives of R & D

While alleviating poverty, reducing income inequality, minimizing income risks, and protecting the environment are all important objectives of development, it is argued that there may be other policy instruments which may be more effective in pursuing those objectives. For example, the poverty and technology impact literature have already shown that without economy-wide growth and rural-urban migration, the power of technological solutions to solve poverty problems is extremely limited (Alston and Pardey 1996). There is also a growing consensus that policy and institutional reforms in many areas are even more important or are required before technology solutions can be effective in addressing water pollution, salinity problems, soil erosion, and other environmental problems.

Economists have long contended that increasing long-term economic efficiency to accelerate agricultural growth should be the main or overriding objective of public research allocation decisions (Alston et al 1995; David and Otsuka 1993). This means choosing an allocation that maximizes long-term net social benefits (social benefit-cost ratio or social rates of return). Social differs from private costs and returns in two ways: a) outputs and inputs are valued at their social opportunity costs (e.g. using border price instead of domestic price for tradeables and shadow prices instead of actual or official foreign exchange rate, interest rates, and wages) and b) long-term benefits and costs as well as externalities are considered, i.e., including the environmental effects associated with the agricultural landscape, costs of involuntary unemployment or adjustment to alternative employment; worker health and safety; and benefits from better nutrition through improved human health and reduced health care system loss.

It should also be emphasized that what is relevant in determining research allocation or priorities is *ex ante* (or expected) net social benefits and costs from new investments, and not *ex post* measures. *Ex post* analyses are, of course, useful in learning from past experience what may be expected about factors affecting diffusion patterns of new technologies, constraints to technology adoption, distributional impacts, effects on the environment and so forth. But changes in the economic environment (or market factors), institutional framework, research resources, and scientific potentials may cause *ex ante* benefit-cost calculations to differ significantly from *ex post* assessments of earlier research efforts.

Economic Principles

Although the production of new agricultural technologies or knowledge aimed at raising farm productivity differs from the production of agricultural or industrial commodities in many respects, the economic theory of the firm is likewise applicable in deriving the basic guidelines for achieving economic efficiency of research system or organizations. Agricultural research is an investment in the production of knowledge and technologies and as such, it needs to be evaluated relative to other types of investments because it is competing with other economic activities for scarce resources. The following explanations of how that theory can be used to derive economic principles of research resource allocation is based largely on Alston et al. (1995) and Evenson (1996).

Available technology or current knowledge (K_t) may be viewed as a capital stock that has been created by past investments in research (K_{t-1}), which depreciates over time (D_t) but can be

$$K_t = K_{t-1} + I_t - D_t$$

augmented by new research investments (I_t), e.g.,

The extent to which available technology or knowledge (F_t) will be utilized or its adoption is a choice of the farmer. And that choice will be determined by the expected profitability of adopting the innovation and the user costs of acquiring the information. The utilization or service flow of the innovation (F_t) therefore will be influenced by the nature of the available technology (K_t), the relative factor prices (P_t), the stock of human capital in agriculture (H_t), the extent and quality of extension services (E_t), and other factors such as environmental conditions, and so

$$F_t = f\,(K_t, P_t, H_t, E_t, ...)$$

forth.

The fact that a technology is developed does not mean it will be adopted widely. For example, if the cost of technology dissemination is not subsidized by the government, the user cost of acquiring the information may be too high. It is also possible that despite substantial government subsidies, farmers will not adopt a new technology. This has been the case with the locally designed and produced mechanical dryers of rice, which have not been widely used by farmers because the labor cost of sundrying continue to be lower than the total cost (including the transport and inconvenience cost) of availing the use of cooperative-run locally -made dryers.[3]

The relation between technology adoption and commodity output is represented by a production function where output (Q_t) depends on the quantities of conventional inputs (X_t) such as fertilizer, labor, land; various infrastructure variables (Z_t) such as irrigation, education, roads;

$$Q_t = q(X_t , Z_t , W_t , F_t ,)$$

uncontrolled factors such as weather (W_t), and the flow or use of technological services (F_t), i.e,

Investments in research can raise productivity (output per unit of conventional inputs, Q/X, or total factor productivity) by changing the quality of conventional inputs or their prices (through a change in the technology used to produce those inputs such as development of new varieties, pesticides, vaccines, feed substitutes), or by changing the management techniques of production (change in cultural process, cropping patterns, etc.), through an increase in the stock of knowledge and/or by increasing the use of the existing knowledge.

The increase in knowledge or development of new technology resulting from a certain research investment (I_t) will be determined by a number of factors including the existing stock of fundamental knowledge and available research capital (K_t). That increase will also be different

[3]Interestingly, many rice traders/millers have now acquired imported mechanical dryers and used these in conjunction with solar drying even without any government subsidies. This implies that the use of mechanical dryers is characterized by strong economies of scale so that the cost of mechanical drying per kg. of palay is lower for traders than farmers because of higher capacity utilization, economies of scale in handling, and evidently the greater efficiency of imported compared to locally produced dryers.

across commodities, scientific disciplines, research problem areas and will be influenced by a number of institutional variables related to the management and development of research staff and resources with which they work as denoted by the vector of variables reflecting productivity of a given amount of research resources (Z_t). Furthermore, there are time lags between investment in research and the yield of results and the dynamics of that relationship with past investments (R_{t-1e}) is generally complicated and uncertain. The research knowledge production function may be written as:

$$I_t = (R_t ,.... R_{t-LR} ; K_t , \overline{Z}_t)$$

In practice, neither F_t nor I_t can be observed directly and thus it is not possible to estimate these relationships empirically. However, understanding these relationships conceptually allows us to specify a reduced form production relationship between investments in research and output that will enable the estimation of the benefits of research investments as shown below:

Where L_R is the maximum research lag that keeps earlier research investments from

$$Q_t = q (X_t , W_t , H_t , P_t , Z_t , R_{t-r} , E_{t-e})$$

affecting the current research-induced increment to knowledge.

for r, e = 0 to 8

Because of data limitations, empirical estimations of production functions are often difficult. Hence, methodologies for estimating net present value of social benefits and costs are typically based conceptually on supply or cost functions, rather than production functions. A supply function defines the relationship between the profit maximizing levels of output at alternative levels of output and input prices, given the production function. The impact of the adoption in new technologies is represented by a shift in the supply curve from S to S^1 in Figure 1. And the benefits from the technical change may be measured by the change in the consumer and producer surplus arising from the shift in the supply curve. If the commodity is tradeable and the country's import or export share in the world market is small or insignificant, demand curve for the product is horizontal. In this case, all the benefits accrue to producers as denoted by the area acd. If the commodity is non-traded, or a country is a closed economy, demand curve is downward sloping and hence increases in domestic supply as a result of technical change will lower prices. In such a case, the benefits will be shared between producers as represented by the area, and consumers benefiting from greater consumption at lower prices as measured by the area of consumer surplus bcfe.

Social Benefit-Cost of Research

The size of the expected gross annual research benefit would depend on the initial value of production (P x Q_0), the size and timing of the per unit cost reductions or yield increases if the research is successful, the adoption rate, the probability of research success, the discount rate, and the cost of research. There are other factors which affect the size of the net benefits that should ideally be taken into account. For example, the price distorting effects of policies mean that the price used should refer to the social opportunity cost of outputs and inputs, i.e., the border price converted by the shadow exchange rate in the case of tradeables and the shadow wage, interest rate and land rental in the case of labor, capital, and land. The full cost of government funds is typically greater than the actual budgetary allocation or public expenditure because of the deadweight cost of taxation. Empirical studies indicate that the social cost of government spending is in the range of 1.2 to 1.5 times the amount spent (e.g., Browny 1987) which can make a significant difference in a calculations of research's net benefits.

In general, the net present benefits from research are higher (see Purcell and Anderson 1997).

* The greater the total pre-research value of production of the commodity (which is indicative of inherent comparative advantage in domestic production).
* The faster the expected growth of the commodity, an indication of market potential which would usually be stronger among tradeable than non-tradeable commodities.
* The greater the technological advantage of research output in terms of reduction of unit cost or yield increase.
* The higher the probability of research success.
* The faster the adoption of research results (or the sooner the reduction in unit cost is realized and the higher the ceiling rates of adoption).
* The lower the rate of research depreciation.
* The lower the interest rate.
* The lower the opportunity cost of government funds.
* The smaller the domestic production as a share of global production of the commodity.
* The greater the effects of research on reducing the distorting effects of price policies.
* The greater the effects of research on reducing the distorting effects of externalities.
* The lower the adoption of research results in other countries.

There are major difficulties in undertaking *ex ante* research evaluation. The data required to evaluate alternative research program areas are great and several key variables are based on subjective judgements that are subject to large degrees of error. Aside from huge data requirements, two other problems are encountered: uncertainty in the nature of the research process itself and the importance of other factors beyond the nature of the new technology or knowledge produced by research on its ultimate impact, e.g., quality of extension, price policies, etc.

An ACIAR-funded research priority setting project in the late 1980's conducted by a research team led by Cynthia Bantilan has organized the basic data base and derived some estimates of *ex ante* net social benefits of research for various commodities/commodity groups (RPPAP 1992). Unfortunately, the results of this project have been largely ignored in the research resource allocation of the Department of Agricultural, PCARRD, SCU’s and Department of Budget and Management. Although the quality of the data/information used particularly the probability of scientific success, probable adoption rate and productivity advantage of new technology, may be subject to question, and only ordinal rankings were derived; that effort could have served as a starting point for introducing a coherent economic framework to the process of research resource allocation. Moreover, it could have served as an organizing framework for developing the necessary data and information base for regularly estimating both *ex ante* and *ex post* net social benefit/cost or rates of return of research investments. Decisions arising from informal assessments based on consideration of the relevant variables and relationships derived from maximizing of net present benefit of research would be more reliable than the current system based solely on stakeholder or participatory consultations without any analytical basis.

Ex ante estimates of present value of net social benefits (NPV) of research programs are absolute measures which indicate that programs with positive values are economically worthwhile and those with negative values should be stopped or not undertaken. However, since public resources available for agricultural research are limited as they compete with other uses, the allocation of limited funds across research program areas (RPA) with positive net social benefits will have to be made. Without additional information, optimal resource allocation across RPA cannot be inferred from estimates of NPV nor NPV per unit of research investment alone.

Optimal Allocation and Congruence Rule

Research resources should not be simply allocated to RPAs ranked from highest to lowest net social benefits until the total budget is exhausted. That allocation will not necessarily maximize the overall NPV per unit of research investment because the programs are presented as discrete alternatives and some reallocation of resources among the programs might lead to an increase in the overall NPV. The optimal resource allocation may be determined through mathematical programming, but information requirements are even greater since the net social benefits at alternative levels of research investments will have to be estimated. Conceptually, total net present value of social benefits from a given research investment will be maximized when marginal social benefits are equal to the marginal social cost of research across program areas.

Because of severe data limitations, highly simplified assumptions may have to be made to derive decision rules or guidance which can serve as a useful starting point in introducing an economic perspective in research allocation. When it is assumed that the marginal costs of research or price of research resources are equal across program areas, optimal research allocation may be derived by setting marginal value products equal to each other. This is the **congruence rule** where the optimal research resource allocation across commodity program areas will be proportional to the respective commodity value added or value of production shares. In other words, given a total budget for agricultural research, the research intensity ratio, i.e., research expenditure as a ratio of the value added contribution should be equal across commodity research program areas.

The congruence model is subject to several limitations:

* It is applicable to research resource allocation across commodity program areas, but does not provide any guidance on allocation by cross-commodity research issues, such as policy, institutional, and other socio-economic research, natural resource management, food safety, nutrition, and so forth.

* It does not consider optimal distribution of research budget between public and private research, nor the choice between importing or locally developing new technologies.

* It does not consider potential change in comparative advantage arising from factor and product market changes, though economic size of a commodity implicitly reflects inherent comparative advantage in its domestic production.

* It does not consider possible differences in scientific potentials for research success, probable adoption patterns, and other cost factors of research, such as discount rates, timing of research benefits and costs, and economies of scale and scope. There is a minimum size needed for a research commodity program to be viable.

Despite major weaknesses, the congruence rule is a useful starting point or base research allocation from which adjustments may be made in consideration of the cost side, such as differences in cost of research. The CGIAR's Technical Advisory Committee has used congruence analysis as the point of departure in its allocation across commodities. Congruence analysis is modified to take account of other objectives, e.g., poverty alleviation is considered by assigning a greater weight on the value of production for a certain commodity of poorer countries than do less poor countries. Other criteria related to efficiency objectives are also considered in adjusting congruence based allocation: international public good nature of the research; alternative source of research products (i.e., NARs or other international or bilateral donor or institutions), and probability of creating an impact.

Obviously, the initial methodology will necessarily be crude but over time and with appropriate investments, especially on adoption studies and *ex post* evaluation of research, better informed measures can be developed.

It should be emphasized that to design a strategy for an improved allocation of research resources as well as to increase efficiency in the use of limited budgetary resources for agricultural research, a critical analysis of the efficiency of the institutional framework of the public agricultural research and development system as well as the current research expenditure allocation by agency, type of expenditure and commodity program area, and the quantity and quality of manpower resources and physical infrastructure would be required.

Institutional Setting

Agricultural research is funded and conducted by the private and the public sector. The focus of the rest of this paper is on the public or the national agricultural research system. The performance of the research system depends crucially on the efficiency of the institutional framework, including the organizational structure and the set of basic operational processes such as the funding mechanisms, incentive structure, priority setting, monitoring and evaluation of programs, coordinating mechanisms among various units and stakeholders, etc. (Trigo, 1986). The organizational structure, in particular, provides the framework linking research and the broader social, political, and economic environments and hence determines the responsiveness of agricultural research to market potentials, technological opportunities, and farm-level socio-economic and physical constraints. Moreover, it conditions the efficiency and effectiveness of the research system through its effects on the optimality in research resource allocations, transaction costs of operations, incentive structure, interaction with the system clientele, capacity to mobilize and develop resources, the capacity to implement certain types of research, and coordinate different tasks and activities to address particular research problem areas.

The appropriate organizational structure depends on many factors, such as a country's agricultural conditions and history, the size and resources of economy and its stage of development, and the nature of the government bureaucracy. Furthermore, the appropriate organizational structure may change over time as those social, economic, political, and scientific conditions change.

Evolution of the research system

The national agricultural research system has evolved over time not only in an effort to strengthen its operations, but as a consequence of changes in the larger bureaucracy involved in agricultural and natural resource and development, science and technology, and education. Prior to the early 1970s, agricultural research and development has been mainly carried out by the various bureaus (principally the Bureau of Plant Industry and the Bureau of Animal Industry) under the Department of Agriculture and National Resources (DANR) and a few state colleges and universities (SCUs) led by the University of the Philippines' College of Agriculture and Forestry at Los Baños. With the greater attention to agricultural development by the government, bilateral and multilateral foreign donors and lending agencies as a response to high world commodity prices and the success of the Green Revolution in rice and wheat, strengthening the country's agricultural research and development system became a priority concern.

To address the apparent weaknesses in the organization and management structure, the lack of planning and coordinating mechanisms of research activities undertaken by the different agencies, and weak linkage in the research and extension, the Philippine Council for Agricultural Research (PCAR) was established in 1972 . It was an autonomous agency attached to the Department of Agriculture and Natural Resources (DANR) with the minister as the ex-officio chairman of the Governing Board responsible for policy formulation. PCAR was conceived as an apex organization with the responsibility “to establish, support, and manage the operations of a national network of centers of excellence for the various research programs in crops, livestock, forestry, fisheries, soil and water, mineral resources, and socio-economic research related to agriculture and natural resources.” Through PCAR’s initiative, the various research units in the DANR and the SCUs were organized to form a national agricultural and natural resources research network, with assignments as national single or multicommodity research centers, regional research centers, and cooperating field stations.

With the split of the DANR into the Ministry of Agriculture and Food (MAF) and the Ministry of Natural Resources (MNR), PCAR was renamed the Philippine Council for Agriculture and Resources Research and Development (PCARRD) and attached to the National Science and Development Board (NSDB). When the NSDB became the DOST, the council system was adopted in other areas of research and the PCARRD’s responsibility for fishery was shifted to a new council called the Philippine Council for Agricultural and Marine Resources Research and Development (PCAMRD) and PCARRD’s responsibility was limited to agriculture and forestry.

The main thrust of the agricultural research development initiated with the creation of PCAR in late 1972 was to assign the responsibility for technology generation primarily to state colleges and universities with the exception of commodities where semi-autonomous agencies are specifically mandated to undertake research and development such as in tobacco, cotton, sugar, coconut, etc. At the same time, a policy decision was made to rely largely on the International Rice Research Institute (IRRI) for rice research, which made the country dependent on an external agency for technology generation of its most important commodity. The MAF was supposed to concentrate mostly on the function of technology transfer or extension.

As a consequence, the bulk of increased public expenditures for agricultural research from both national and foreign sources was allocated mostly for the strengthening of manpower, infrastructure, and research programs of SCUs. Many research centers and institutes were established outside the regular teaching departments of a number of SCU's. These included the Institute of Plant Breeding, Farming Systems Research Institute, and others at UPLB, the Philippine Root Crop Center at the Visayas State College of Agriculture (VISCA), and several others in various SCUs.

In the meantime, the research capability of the Ministry of Agriculture and Food declined as it became isolated from the mainstream of the country's programs of agricultural research, and eroded its capacity to mobilize the national research effort for agricultural development for which it has the main responsibility (ISNAR 1986). The gap in technical manpower resources and infrastructure facilities between MAF and SCU's further widened and the MAF's share in the public research budgets declined.

Organizational changes within the MAF exacerbated the problem as separate research agencies for sugar (Philsugin) an coconut (Philcorin) and others were merged into commodity-based agencies mandated to perform a variety of functions including market regulations, research, extension, and other development programs. Under that structure, research or technology development inadvertently became of secondary importance to market and other regulations which are easier to implement, have short-term impact, and generate resources for the agency. In contrast, agricultural research have longer-term impacts, and requires higher technical skills and budgetary resources for effective implementation. Moreover, the position classifications of researchers were effectively down-graded and their incentives to remain and improve performance are lowered since head of commodity agencies are typically non-technical persons who may not fully appreciate the important contribution of technical change or the scientific skills and different type of management style required for productive research.

By the mid-1980's, weaknesses in the national agricultural research system that evolved since the early 1970's have become apparent. The ISNAR (1986) study emphasized the limitations of the strategy adopted in strengthening the agricultural research system. And the 1986 Agenda for Agricultural Policy Reform highlighted the fragmentation, weak research and extension, and lack of accountability of the agricultural research system as the mandate for technology generation rested on the PCARRD and PCAMRD of the DOST, while the MAF (renamed the Department of Agriculture) had responsibility for extension and overall agricultural development.

Department of Agriculture

Because of the resistance to the transfer of PCARRD and PCAMRD to the DA recommended in 1986, a Bureau of Agricultural Research (BAR) was established at the DA. It is supposed to strengthen, coordinate and monitor agricultural research and development within the Department, essentially duplicating the function of the PCARRD and PCAMRD. Since the late 1980's, the DA has made some efforts to strengthen its research capability and administers its own research grants to SCU's. The major focus was the development of the Philippine Rice Research Institute (PhilRice) and the Philippine Carabao Center (PCC), as well as the strengthening and rationalization of the Regional Integrated Agricultural Research Centers (RIARC's) and the Regional Outreach Stations (ROS's).

The Department of Agricultural Research and Development System (DARDS) coordinated by BAR is a hierarchy of research institutes, centers, and stations classified either as national or regional. At the national level are eleven (11) attached bureaus, agencies, and corporations that operate 46 national research centers/stations (NCRCS) in various locations in the country (see Appendix A). Most of the national research centers are part of single commodity focused agencies whose functions also include regulatory services. Multi-commodity focused institutions include BPI and BAI, while purely research single commodity-focused institutions or attached agencies including PhilRice, PCC, National Tobacco Administration (NTA), Philippine Coconut Authority (PCA), Sugar Regulatory Administration (SRA), and others.

At the regional level are 15 RIARCS or one integrated center per region; however, some RIARCS have multiple locations. Thus, the whole country has a total of 36 stations as part of the RIARC system. Below the RIARCS are 67 Research Outreach Stations (ROSES) or an average of four per region. In theory, ROSES are directly under the RIARCS; but some regions have placed these under Field Operations by virtue of Special Order 5 issued then by Secretary Escudero. In short, there are regions where ROSES are performing purely extension functions.

RIARCS have specific agroclimatic thrusts and organize their research programs based on the farming system's approach. The same is true for most ROSES; however, there are still stations left with commodity orientation despite DA's shift from commodity to farming system's approach in 1988 as the list indicates.

DENR

The Department of Environment and Natural Resources (formerly the MNR) as part of its overall reorganization in 986 moved to strengthen its research and development efforts by creating the Ecosystem Research and Development Board (ERDB) at the national level and its research arm at the regional level consisting of Ecosystem Research and Development Service (ERDS) at all the various regions. Within DENR, the Protected Areas and Wildlife Bureau also conducts research related to technologies policies and institutions that will protect biodiversity and other environmental objectives.

DOST

Aside from the PCARRD and PCAMRD which are among the several councils coordinating research and development at the DOST, its Forest Product Research and Development Institute (FPRDI) conducts research and development activities to increase efficiency in the utilization of forest products.

The PCARRD has organized the various components of the research system into the National Agriculture and Resources Research Development Network (NARDDN), composed mainly of two subsystem: the DARDS and the State Colleges/Universities of Agriculture Research and Development System (SCU-ARDS).

The NARRDN has a hierarchical structure in terms of level of research capacity where the national research centers focus on basic and applied research for technology generation, while the regional centers are supposed to focus on region-specific technology adaptation research. Cooperating stations around the country conduct mainly extension-oriented (research, i.e., techno-demonstration farms, seeds and animal productions etc.). As shown in Appendix B, the universities dominate the top responsibilities in the hierarchy as they account for all the four multi-commodity national research and out of the seven single-commodity national research centers, 5 are SCUs and only 3 are DA research units. Many of the DA experiment stations are simply part of the 67 cooperating field stations in the network.

At the regional level, PCARRD also established and coordinates 14 research and development consortia corresponding to the various regions.

Patterns of Public Expenditures for

Agricultural Research

Agricultural research is a form of economic investment. As such, net social benefits will be maximized by investing at a level where the marginal social benefit equal its marginal social cost. Alternatively, optimal research investment may be viewed as the level where no further reallocation will increase overall social rate of returns of public expenditures, i.e., social rate of return of agricultural research is equal to all other types of public expenditure.

Not only the absolute magnitude of government funding for agricultural research, but also the allocation across commodity-specific and cross-commodity research program areas, across disciplines, across types of expenditures – personnel, operations and maintenance, and capital outlay – directly affect returns to agricultural research. In addition, the timing and stability of government funding are also important factors affecting efficiency of agricultural research. If research budgets are chronically insufficient, the research institution may get stuck at the start-up phase and never achieve its potential rate of return (Tabor 1998). Also, uncertainty and instability of funding reduces returns as long-term projects are interrupted and capacity utilization of research infrastructure and manpower declines.

The research expenditure data compiled in this study provide some important insights about the adequacy and efficiency in allocation of public expenditures for agricultural research and development. It should be noted that while coverage of the various government agencies conducting agricultural research is essentially complete, a number of limitations with the research expenditure data base remains. For example, data on budget allocation by commodity, discipline, and other program-related categories are quite fragmentary. Reported research expenditures contain some extension-related activities, such as funding for technology-demonstration projects, seed production, and the like. There are still some cases of relatively small double-counting, e.g., project funds granted by PCARRD and PCAMRD to SCUs, DA, or DENR agencies. Salary support for the research time of the SCU faculty members is excluded. Nonetheless despite these limitations, a number of important patterns in expenditure allocations may be observed that are quite robust and will not change significantly with further refinements of the data.

Agricultural R&D Expenditures

In practice, allocation of public expenditures across sectors or policy instruments is a political process that is conditioned by the relative weights assigned to various public objectives, distribution of political power across sectors and regions, historical patterns, and so forth. Moreover, evaluating whether or not the level of public expenditures for agricultural research is appropriate becomes a matter of considered judgement because estimating the social rates of return of alternative public expenditure for education, infrastructure, etc., or the marginal social cost and returns to agricultural research are extremely difficult.

It should be noted, however, that the high estimated *ex post* rates of return of agricultural research, particularly in developing countries, generally indicate underinvestments. Indeed, the Philippine public expenditure for agricultural research from 1992 to 1996 show underfunding even by developing country standards. Whereas the public sector in developing countries spend on the average about 1% of gross value added in agriculture on research, the total Philippine agricultural research expenditure of about P2.1 billion imply a research intensity ratio of about 0.47% in 1996 (Table 8). If the contributions of foreign funding agencies and our international financial commitment to the SEAFDEC Aquaculture Department are excluded, the public expenditures to agricultural research amounted to only about P1.7 billion, reflecting a RIR of 0.38% . The government's contributions to SEAFDEC alone constitute 10% of public agricultural R&D expenditures. Foreign grants to the national research system accounted for another 10% at the most.

It is encouraging, however, that in the 1990s, public expenditures for agricultural research increased rapidly in real terms by an average annual growth rate of 8-9%. As a result, the total agricultural research intensity ratio grew from 0.40% in 1992 up to 0.47% by 1996. When the SEAFDEC is excluded, the RIR in 1992 of 0.32% rose to 0.43% in 1996.

Research Expenditure by Institution

Funding for research institutions consists of direct budgetary support and project funds obtained from other government agencies, foreign sources, and to a minor extent, the private sector. Overall, at least 75% of research expenditures are direct budgetary support and 25% are project funds. Of the share of project funds, 15% originate from local (mainly government) sources, and 10% from foreign sources. That ratio differs widely, across institutions. The DA's and the DENR's direct budgetary support accounts for almost 90% of its research budget and only 10% are from external sources[4] (Table 9). The share of external sources of funds are significantly higher among the SCUs (44%), DOST agencies (38%), and SEAFDEC (18%). External grants to PCARRD and PCAMRD largely come from the DOST itself, though PCAMRD has had major contributions from foreign loans and grants.

Approximately 60% of direct budgetary support for agricultural research or about 52% of the total research expenditures amounting to P900 million is allocated to the DA. A third of the DA research budget (about P300 million) is used to support the expenditures for various RIARCs and ROSs at the regional level. As may be expected, the single biggest budgetary allocation provided to a research agency goes to PhilRice which has the responsibility for the most important crop (Table 10). This budget, however, is somewhat lower than the country's contribution to SEAFDEC. But surprising is the relatively high budgetary allocation to the recently established

[4]Research project funds granted by the DA to other government agencies and SCU's are included in the research budgets of receiving institutions.

research center for carabao (PCC), averaging about P140 million between 1995-1997, which is second only to that of PhilRice and for higher than public expenditure for coconut research by the PCA.

Direct budgetary support for sugar research under the SRA is also higher than for PCA, though as the gross value added of coconut is 25% higher than sugar. If the funds contributed by the sugar industry through Philsurin is included, total research budget for sugar rises up to about P100 million. DA agencies with budgets ranging from P40-48 million are BPI and BPRE. Other commodity-based research agencies such as the NTA, FIDA, and CRDI receive budgets range from P30-40 million.

The DENR's research budget is now more than P200 million, representing about 10% of the total agricultural R&D budget. The bulk of that (80%) is spent by the ERDS in the various regional offices, and the remainder by the ERDB and the PAWB. If the research budget for the FPRDI under the DOST is added to DENR's as a measure of research budget allocation to natural resources (principally forestry), the total R&D budget for the subsector increases significantly to more than P300 million.

The PCARRD and PCAMRD's direct budgetary support is nearly P150 million (6-7% of total) and about P250 million (10% of total) when external grants are added. That budget is spent for the coordinating and monitoring role, funding for research projects, and to a limited extent, for manpower development.

Direct budgetary support for the SCUs as a group reached P330 million in 1997, and almost P500 million when external grants are included. That represents slightly more than a fourth of the total R&D expenditures in the sector. The UP system accounts for about 42% of the direct budgetary support for research received by SCUs, but this share increases to 57% of total research expenditure.

The UPLB received the dominant share of the research budget granted to the SCUs. Its total research budget could be equal or even more than all the other SCUs combined, if the research budget administered by the UPLB Foundation or SEARCA which are typically conducted mostly by UPLB faculty are covered. Among the other SCUs, DMMSU has received the highest direct budgetary allocation for research since 1996, surpassing VISCA's budget even when external grants are included (Table 10). The fourth highest research budget is spent by CLSU[5], followed by BSU and MMSU with expenditures ranging from P23 to 28 million in 1997. Research expenditures for all the other SCUs are below P20 million.

[5]The research budget reported for the MSU refers to GAA and also includes research for non-agriculture. Only the research expenditures for fishery research (Naawan campus) was provided by MSU which amounted to about P10 million in 1997.

Not surprisingly, the UP-system has generated the highest external funding support in absolute and relative terms, in part because of the relatively greater availability and better quality of research manpower and infrastructure. At least half of research expenditures at UPLB are from external grants, three-fourths of which are from local sources.[6] Though VISCA has the second strongest research capacity, its ability to generate external funds (relative to its direct budgetary allocations) was only about equal to other major SCUs. But unlike all the other SCUs where external grants generally come from local sources, VISCA's external grants were mostly from foreign sources (75%).

Growth of Research Budget by Institution

The growth rate of research expenditures varied widely across institutions (Table 11). At the departmental level, the most rapid growth was experienced by the DENR and DOST agencies, as their total research budgets increased at an average of 12% per year and at an even higher rate of 15-17% for direct budgetary support. The DA research budget in total grew at slightly above the overall average of about 10% per year. In contrast, total research expenditures of SCUs increased at a much slower rate (4%). It is interesting to note that direct budgetary support grew faster than external grants mainly because of the slower growth rate of foreign-funded research.

Among the DA agencies and across the SCUs, differences in growth rates in research budgets are even more marked (Table 13). Because the research infrastructure is still being built up, average growth rate of PCC's research budget between 1992-97 was extremely high. BSWM also showed unusually rapid growth, but this is only because it is starting at a very low level of research budget. Otherwise, BFAR, BPI, FIDA, PhilRice, and NFA experienced the faster

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[6]This is even an underestimate because the research budget administered by the UPLB Foundation, and SEARCA, which are primarily undertaken by its faculty, is not included.

growing research budgets (15-25% per year). BAI and NIA's budgets stagnated and even decreased, while that of SRA grew slowly at about 4%. Research budgets of PCA, CRDI and BPRE grew at 9-13% mainly because of external grants.

Remarkable growth (15%-18%) of research expenditures may be observed in SCUs located in the Northern and Central Luzon such as DMMSU, PSU, CLSU, BSU, and MMSU (Table 14). Research budgets of DSAC, BU, CSSAC in Luzon, and CMU in Mindanao also grew rapidly, but these have comparatively much smaller programs. In contrast to those very high growth rates, research expenditures stagnated for the largest SCUs in Luzon, Visayas, and Mindanao, i.e., UPLB, VISCA, and USM, respectively. Ironically, these are the SCUs with the heaviest research responsibilities and the strongest manpower and infrastructure capacities. One may argue that research budgetary support for these SCUs may be expected to level off as they have already been expanded in the past. On the other hand, another view is the inefficiency of fragmenting research funding over too many SCUs, especially when later sections show the research support per scientist is relatively low in these universities for Mindanao and research budgets relative to its contribution to gross value added in agriculture continue to be much lower than in other regions.

Distribution by Commodity

Although the congruence rule, i.e., consistency of the distribution of research budgets with the relative economic importance of the commodity, does not necessarily reflect optimal or efficient research resource allocation, it is a useful starting point in evaluating patterns of allocation by commodity. As mentioned earlier, it was not possible to compile a complete database on annual research budgets by commodity because the accounting system of multi-commodity research institutions such as BPI at the DA and the various SCUs do not record research expenditure by commodity. Based on budgets of commodity-specific research agencies, work and financial plans of a number of institutions, and data obtained directly from a few SCUs, some indicative estimates of research intensity ratios by commodity were estimated.

Table 15 shows that research expenditure allocation across commodities is highly incongruent with their economic contribution as the estimated research intensity ratios range from less than 0.01% for cattle, hogs and chicken as a group and 0.05% for corn to an extremely high ratio of 3.6% for carabao and 25% for cotton. In general, relatively higher allocations are accorded to minor commodities not commensurate with their economic contribution, where the country has no historical comparative advantage nor is there any clear indication of greater scientific potential or strong future comparative advantage or market potential.

Among major crops, corn research has been the most neglected with the research expenditures not exceeding P10 million a year since 1992, which is only 0.05% of its contribution to gross value added. While the private sector conducts corn research, this is limited to development of hybrid corn, which would be suited primarily to the favorable production environments accounting for no more than 30-40% of crop area grown to corn. Because of the absence of a research institution dedicated to corn research, there has been no regular budgetary allocation for that purpose, nor any concerted effort by the DA or PCARRD to regularize a budgetary allocation for corn research. Assignment of national or regional commodity research responsibility to SCUs (as corn for USM) as determined by PCARRD does not have any corresponding budgetary allocation unless this is conducted by a separate dedicated unit in the university.

The IPB of UPLB, USM, and the DA-CVIARC are the major institutions conducting corn research, but their corn research operations depend largely on external grants. USM is assigned national responsibility not only for corn, but also industrial and fruit crops (as well as regional responsibilities for many other commodities and program areas), but its regular research budget is only about P9-10 million (P13 million with external grants). Its annual corn research budget in recent years averaged only about P1.5 million with P500 thousand being contributed by the DA-BAR and PCARRD. USM's corn research was more active in the late 1980s up to 1991 mainly because of USAID funding.

IPB's corn research has also relied heavily on external funding as regular MOE budget of the whole institute is only about 4 million. In fact, because of scarce government funds for corn research, IPB entered into a research contract with a private seed company (Ayala Corporation) which explains to some extent, its research focus on hybrid, rather than on open-pollinated corn. The only major government funding allocated to corn for IPB in recent years was for seed production. The DA-CVIARC was active in corn research earlier but has done mostly corn seed production in the 1990's as the DA accelerated distribution of hybrid corn seeds with the GPEP and Gintong Ani Program.

Except for carabao, research and development in the other major animals is very much underfunded. As in corn, the role of private sector research in hogs, chicken, and eggs is perhaps even stronger. Nevertheless, some significant public sector research may still be socially profitable for the other livestock, especially in cattle and backyard hog production. The much greater research intensity ratio for carabao compared to other major commodities, such as rice, corn, coconut, sugar, fishery, and others clearly indicate misallocation of research resources. While some research and development on carabao is justified, the fact is that increasing scarcity of labor, more intensive cropping and growing, water shortages will eventually raise the profitability of mechanization over the use of carabaos as draft animal[7]. It is not also clear that carabao meat,

[7]Increasing cropping intensity reduces availability of grazing land for animals; and carabaos are not suited to drier type of farming.

considered to be inferior, will have a greater market potential over beef, as per capita income increase and as international technical change in cattle production may be more rapid.

Fishery research is also significantly underfunded, especially if the international funding commitment to the SEAFDEC-AQD is excluded. Public research support to BFAR, PCAMRD, UPV, UPMSI and a few other SCU's total less than P80 million, which is about 0.12% of gross value added of fishery. Even if the P153 million budget allocation to SEAFDEC in 1996 were included, research intensity would only rise up to 0.35%. Clearly, public research allocation for fishery, a major livelihood of many of the landless poor, as well as a major earner of foreign exchange, is substantially underfunded. Given the significant government financial contribution to SEAFDEC, representing more than 10% of total public research support for all of agriculture and natural resources research, greater efforts must be made to maximize its contributions to the country's fishery development.

The highest research intensities are found among fiber crops which as a group has a RIR of 2.5-3.0%. Moreover, budgetary allocation for fiber crops is spent on commodities that the country has no inherent comparative advantage as evidenced by the insignificant level of production. Research budget for cotton allocated to the CRDI is in the order of P25 million, higher than public research budget for corn which contributed about P22 billion to GVA in contrast to cotton's 1996 production value of about P100 million. Consequently, research intensity of cotton is extremely high at 25%. Silk is another fiber crop where research intensity would be extremely high, because local production is so small the statistical office does not make an estimate of its production. Yet, there is a research center for sericulture in DMSSU with a budget of more than P5 million, and a few other-related research at the BSU has been funded by PCARRD. It seems obvious that the potentials for developing any competitive advantage for these commodities in the world market are nil, and those budget allocations though extremely high in relative terms are low in absolute terms and thus could not be expected to produce much impact, as seems clear from the experience of these institutions. This is the same case for wheat which is not grown locally but continues to be included, at least nominally, in the research program of IPB.

In contrast to cotton and silk, research intensity of abaca and other fiber crops is about 1%, much lower than cotton and silk, but still significantly higher than for most major commodities. Abaca, however, deserves research funding because the country has historically had a comparative advantage in this commodity, world market demand is expanding, and the crop is suited to the high rainfall, typhoon-prone, and economically depressed areas of Bicol, Samar, and Leyte.

As a ratio of the GVA of forestry, forestry-related research expenditure is quite high, 3.5 to 4.0%. However, the contribution of better forest and other natural resource management is much greater than the GVA for forestry – fishery indicates because of their environmental consequences but the fact that research expenditure for natural resources, thus their contribution to the sustainability of agriculture and quality of life overall. These other positive contributions to the economy are difficult to quantify, but the fact that research expenditure for natural resource management as a ratio of total research budget is about 10-15%, comparable to the allocation found in CGIAR, and other developed economies which suggest that in relative terms, allocation to these program areas may be satisfactory.

Distribution by Region

It is also interesting to compare the distribution of research expenditure by region and the economic value of agriculture in those regions. The comparison is limited to research expenditures of DA regional offices and regional SCUs mandated specifically to serve their respective regions. Of course, national research programs on major crops such as rice, sugar, coconut, tobacco, have differential impacts across regions and regional level research have spill-over effects by region. But it is not possible to take these into consideration given available data at this time.

Table 16 shows the estimates of research intensity ratios by region. Note, however, that for Southern Tagalog UPLB/MSI which primarily conducts research at the national level have been included under the SCU column. Hence its RIR may not be quite comparable with other regions. A consistent pattern of underfunding of agriculture R&D in Mindanao is clearly observed both in terms of DA regional offices and SCU research budgets. Luzon overall had the highest rate of RIRs, while in Visayas these are slightly above the average. Interesting is the fact that among the three broad geographic regions, the ranking of RIRs of DA regional office is consistent with the SCUs.

Research Expenditure by Type of Expenditure

The allocation of research budgets across personal services, (PS), maintenance and operating expenses (MOE) and capital outlays (CO) affects efficiency of agricultural research. Researchers and managers often raise the problem of limited budgets for MOE and capital outlay. This problem was exacerbated by the Salary Standardization Law which further increased the proportion of funding for salary support against the operational budgets. The consequence is the underutilization of manpower and physical infrastructure and the accelerated deterioration of physical facilities. Although some research agencies, such as the leading SCUs, may be relatively successful in generating external funds, it also means that their research agenda are driven by donors' priorities. Moreover, external funds tend to be more available for shorter-term projects, whereas many technological, institutional, and policy problems would require long-term research.

Tables 17 to 19 indicate the distribution of direct budgetary allocations by expenditure categories of the various research agencies. It is clear that expenditures for personal salaries on the average tend to be disproportionately high (58%), while MOE is about 36%, and capital outlay only 6%. In agricultural research systems in more developed countries where salary rates are much higher, the distribution of expenditures is 40% (PS), 40% (MOE), and 20% (CO). While such a distribution may differ depending on the type of research or activity being undertaken by a research agency, the overly high share of personal salaries may reflect overstaffing, bureaucratic rigidities, and poor planning.

The shares of PS are generally high (at least 50%) in all the research agencies. In several commodity research agencies and SCUs, these can be as high as 70-80%. An exception is PhilRice where the distribution of 40-50-10 which allows a more efficient utilization of its manpower and physical facilities. In addition, the relatively high share of core funds promotes a more systematic and long-term research planning.

The opposite extreme is the case of UPLB where the share of PS is 70%. Research projects even in its own research institutes and centers are primarily driven by priorities of external donors, which contribute about half of its research budget. Consequently, even though UPLB may have the best scientists and facilities in the country, effectiveness of research is constrained by uncertain and short-term nature of funding.

Characteristics of Manpower Resources

The availability and quality of manpower resources are among the key determinants of the productivity of the agricultural research system. Although the administrative and other support staff perform important functions, our analysis of manpower resources will focus on the research system's technical capability. Manpower profiles of the technical staff and/or faculty of the DA, DENR, DOST, and the 14 major SCU's involved in agriculture and natural resources research as of early 1998 were collected directly from the various units in these institutions. The profiles covered data on their gender, age, position titles, educational attainment (and universities from where degrees were obtained), and fields of expertise.

Several issues and problems were encountered in the compilation of this database. First, the classification of technical and non-technical personnel may not be consistent across agencies, but could not be readily corrected partly because of the great variety of position titles. Second, the technical manpower employed on a project or contractual basis may not be fully covered; in several cases, only the staff members occupying plantilla positions were reported. Finally, the choice of departments to be included in a number of the SCUs was based on subjective judgements and may be subject to question, particularly those outside the colleges of agriculture, fishery, and forestry. And once the unit or department within an SCU is chosen, all the technical staff has been automatically included, except when the field of expertise is clearly not relevant to agricultural research. For a number of SCUs, some time allocation data of faculty members were collected which became the basis for estimating full-time equivalent measures of research manpower resources in the SCUs.

Manpower by Academic Degree

Table 20 presents a summary of the number of technical manpower resources by gender and highest degree attained.[8] Except for the SCUs, the actual number of technical manpower reported is assumed to be their full-time equivalents (FTE). To derive the FTE of research inputs by the teaching faculty in SCUs, it is assumed that 20% of their time is allocated to research, regardless of degree obtained Technical staff of research centers/institutes within an SCU are assumed be full time in research. This is admittedly a very crude assumption based roughly on

[8]Appendix Table B1,... and other tables showing manpower profile for SCUs refer to actual counts of faculty in teaching departments without any adjustment for time allocation for research.

time allocation data from several of the relevant research and teaching departments at UPLB. But such crude estimates of FTE number would be a better measure of research manpower resources in the SCUs than a simple count of the faculty members. In the case of the MSI of the UP system, that time allocation for research is expected to be much higher since it offers only graduate programs.

The technical personnel of the DA comprise the highest number (2544) in FTE, constituting more than half of the total manpower resources in the whole agricultural research system. The 14 largest SCUs as a group has the second highest number (1131) accounting for about 25% of total, while the DENR and DOST's share are 11% and 7%, respectively. The number of staff reported for the SEAFDEC-AQD appears rather small, mainly because of the very low number of BS degree holders suggesting a difference in classification of technical vs non-technical staff at lower positions, or the possible preponderance of unreported contractual employees at the research assistant level.

Whereas the number of females among the technical manpower resources slightly exceed the males as a whole, in terms of academic qualifications, that pattern is true only among MS and BS holders. The DA as a whole, the ERDS and PAWB of DENR, and the FPRDI of DOST have the lowest share of Phd holders, ranging from 4% to 6%. Majority (65-75%) of their staff are BS degree holders, and some have not even completed any undergraduate degree. Interestingly, the highest proportion of technical staff with no BS degree is found in FPRDI (26%) under the DOST. MS holders constitute about 25% of the total technical manpower in these agencies. At the ERDB of DENR, the ratio of Phd and MS holders are somewhat higher, i.e., 13% and 30%, respectively. PCARRD and PCAMRD have higher proportions of staff with advanced degrees but these are still lower compared to the SCUs. About 13-16% of the staff have Phd degrees and 39% to 44% have Master's degrees.

The very low ratios of technical manpower resources with advanced degrees at the DA and DENR compare quite unfavorably with similar institutions of our Asian neighbors (Pardey and Roseboom 1989; Pardey et al 1992). In the Malaysian agricultural research system (excluding universities), 20% and 42% of agricultural researchers were already Phd and MS degree holders, respectively, way back in 1983.[9] By 1989, the research manpower of Indonesia's Agency for Agricultural Research and Development (AARD)under its Ministry of Agriculture consisted of 8% Phd holders and 21% MS holders. The Bangladesh national agricultural research system (excluding the university component) had an even higher ratio of Phd holders (11%) and MS holders (64%) way back in 1986. If we are making the comparison with the 1998 profile of their staff, the academic qualifications of our country's manpower resources for agricultural research outside the universities would even be much lower.

The distribution of technical manpower resources across the different agencies in the DA is shown in Table 21. Research units of the regional offices account for about half (1241) of the total. Among the bureaus and attached agencies, BPI (198) had the highest number of technical staff for research followed by SRA (153), PhilRice (147), and the PCC (103).

The greatest concentration of advanced degree holders are in the BSWM and the CRDI comprising 55% of the technical staff. Among the larger DA research agencies, PhilRice, PCC, PCA, and BPRE would also have relatively strong manpower resources in terms of educational qualifications.

The lowest ratio of Phd (2%) and MS (19%) holders are in the regional offices of the DA (and also of the DENR). Six (5) out of the 15 regional research offices of the DA (DENR) do not

[9]This consists of the Malaysian Agricultural Research and Development Institute (MARDI) plus the forestry, fisheries, palm oil, rubber, and veterinary research institutes.

have any Phd holders at all. Approximately 80% of the research staff at the DA regional centers and stations are BS and pre-BS degree holders. Among the bottom heavy (high share of BS holders) DA bureaus and attached agencies are FIDA (87%), SRA (77%), NFA (80%), BAI (78%), and BPI (75%).

While the SCUs may have the largest number of technical personnel for agricultural research and natural resources, many of them have heavy teaching and other responsibilities. Hence in full-time equivalents (FTE), total research manpower of the major SCUs is less than half that of the DA or about 25% of the total (Table 22).[10] The SCU's, however, uniformly have the highest proportion of staff with Phds, averaging close to 30%. They have on the average the highest ratio of staff (70%) with advanced degrees (Phd and MS holders), as BS holders account only for about 30% of total manpower resources.[11] Among all the Phd and MS holders working in the agricultural research system, nearly two-thirds and one-third, respectively, are located in SCUs; while they account for only 15% of BS holders.

The UP system, particularly the UP Los Banos, contributes about half of the SCU research manpower with advanced degrees and 40% of the SCU total. The number of full-time researchers with Phds at the UPLB's various research centers is 84 compared to 96 for the whole DA(see

[10]Note that all reference to the number of SCU staff in this section refer to their full-time equivalent in research.

[11]The researchers of the US State Agricultural Experiment Stations (SAES) which are integrated into the land grant universities had similar educational attainments, way back in 1925-1930. By 1980, 80% of the SAES have PhDs, 13% have MS degrees and only 7% are BS degree holders (Huffman and Evenson, 1991)

Table 23); and if the full time equivalent number of faculty members conducting research is included, the FTE number of Phd (145) is 50% higher than those at the DA. Other national multi-commodity R&D centers pale in comparison to the sheer size of human resources at the UPLB. VISCA is the second strongest in terms of manpower resources with 31 Phd holders (20 are full-time researchers) and 33 MS holders (23 are full-time); CLSU has 17 Phd holders (9 are full-time) and 16 MS holders; and USM has 10 Phd holders (only one full-time researcher) and 21 MS holders.

The distribution of technical research manpower by Phd and MS holders is in both UPLB (37% each) and VISCA (41-40% each). By contrast, the CLSU and USM have relatively larger ratios of manpower with MS degrees (43% and 57%, respectively) compared to those with Phds (30% and 28%, respectively).

Although DMMSU only has regional responsibilities, by the mid 1990s it had the highest research budget and number of technical personnel after UPLB. It is still second to VISCA in terms of number of Phd holders, but the number of MS holders is now higher.

Country Sources of Advanced Degrees

The university where the advanced degree was obtained reflects to a large extent the quality of graduate training received by a researcher. A Masters and Phd degrees are generally required to effectively undertake independent scientific agricultural research. Table 24 summarizes the number of technical manpower resources by local university or country source of Phd and Master’s degree obtained abroad. Advanced degrees earned from abroad are classified by country where the university is located to reduce the number of categories. It should be pointed out that the number of manpower shown for the SCUs refers to a simple count unadjusted for full time equivalence.

About 70% of advanced degrees of the research system's manpower resources were obtained locally. That ratio is lower (53%) for Phd degrees, and as high as 80% for Masters degrees. The UP system, principally the UPLB, is the single largest source of graduate training accounting for 35% of Phd holders and 45% of Master's holders. The contributions of other local universities are far lower. And except for the private Araneta University which is second only to UPLB as a source of PhD (and 7th in MS) and De La Salle University, all the other advanced degrees from the Philippines were mostly from other SCUs. For Phd, only CLSU, DMMSU, and BSU had shares ranging from 1.4% to 2.4%. While for MS degree, several others besides them such as USM, ISU, CMU, MMSU, CSSAC, and VISCA contributed from 1.1-3.9% of the total.

Approximately 43% of Phd degrees were obtained from foreign universities, slightly half of which were from the US (24%), followed by Japan (75), and then Australia (5%). Only about 11% of MS degree holders (as a final degree) studied abroad in Australia (2.7%), US (2.5%), UK (1.3%), and Thailand (1.5%), and elsewhere.

At the DA (see Table 25), relatively more Phd's than the average were obtained locally (57%) with UPLB again as the major source. Exceptions are PhilRice, PCA, PCC, and BPRE where the ratio of foreign Phd holders are relatively high ranging from 40%-100%. About 80% MS degrees of the technical R&D personnel of DA are largely obtained from local universities (Table 26). UPLB is again the major source of degrees followed by other UP units, USM, CLSU and Araneta University. Those who obtained their MS degrees locally are in such attached agencies as PhilRice, CRDI, NTA, SRA, and PCA. Of those in the staff bureaus, many of them are at BPI, BFAR, BAI and BPRE. The foreign graduates with MS degrees mostly from the USA and Australia are in the staff bureaus such as BFAR, BPRE, and BSWM and the attached agencies such as NIA, NFA, and PCA. As may be expected, MS degree holders employed at the regional offices obtain relatively more of their degrees from regional SCUs, rather than UPLB.

For the R&D personnel of DENR, a very large proportion of the Phds (81%) and MS (93%) degrees were obtained from local universities (Table 27). Again UPLB is the favorite university for obtaining Phds especially for ERDB staff (60%) and ERDS staff (40%). Phds from abroad were obtained from US and Canadian universities. At the PAWB, that there are no PhDs. Consistently, a very large proportion of MS degrees were obtained from UPLB and other UP units while Araneta university graduated 6.4%. Foreign graduates of MS degrees are mostly at ERDS and obtained their degrees from such countries as USA, Canada, Singapore, and Thailand.

The R&D personnel of DOST obtained their advanced degrees mostly from local universities especially UPLB (Table 28). Ninety percent of local Phds were from UPLB, 63% are at PCARRD, 16% at PCAMRD, and 21% at FPRDI. Phds from foreign universities were mainly from USA with very few from Japan and Australia. For MS degree holders, 82% obtained their degrees from UPLB most of whom are based at PCARRD and FPRDI. Foreign MS graduates obtained their degrees from USA, Australia, Malaysia, and Thailand. There are relatively more of them at PCARRD and FPRDI than at PCAMRD.

Table 29 gives the country sources of Phd degrees of manpower resources in SCUs. In general, more than half (52.2%) of Phds were obtained from local universities; nearly 60% of these degrees were obtained from UPLB. Of the technical staff at the research centers /institutes of UPLB who obtained their Phds locally, 90% got these from UPLB. Similarly, a significant proportion for Phds were obtained in their own backyard such as in DMMSU, CLSU, BSU, PSU, and BU.

The UP system units have the highest percentages of Phds obtained from abroad; UPLB 66%, UPV 100%, and UPMSI 84%. A very high proportion of these degrees were earned in the USA, Japan, and Australia. Among the other major SCUs, relatively larger proportions of Phds from foreign universities are found in VISCA (49%), CLSU (38%), CMU(26%), and BSU (26%), most of which are national R&D centers. Similar to UP, these foreign doctoral degrees were mostly obtained from universities in the USA, Japan, and Australia.

Compared to Phds, the MS degrees were predominantly (78%) obtained from local universities (Table 30). In-breeding, where SCU staff had their advanced degrees from the same university, while evident for PhDs is even more prevalent for MS degrees. For UPLB, 86% of local MS degrees were obtained from UPLB. At VISCA, this ratio is 24%; at CLSU, 56%; and at CMU, 32%. Among the regional centers, the percentages are as follows: MMSU 33, BSU 67, ISU 67, CSSAC 45, and CMU 32. The situation is similar in cooperating stations: DMMSU 50.6, PSU 40.6 and BU 38.5. Only 12 % of MS degrees were obtained from foreign universities. The relatively higher percentages are those based at CLSU, VISCA, CMU, and UPLB, again the national R&D centers. The country sources with relatively higher percentages of MS degrees were Australia, the USA, Thailand, and the UK.

For SEAFDEC-AQD, Phd degrees were obtained split between local and foreign universities. Only one female Phd obtained her degree from other UP units. Those obtained elsewhere were mainly from Japan with a few from the USA and Canada. In contrast, significant proportions of MS degrees were obtained locally (70.45) with 77.4% from other UP units. The MS degrees from foreign universities were mostly from Belgium and Japan.

Concluding Remarks

Public sector support for agricultural research is necessary for promoting technical change in agriculture and the preservation of the sustainability of our natural resources. Our analysis indicates, however, that agricultural research continues to be underfunded. Equally important, efficiency of public sector research funding has been significantly lowered by the misallocation of the limited budgetary resources, as well as by institutional weaknesses of the agricultural research system.

Allocation of research expenditures across commodities and regions have been highly incongruent to their relative economic importance measures in terms of gross value added contribution of the commodity. Relatively greater research budgets are provided to minor commodities such as cotton, silk, or carabao, and too litttle on major ones such as corn, coconut, fisheries and others. Mindanao regions are relatively neglected in terms of research budgets of the DA and SCUs compared to regions in Luzon and to a lesser extent to those in the Visayas. While congruency does not strictly coincide with optimal research resource allocation, the differences in researh intensity ratios observed among commodities and across regions cannot be explained by possible differences in cost of research (probability of research success, etc.), future mare\ket potential, nor of equity considerations.

The allocation of budgetary resources by type of expenditures affects the productivity of research. As often complained about, too little resources area available to perform research activities and to properly maintain the physical facilities, after the salaries of personnel have been paid. Indeed, the average share of personal services to diret budgetary outlays is close to 60% and as high as 70% to 80% in many cases. Consequently, either the research manpower is underutilized and or the researh agenda is driven by donor's priorities.

A broad examination of the work and financial plans and projects completed at a number of SCUs shows that except for a few major commodities, reserach projects are highly fragmented and short-term. There is no effective mechanism for coordinating the reserach findings and outputs for the benefit of future research, nor of linking these to the extension system for the benefit of the clientele. It is also obvious that the profile of research projects does not reflect a sense of problem - orientation.

The analysis of the manpower profile indicates that the problem is not in terms of number, but in the relatively low level of scientific qualification of the agriculture research system. With some few exceptions, the need to strengthen manpower capability is much more urgent in the DA and DENR research agencies. It should be emphasized that the quality of research manpower in the SCUs is not uniformly nor always significantly better. While the share of manpower with advanced degrees may be higher, the problem of in-breeding is worsening. Though a greater share of PhD degrees were obtained from abroad than MS degrees, this is still low relative to the importance of having our scientists, particularly those engaged in education, to be at the frontier of international knowledge. Finally, the wide gap in size and quality of manpower between UPLB and other major SCU's is not healthy. It leads to higher cost of manpower development, promotes in-breeding, limits competition, and lowers the effectiveness of the agricultural research system in general.

This paper argued that research resources must be allocated to maximize the net social benefits of these investments, consistent with the objective of achieving long-term efficeincy in agricultura research. At the operational level, such an economic framework of reserach planning may be applied only at the strategic level or resource allocation at the program area level. Within each commodity (or across-commodity) program area, research prioritization is best undertaken through extensive direct and indirect consultations with clients, among researchers knowledgeable about scientific potentials, and other professionals involved in agricultural development such as extension workers, private sector input and seed suppliers, and so forth.

As a start, a notional researh allocation across commodity program areas based on the congurence rule may be adopted. That allocation should be modified according to probability of scientific success, economies of scale and scope, future market potential, role of private sector research, etc. A notional allocation for cross-commodity reserach may also be determined based on observations from other more effective research systems. For example, 60-65% may be allocated for commodity-speficic reserach, while cross-commodity research such as natural resource management (soil, water, forest, pests) may be provided 10-12%, socio-economic, policy, and communications 12-15%, biotechnology and other basic research 15%.

Judging from existing research expenditure allocation and distribution of the number and quality of manpower resources, some major reallocations are called for, not only in terms of budgets, but also of manpower resources (see Tables 32 and 33 for estimates of relative economic importance of commodities at the national and regional levels). Furthermore, a significant part of the reserach budgets will also have to be allocated for the strengthening of manpower resources. Beyond these and equally important, a restructuring of the instituional framework -- organization, incentive system, etc. -- is necessary to raise efficiency and accountability of the research system. An effective monitoring and evaluation system at various levels of the research and development process will have to be instituted to promote better accountability and performance.

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Table 1. Average growth rates of agriculture gross value added and agricultural exports in selected South and Southeast Asia countries (%).

	1980-90		1990-96	1990-94
	Agricultural gross value added	Agricultural export	Agricultural gross value added	Agricultural export
Philippines	1.0	-4.6	1.7 [a]	5.9
Indonesia	4.9	4.7	4.4	11.9
Malaysia	3.8	3.1	1.9	9.9
Thailand	3.9	4.9	2.9	6.4
India	3.2	0.8	3.1 [b]	6.9
Pakistan	4.3	3.2	3.9	-7.5
Nepal	2.7	0.7	1.1	8.4 [c]
Bangladesh	1.9	-1.5	1.7	-5.9
Sri Lanka	2.1	0.03	1.8	-7.7

[a] Refers to 1990-1997

[b] Refers to 1990-1995

[c] Refers to 1990-1993

Note: End years are three year averages centered at year shown.

Source of basic data: ADB Key Indicators, various issues.

Table 2. Growth rates of gross value added (at constant prices) of palay, corn, coconut, sugar, banana, other crops, livestock and poultry, 1960-1996 (%).

	1980-1985	1985-1990	1990-1996
Palay	2.7	2.8	2.6
Corn	2.7	3.5	-1.2
Coconut	-0.8	-9.4	1.1
Sugar	-3.7	-1.5	1.1
Banana	-0.5	-5.2	0.3
Other crops	-2.9	5.1	2.1
Livestock	2.5	7.2	3.9
Poultry	1.3	10.4	6.8
Fishery	1.5	-0.7	1.3
Forestry	-6.6	-11.7	-29.2

Note: End years are three year averages centered at yar show.

Source of basic data: NSCB

Table 3. Trends in revealed comparative advantage in agriculture and selected major agricultural exports.[a]

	Agriculture[b]	Coconut	Sugar[c]	Banana	Pineapple (canned)
1980	2.9	224.1	12.1	30.4	82.2
1985	2.4	212.3	7.6	31.2	91.6
1990	1.5	210.8	3.8	23.3	69.7
1995	1.2	181.2	1.5	13.8	40.5

[a] Estimated as the ratio of the share of a commodity group in a country's exports to that commodity group's share of world exports.

[b] Includes fisheries.

[c] Note that sugar has been historically exported only to the US typically at a premium price (i.e., higher than the world prices). Hence a value greater than unity in this case does not reveal comparative advantage. However, the sharp declining trend may still be interpreted as a rapid deterioration in comparative advantage.

Except for 1995, all are 3-year averages centered at year shown.

Table 4. Growth rates of labor and land productivity of the crop sector (%).

	Labor	Land	
		Cultivated	Crop
1980-1985	-4.4	-2.0	-1.3
1985-1990	1.6	0.4	1.7
1990-1995	-0.5	0.2	2.0

Source: David (1998)

Table 5. Agricultural research intensity ratios of selected countries.

Country	RIR (%)	Reference year
Philippines	0.33	1992
Thailand	1.40	1992
Indonesia	0.27	1990
Malaysia	1.06	1992
China	0.43	1993
Taiwan	4.65	1992
Australia	3.54	1992
India	0.52	1990
Pakistan	0.47	1992
Bangladesh	0.25	1992
Sri Lanka	0.36	1993
South Korea	0.56	1993
Japan	3.36	1992
Developing countries	1.00	
Developed countries	2-3	

Source:

Philippines (this study)

Other countries: Pardey, P.G., J. Roseboom, and S. Fan (1997)

Table 6. Distribution of public expenditures for agricultures and natural resources by policy instruments, 1987-1994 (%).

	1987-94	1994
Agrarian Reform	26	24
Natural Resources and Environment	23	23
Agriculture	51	53
Irrigation (NIA)	12	8
Price stabilization (NFA)	9	13
Research	4	5
Extension	7	9
Coconut development	2	2
Livestock	1	2
Other	17	15

Source: David (1998)

Table 7. Summary of social rates of return to agricultural research, extension, and education (%).

	Core range	Full range
All public agricultural R & D	40-60	0-100
Basic public R & D	60-90	57-110
Private R & D	30-45	26-90
Agricultural extension	-	20-110
Farmer's schooling	30-45	15-83

- no evidence of a core range

Source: Evenson (1996)

Table 8. Public expenditures for research and development in agriculture and natural resources, gross value added in agriculture including fishery and forestry, and research intensity ratios (RIR), 1992-1996

	1992	1993	1994	1995	1996
1. Research expenditures (₱ million)[a]					
a. w/out SEAFDEC	800	853	1,065	1,290	1,554
	(1,027)	(1,121)	(1,400)	(1,638)	(1,919)
b. with SEAFDEC	881	958	1,184	1,434	1,707
	(1,228)	(1,248)	(1,540)	(1,815)	(2,114)
2. Gross value added (₱ million)	281,748	303,415	355,612	392,954	449,080
3. Research Intensity Ratio (%)					
1a/2	0.28	0.28	0.30	0.33	0.35
	(0.36)	(0.37)	(0.39)	(0.42)	(0.43)
1b/2	0.31	0.32	0.33	0.36	0.38
	(0.40)	(0.41)	(0.43)	(0.46)	(0.47)

Note: Refers to direct budgetary outlay. Figures in parenthesis refer to total research expenditure, including external grants from local and foreign sources.

Table 9. Public expenditures for research and development in agriculture, natural resources, and related environmental issues (in million pesos)

	1992	1993	1994	1995	1996	1997
DA[a]	459.74	464.27	651.59	758.84	913.90	na
	(500.84)	(524.46)	(695.59)	(841.89)	(1029.56)	(na)
DENR	68.98	78.60	109.69	120.80	149.33	213.97
	(84.79)	(92.76)	(123.29)	(132.87)	(160.54)	(218.30)
ERDB	23.03	21.04	15.65	15.58	21.78	64.16
	(32.35)	(29.96)	(24.15)	(22.85)	(31.78)	(65.97)
ERDS[b]	43.35	55.08	92.12	99.65	122.21	149.81
	(49.84)	(60.32)	(97.22)	(104.45)	(123.42)	(152.33)
PAWB	2.60	2.48	1.92	5.57	5.34	10.69
	(2.60)	(2.48)	(1.92)	(5.57)	(5.34)	(10.69)
DOST	81.25	100.52	103.01	153.08	180.13	228.42
	(149.62)	(159.79)	(187.96)	(216.72)	(276.71)	(378.49)
PCARRD	42.82	56.24	56.88	88.66	105.00	127.10
	(61.86)	(84.09)	(98.95)	(122.69)	(167.99)	(179.58)
PCAMRD	9.60	11.01	10.96	9.09	18.61	19.40
	(49.97)	(25.92)	(40.40)	(31.82)	(46.41)	(88.87)
FPRDI	28.83	33.27	35.16	55.33	56.53	81.93
	(37.79)	(49.78)	(48.61)	(62.21)	(62.31)	(110.04)
SCUs	189.57	209.42	200.88	257.72	309.68	331.71
	(291.63)	(343.66)	(392.80)	(446.11)	(452.01)	(495.68)
UP System	91.71	94.54	80.61	113.66	130.52	128.05
	(183.35)	(202.89)	(239.24)	(261.48)	(235.12)	(236.91)
UPLB	87.32	90.69	76.73	108.88	123.69	120.36
	(161.57)	(196.47)	(218.76)	(250.67)	(222.99)	(224.22)
UPMSI	3.70	3.70	3.15	3.97	5.67	5.79
	(na)	(na)	(na)	(na)	(na)	(na)
UPVISAYAS	0.69	0.15	0.73	0.82	1.17	1.90
	(18.08)	(2.72)	(17.33)	(6.84)	(6.46)	(6.90)
Other major universities[c]	81.98	95.88	95.53	112.57	142.97	165.84
	(92.40)	(121.78)	(128.82)	(153.14)	(180.70)	(220.95)
Other universities	15.88 *	18.99 *	24.74 *	31.49 *	36.19 *	37.82 *
	(na)	(na)	(na)	(na)	(na)	(na)
SEAFDEC	81.25	104.72	118.75	143.25	153.48	185.27
	(100.84)	(127.46)	(140.29)	(177.18)	(194.82)	(213.00)
Total w/out SEAFDEC	**799.54**	**852.81**	**1,065.17**	**1,290.44**	**1,553.04**	**na**
	(985.78)	**(1,060.48)**	**(1,355.64)**	**(1,554.54)**	**(1,918.82)**	**(na)**
Total with SEAFDEC	**880.79**	**957.53**	**1,183.92**	**1,433.69**	**1,706.52**	**na**
	(1,086.62)	**(1,187.94)**	**(1,495.93)**	**(1,731.72)**	**(2,113.64)**	**(na)**

[a] See Tables 2 & 3 for details.

[b] See Table 5 for details.

[c] See Table 9 for details.

* Refers to GAA, otherwise, it is the actual expenditure.

Note :

The numbers in parenthesis include external grants.
na = not available

Table 10. Public expenditures for research and development of the Department of Agriculture by agency (in million pesos)

	1992	1993	1994	1995	1996	1997
Regional Offices	**211.50**	**192.80**	**225.47**	**257.34**	**286.22**	**na**
	(234.26)	**(204.12)**	**(242.19)**	**(268.26)**	**(304.39)**	**(na)**
Staff Bureaus	**78.58**	**65.64**	**94.06**	**101.79**	**123.43**	**na**
	(80.16)	**(96.54)**	**(105.38)**	**(118.63)**	**(142.95)**	**(na)**
BAR	10.79 [a]	11.37 [a]	14.68 [a]	17.18 [a]	18.55 [a]	na
BAI	8.24	7.59	7.13	8.69	7.82	5.30
	(8.24)	(7.59)	(7.44)	(9.28)	(8.60)	(5.30)
BFAR	5.80	5.03	7.36	8.68	16.37	20.69
	(5.80)	(5.03)	(7.56)	(8.82)	(17.46)	(24.62)
BPI	17.40	17.40	32.97	33.02	44.27	47.57
	(17.40)	(17.40)	(32.97)	(33.02)	(44.27)	(47.57)
BSWM	5.59	2.96	8.41	2.93	2.93	14.45
	(5.70)	(3.16)	(8.62)	(3.04)	(4.19)	(14.88)
BPRE	30.76	21.29	23.51	31.29	33.49	44.80
	(32.23)	(51.99)	(34.11)	(47.29)	(49.88)	(na)
Attached Agencies	**179.36**	**214.42**	**336.78**	**405.22**	**513.19**	**532.20**
	(186.41)	**(223.80)**	**(348.03)**	**(455.00)**	**(581.22)**	**(na)**
FIDA	6.31	9.05	11.40	16.31	17.76	22.94
	(6.31)	(12.54)	(14.12)	(20.14)	(20.73)	(na)
NTA	17.73	16.95	17.62	16.07	18.47	36.29
	(17.73)	(16.95)	(17.62)	(16.07)	(18.47)	(36.29)
PCA	28.56	32.99	38.72	45.71	54.23	59.00
	(30.59)	(34.94)	(44.06)	(55.10)	(70.37)	(na)
PHILRICE	56.99	68.67	136.41	108.06	131.50	176.92
	(61.89)	(72.49)	(139.42)	(143.88)	(179.41)	(na)
SRA[b]	42.40	45.69	47.55	50.57	63.73	73.72
	(42.40)	(45.69)	(47.55)	(50.57)	(63.73)	(74.72)
PCC[c]	-	13.43	52.84	123.23	181.90	104.20
	-	(13.43)	(52.84)	(123.23)	(181.90)	(104.20)
NIA	6.64	4.64	6.59	7.36	8.41	8.50
	(6.76)	(4.76)	(6.72)	(7.96)	(9.01)	(9.10)
NFA	5.93	4.63	5.67	14.14	11.96	17.82
	(5.93)	(4.63)	(5.71)	(14.25)	(11.99)	(18.69)
CRDI	14.80	18.37	19.99	23.77	25.23	32.81
	(14.80)	(18.37)	(19.99)	(23.80)	(25.61)	(34.55)
Total	**469.44**	**472.86**	**656.32**	**764.34**	**922.84**	**na**
	(500.84)	**(524.46)**	**(695.59)**	**(841.89)**	**(1028.56)**	**(na)**

[a] Figures cannot be broken down into regular funds and external grants.
[b] Includes Industrial R&D Department expenditure.
[c] Established only in 1993.
Source: Forms submitted by individual agencies and bureaus.

Table 11. Public expenditures for research and development in agriculture, natural resources, and fishery by other major universities (in million pesos).

SCUs	1992	1993	1994	1995	1996	1997
DMMMSU	12.36	14.45	12.47	18.10	28.25	34.94
	(12.43)	(15.43)	(13.48)	(19.37)	(32.00)	(36.19)
VISCA	17.33 *	19.93	19.25	19.54	23.81	24.18
	(28.42)	(29.70)	(26.30)	(27.99)	(31.31)	(33.79)
MSU	11.93 *	10.32 *	12.32 *	11.12 *	17.22 *	20.89 *
	(na)	(na)	(na)	(na)	(na)	(na)
CLSU	6.61 *	10.64	12.18	14.21	14.64	17.49
	(8.57)	(13.33)	(14.57)	(21.85)	(17.09)	(22.84)
BSU	5.69 *	5.96	6.99	10.48	11.54	14.30
	(na)	(8.86)	(10.14)	(14.65)	(19.12)	(23.01)
MMSU	6.77	8.17	6.49	10.01	12.19	13.50
	(na)	(11.18)	(12.11)	(14.98)	(20.27)	(27.52)
USM	9.29	13.12	8.62	8.62	9.41	9.85
	(11.45)	(16.04)	(14.39)	(12.88)	(13.34)	(16.66)
PSU	3.31 *	3.36 *	2.97	4.53	7.47	8.51
	(na)	(na)	(na)	(na)	(na)	(12.34)
DSAC	1.89	2.00	3.52	4.86	6.09	8.35
	(na)	(2.23)	(3.71)	(4.96)	(7.21)	(8.81)
ISU	2.95	3.40	3.14	3.86	3.74	4.10
	(3.77)	(5.44)	(10.72)	(12.12)	(na)	(na)
BU	1.57	1.74	2.16	3.44	3.68	3.69
	(1.57)	(1.74)	(2.48)	(3.80)	(6.91)	(7.75)
CMU	1.00	1.25	2.95	2.14	3.12	3.60
	(na)	(na)	(na)	(na)	(na)	(na)
CSSAC	1.29	1.55	2.48	1.66	1.82	2.44
	(1.29)	(2.90)	(2.67)	(2.76)	(1.90)	(3.46)
Total	**81.98**	**95.88**	**95.53**	**112.57**	**142.97**	**165.84**
	(92.40)	**(121.78)**	**(128.82)**	**(153.14)**	**(180.70)**	**(220.95)**

*Based on GAA, otherwise, it is the actual expenditure.

Note:

Figures in parenthesis include external grants.

na = not available

Table 12. Growth rate of real public expenditures for research and development in agriculture, natural resources, and related environmental issues, (%).[a]

	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	Average 1992-1997
DA[a]	-5.09	27.08	8.35	10.53	na	10.22 [b]
	(-1.58)	(20.09)	(12.60)	(12.16)		(10.82)
DENR	7.09	26.36	2.46	13.38	34.87	16.83
	(2.82)	(20.35)	(0.26)	(10.81)	(27.99)	(12.45)
ERDB	-14.14	-32.65	-7.38	28.21	177.27	30.26
	(-12.96)	(-27.01)	(-11.97)	(-27.56)	(-95.39)	(14.20)
ERDS[b]	19.42	51.44	0.64	12.48	15.38	19.87
	(13.75)	(45.94)	(-0.05)	(8.37)	(16.17)	(16.84)
PAWB	-10.35	-29.90	169.90	-12.07	88.43	41.20
	(-10.35)	(-29.90)	(169.90)	(_12.07)	(88.43)	(41.20)
DOST	16.29	-7.21	38.25	7.92	19.36	14.92
	(0.37)	(6.51)	(7.27)	(17.10)	(28.75)	(12.00)
PCARRD	23.44	-8.41	45.00	8.62	13.94	16.52
	(27.76)	(6.55)	(15.35)	(25.58)	(0.62)	(15.17)
PCAMRD	7.86	-9.87	-22.81	87.63	-1.88	12.19
	(-51.25)	(41.13)	(-26.72)	(33.77)	(80.24)	(15.43)
FPRDI	8.47	-4.31	46.38	-6.30	36.42	16.13
	(23.81)	(-11.58)	(19.06)	(-8.14)	(66.23)	(17.87)
SCUs	3.82	-13.14	19.36	10.21	0.82	4.21
	(10.75)	(3.50)	(5.66)	(-7.07)	(3.22)	(3.21)
UP System	-3.11	-22.80	31.18	5.32	-7.66	0.59
	(4.00)	(6.77)	(1.68)	(-17.53)	(-5.16)	(-2.05)
UPLB	-2.38	-23.39	32.01	4.19	-8.41	0.40
	(14.29)	(0.82)	(6.60)	(-18.41)	(-5.36)	(-0.41)
UPMSI	-6.07	-22.86	17.06	31.05	-3.85	3.07
UPVISAYAS	-79.52	338.89	4.39	31.20	53.03	69.60
	(85.86)	(476.91)	(-63.28)	(-13.38)	(-0.54)	(62.98)
Other major universities	9.92	-9.79	9.63	16.48	9.18	7.09
	(23.87)	(-4.22)	(10.60)	(8.22)	(15.09)	(10.71)
Other universities	12.39	17.96	18.42	5.40	-1.64	10.51
SEAFDEC	21.13	2.68	12.23	-1.74	13.62	9.59
	918.80)	(-0.34)	(17.50)	(0.85)	(2.91)	(7.94)
Total w/out SEAFDEC	0.25	13.10	12.71	10.42	na	9.12 [b]
	(2.57)	(13.09)	(8.85)	(7.47)		(7.99)
Total with SEAFDEC	2.18	11.96	12.66	9.21	na	9.00 [b]
	(4.02)	(11.72)	(9.64)	(6.82)		(8.05)

[a] Based on Table ____.

[b] Refers to average annual growth rate from 1992-1997.

Table 13. Growth rate of public expenditures for research and development of the Department of Agriculture by agency (%).

	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	Average 1992-1997
Regional Offices	**-14.33**	**5.89**	**6.18**	**2.01**		**-0.06** [b]
	(-18.11)	**(7.43)**	**(3.05)**	**(4.07)**		**(-0.89)** [b]
Staff Bureaus	**-21.49**	**29.75**	**0.68**	**11.21**		**5.04**
	(13.19)	**(-1.16)**	**(4.73)**	**(10.52)**		**(6.82)**
BAR	-0.96	16.91	8.88	-0.97		5.96
BAI	-13.43	-14.94	13.39	-17.47	-36.21	-13.73
	(-13.43)	(-11.24)	(16.04)	(-15.01)	(-41.99)	(-13.13)
BFAR	-18.49	32.49	9.72	72.97	18.96	24.17
	(-18.49)	(36.09)	(8.54)	(81.56)	(32.73)	(26.92)
BPI	-6.01	71.57	-6.82	22.96	1.14	16.57
	(-6.01)	(71.57)	(-6.82)	(22.96)	(1.14)	(16.57)
BSWM	-50.23	157.27	-67.59	-8.29	364.34	79.10
	(-47.90)	(147.00)	(-67.19)	(26.41)	(234.27)	(58.52)
BPRE	-34.94	-0.02	23.82	-1.84	25.91	2.59
	(51.61)	(-40.59)	(28.98)	(-3.26)		(9.18)
Attached Agencies	12.36	42.22	11.94	16.15	-2.39	16.06
	(12.84)	(40.81)	(21.63)	(17.16)		(23.11)
FIDA	34.80	14.06	33.10	-0.13	21.58	20.68
	(86.78)	(1.96)	(32.70)	(-5.60)		(28.96)
NTA	-10.15	-5.87	-15.15	5.41	84.94	11.84
	(-10.14)	(-5.87)	(-15.15)	(5.41)	(84.94)	(11.84)
PCA	8.56	6.27	9.83	8.81	2.40	7.18
	(7.35)	(14.18)	(16.35)	(17.13)		(13.75)
PHILRICE	13.24	79.87	-26.30	11.61	26.64	21.01
	(10.08)	(74.14)	(-3.99)	(14.36)		(23.65)
SRA[b]	1.28	-5.77	-1.05	15.59	8.87	3.78
	(1.28)	(-5.77)	(-1.05)	(15.59)	(10.35)	(4.08)
PCC[c]		256.26	116.97	35.38	-46.08	90.63
		(256.26)	(116.97)	(35.38)	(-46.08)	(90.63)
NIA	-34.32	28.60	3.90	4.80	-4.87	-0.377
	(-33.82)	(27.83)	(10.20)	(3.81)	(-4.94)	(0.62)
NFA	-26.62	10.89	132.01	-22.43	40.25	26.82
	(-26.62)	(11.67)	(132.18)	(-22.83)	(46.72)	(28.22)
CRDI	16.66	-1.47	10.63	-2.65	22.39	9.11
	(16.64)	(-1.45)	(10.74)	(-1.30)	(26.97)	(10.32)
Total	**-5.33**	**25.68**	**8.35**	**10.73**		**9.86**
	(-1.58)	**(20.09)**	**(12.60)**	**(12.05)**		**(10.79)**

b

c

Table 14. Growth rate on public expenditures in research and development in agriculture, natural resources and fishery by other major universities (%).

SCUs	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1992-1997
DMMMSU	9.87	-21.86	35.12	43.09	16.42	16.53
	(16.69)	(-20.89)	(33.65)	(51.52)	(6.45)	(17.48)
VISCA	8.1	-12.58	-5.54	11.75	-4.39	-0.53
	(-1.78)	(-19.82)	(-0.99)	(2.59)	(1.58)	(-3.68)
MSU	-18.7	8.1	-16.03	42.03	14.18	5.92 *
CLSU	51.24	3.69	8.54	-5.52	12.47	14.08
	(46.20)	(-1.04)	(39.49)	(28.26)	(25.80)	(16.44)
BSU	-1.55	6.21	39.46	0.96	16.68	12.35
		(3.65)	(34.39)	(19.75)	(13.22)	(17.75)
MMSU	13.44	-28.07	43.46	11.71	4.21	8.95
		(-1.92)	(15.08)	(24.10)	(27.79)	(16.26)
USM	32.73	-40.53	-6.92	0.13	-1.51	-3.22
	(31.62)	(-18.72)	(-16.77)	(-4.99)	(17.55)	(1.74)
PSU	-4.59	-19.96	41.9	51.24	7.23	15.16
DSAC	-0.54	59.36	28.45	14.93	29.05	26.25
		(50.64)	(24.38)	(33.32)	(15.01)	(30.84)
ISU	8.49	-16.38	14.37	-11.14	3.18	-0.294
	(35.62)	(78.43)	(5.18)			(39.74)
BU	4.16	12.4	48.17	-1.89	-5.62	11.45
	(4.16)	(29.06)	(42.55)	(66.78)	(5.57)	(29.62)
CMU	17.48	113.69	-32.51	33.71	8.61	28.20
CSSAC	12.93	44.88	-37.73	0.55	26.19	9.36
	(111.29)	(-16.63)	(-3.83)	(-36.86)	(71.41)	(25.07)
Total	**9.92**	**-9.79**	**9.63**	**16.48**	**9.18**	**7.09**
	(23.87)	**(-4.22)**	**(10.60)**	**(8.22)**	**(15.09)**	**10.71**

Note:
Figures in parenthesis include external grants.

Table 15. Indicative estimates of research intensity ratio by commodity 1994-1996 (%)

	RIR
Overall (excl. SEAFDEC)	0.41
(incl. SEAFDEC)	0.45
Rice	0.25
Corn	0.05
Sugar	0.5
Coconut	0.3
Fiber crops	2.5-3.0
Cotton or silk	25
Abaca	1
Tobacco	1.1
Livestock	0.15
Carabao	3.6
Other livestock	0.02
Fishery (excl. SEAFDEC)	0.12
(incl. SEAFDEC)	0.35
Forestry	3.5

Table 16. Distribution of agriculture-related research & development expenditures and gross value added in added in agriculture, 1994-96 (P million).

	R&D Expenditure			GVA[a]	Research Intensity Ratio[c] (%)		
	Total	DA Reg. Offices	SCUs		Total	DA Reg. Offices	SCUs
Luzon	**497.75**	**151.91**	**346**	**183,049**	**0.272**	**0.083**	**0.189**
Luzon w/o Southern Tagalog	**228.34**	**128.13**	**100.21**	**108,700**	**0.210**	**0.118**	**0.092**
CAR	20.76	4.74	16.02	7,532	0.276	0.063	0.213
I. Ilocos	62.89	19.15	43.74	22,616	0.278	0.085	0.193
II. Cagayan Valley	59.83	50.44	9.39	20,287	0.295	0.249	0.046
III. Central Luzon	37.43	13.21	24.22	38,286	0.098	0.035	0.063
IV. Southern Tagalog[b]	269.41	23.78	245.63	74,349	0.362	0.032	0.330
V. Bicol	47.43	40.59	6.84	19,979	0.237	0.203	0.034
Visayas	**115.97**	**69.45**	**46.52**	**77,634**	**0.149**	**0.089**	**0.060**
VI. Western Visayas	31.32	18.36	12.96	43,459	0.072	0.042	0.030
VII. Central Visayas	33.82	33.06	0.76	18,198	0.186	0.182	0.004
VIII. Eastern Visayas	50.83	18.03	32.80	15,977	0.318	0.113	0.205
Mindanao	**84.72**	**51.50**	**33**	**135,463**	**0.063**	**0.038**	**0.025**
IX. Western Mindanao	20.29	17.93	2.36	25,631	0.079	0.070	0.009
X. Northern Mindanao	12.91	10.17	2.74	34,526	0.037	0.029	0.008
XI. Southern Mindanao	10.99	9.96	1.03	48,448	0.023	0.021	0.002
XII. Central Mindanao	31.52	4.43	27.09	17,188	0.183	0.026	0.158
CARAGA	3.72	3.72	-	-	-	-	-
ARMM	5.29	5.29	-	9,670	0.055	0.055	-
Total	**696.64**	**271.61**	**425.03**	**396,146**	**0.176**	**0.069**	**0.107**
Total w/o Southern Tagalog	**429.03**	**249.08**	**179.95**	**321,797**	**0.422**	**0.245**	**0.177**

[a] Includes crops, livestock and fisheries.

[b] Includes UPLB and UPMSI.

[c] Research Intensity Ratio = R&D Expenditure/GVA X 100.

Table 17. Distribution of average direct budgetary support for agriculture & natural resources research & development across agencies, 1992-1996, (%).

	PS	MOOE	CO	Total
DA	56	36	8	100
DENR	63	32	6	100
ERDB	90	10	-	100
ERDS	65	28	7	100
PAWB	-	100	-	100
DOST	50	42	8	100
PCARRD	41	56	2	100
PCAMRD	38	58	3	100
FPRDI	60	24	17	100
SCUs	64	36	-	100
UPLB	71	29	-	100
UPVISAYAS	39	50	11	100
UPMSI	59	41	-	100
Others	56	44	-	100
SEAFDEC	70	25	6	100
Total	**58**	**36**	**6**	**100**

Table 18. Distribution of average direct budgetary support for agriculture & natural resources research & development across DA, 1992-1996, (%).

	PS	MOOE	CO	Total
Regional Offices	**67**	**33**	**-**	**100**
Staff Bureaus	**53**	**47**	**-**	**100**
BAR	35	65	-	100
BAI	57	43	-	100
BFAR	49	51	-	100
BPI	59	41	-	100
BPRE	59	41	-	100
BSWM	35	65	-	100
Attached Agencies	**49**	**35**	**15**	**100**
CRDI	70	23	7	100
FIDA	69	31	-	100
NFA	76	12	11	100
NIA	72	28	-	100
NTA	75	25	-	100
PCC	17	35	48	100
PCA	62	36	2	100
PHILRICE	40	50	10	100
SRA	66	30	5	100
DA	**56**	**36**	**8**	**100**

Table 19. Distribution of average direct budgetary support for agriculture & natural resources research & development across SCUs, 1992-1996, (%).

	PS	MOOE	CO	Total
SCU	64	36	-	100
UPLB	71	29	-	100
UPVISAYAS	39	50	11	100
UPMSI	59	41	-	100
DMMSU	61	39	-	100
MMSU	65	35	-	100
PSU	88	9	3	100
BSU	91	9	-	100
CLSU	54	46	-	100
DSAC (CvSU)				
VISCA	58	42	-	100
USM	9	91	-	100
MSU NAAWAN	83	17	-	100
BU	53	47	-	100
CSSAC	45	53	2	100
CMU	78	22	-	100
ISU	49	51	-	100

Table 20. Number (in FTE) of technical manpower in public agriculture and natural resources research and development by department, SCUs, and SEAFDEC by degree, 1998.

	PhD			MS			BS			Pre BS			Total		
	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Dept. of Agriculture[a]	64	32	96	295	304	599	814	942	1,756	71	22	93	1,244	1,300	2,544
Dept. of Env. & Nat'l Resrcs.	19	12	31	64	71	135	122	192	314	13	10	23	218	285	503
ERDB	11	8	19	15	29	44	22	56	78	1	2	3	49	95	144
ERDS[b]	8	4	12	46	39	85	90	95	185	12	8	20	156	146	302
PAWB	-	-	-	3	3	6	10	41	51	-	-	-	13	44	57
Dept. of Science & Tech.	17	16	33	33	79	112	63	92	155	31	12	43	144	199	343
PCARRD	9	11	20	16	44	60	25	50	75	-	-	-	50	105	155
PCAMRD	2	2	4	3	8	11	4	6	10	-	-	-	9	16	25
FPRDI	6	3	9	14	27	41	34	36	70	31	12	43	85	78	163
SCUs[c]	158	129	287	197	260	457	161	226	387	-	-	-	516	615	1,131
UPLB	75	70	145	75	113	188	43	86	129	-	-	-	193	269	462
UPV	3	1	4	3	3	6	1	2	3	-	-	-	7	6	13
UPMSI	2	2	4	-	-	-	1	4	5	-	-	-	3	6	9
Others[d]	78	56	134	119	144	263	116	134	250	-	-	-	313	334	647
SEAFDEC-AQD	7	14	21	16	28	44	3	1	4	-	-	-	26	43	69
Total	**265**	**203**	**468**	**605**	**742**	**1,347**	**1,163**	**1,453**	**2,616**	**115**	**44**	**159**	**2,148**	**2,442**	**4,590**

[a] See Table 21 and Appendix Table B4 for details by agency and by region.

[b] See Appendix Table B5 and for details by region.

[c] See Tables 22 and 23 for details. Data include those with both teaching and research responsibilities.

[d] Includes DMMMSU, VISCA, MSU, CLSU, MMSU, USM, BSU, PSU, ISU, CMU, DSAC, CSSAC & BU.

Table 21. Number (in FTE) of technical manpower in agriculture (including fishery) research and development in the Department of Agriculture by agency and degree, 1998.

	PhD			MS			BS			Pre BS			Total		
	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Bureaus	**18**	**7**	**25**	**64**	**78**	**142**	**116**	**228**	**344**	**5**	**3**	**8**	**203**	**316**	**519**
Agri. Research	1	-	1	8	6	14	6	11	17	-	-	-	15	17	32
Animal Industry	-	1	1	7	11	18	30	37	67	-	-	-	37	49	86
Fish. & Aqua. Resources	1	1	2	12	12	24	9	30	39	-	-	-	22	43	65
Plant Industry	3	3	6	11	31 [a]	42	39	105 [b]	144	4	2	6	57	141	198
Postharvest Res. & Ext.	5	1	6	14	8	22	26	26	52	-	1	1	45	36	81
Soils & Water Mgt.	8	1	9	12	10	22	6	19	25	1	-	1	27	30	57
Attached agencies	**37**	**16**	**53**	**124**	**112**	**236**	**193**	**268**	**461**	**25**	**9**	**34**	**379**	**405**	**784**
Cotton Res. & Devt. Inst.	7	4	11	26	14	40	27	17	44	-	-	-	60	35	95
Fiber Ind. Devt. Authority	-	1	1	3	6	9	34	31	65	19	5	24	56	43	99
Nat'l Food Authority	-	1	1	4	4	8	6	29	35	-	-	-	10	34	44
Nat'l Irrigation Admin.	-	-	-	9	-	9	5	4	9	-	-	-	14	4	18
Nat'l Tobacco Admin.	2	1	3	5	24	29	17	25	42	3	2	5	27	52	79
Phil. Carabao Center	10	1	11	17	13	30	37	21	58	3	1	4	67	36	103
Phil. Coconut Authority	2	1	3	17	12	29	4	10	14	-	-	-	23	23	46
Phil. Rice Res. Institute	11	5	16	29	25	54	37	39	76	-	1	1	77	70	147
Sugar Regulatory Admin.	5	2	7	14	14	28	26	92	118	-	-	-	45	108	153
Regional Offices[c]	9	9	18	107	114	221	505	446	951	41	10	51	662	579	1,241
Total	**64**	**32**	**96**	**295**	**304**	**599**	**814**	**942**	**1,756**	**71**	**22**	**93**	**1,244**	**1,300**	**2,544**

[a] 1 Agri. Center Chief III under BPI with no specified degree is included.
[b] 1 Chemist II under BPI whose degrees was not specified are included.
[c] See Appendix Table B4 for details by region.

Table 22. Number (in FTE) of technical manpower resources for agriculture and natural resources research and development in major SCUs by degree and gender, 1998.

	PhD			MS			BS			Total		
	M	F	All	M	F	All	M	F	All	M	F	All
UP System	80	73	153	78	116	194	45	92	137	203	281	484
UP Los Baños	75	70	145	75	113	188	43	86	129	193	269	462
UP Visayas	3	1	4	3	3	6	1	2	3	7	6	13
UP Marine Sci. Inst.	2	2	4	-	-	-	1	4	5	3	6	9
	78	56	134	119	144	263	- 116	134	250	- 313	334	647
Don Mariano Marcos MSU	8	10	18	14	26	40	26	31	57	48	67	115
Visayas State CA	21	10	31	17	16	33	6	9	15	44	35	79
Mindanao SU[a]	5	2	7	14	12	26	8	11	19	27	25	52
Central Luzon SU	12	5	17	13	13	26	10	11	21	35	29	64
Benguet SU	4	4	8	7	16	23	10	9	19	21	29	50
Mariano Marcos SU	2	4	6	10	13	23	14	18	32	26	35	61
U of Southern Mindanao	5	5	10	9	12	21	5	3	8	19	20	39
Pangasinan SU	2	3	5	5	5	10	8	7	15	15	15	30
Don Severino AC (now CvSU)	4	3	7	3	4	7	6	9	15	13	16	29
Isabela SU	7	2	9	9	9	18	13	14	27	29	25	54
Bicol U	2	4	6	5	6	11	6	6	12	13	16	29
Central Mindanao U	5	2	7	9	6	15	3	4	7	17	12	29
Camarines Sur SAC	1	2	3	4	6	10	1	2	3	6	10	16
Total	**158**	**129**	**287**	**197**	**260**	**457**	**161**	**226**	**387**	**516**	**615**	**1,131**

Table 23. Number (in FTE) of technical manpower resources for agriculture and natural resources research and development in major SCUs into research and research & teaching, 1998.

	PhD			MS			BS			Total		
	R	R & T	All	R	R & T	All	R	R & T	All	R	R & T	All
UP System	84	69	153	138	56	194	97	40	137	319	165	484
UP Los Baños[a]	84	61	145	138	50	188	97	32	129	319	143	462
UP Visayas	-	4	4	-	6	6	-	3	3	-	13	13
UP Marine Sci. Inst.	-	4	4	-	-	-	-	5	5	-	9	9
Don Mariano Marcos MSU	10	8	18	27	13	40	49	8	57	86	29	115
Visayas State CA	20	11	31	23	10	33	12	3	15	55	24	79
Mindanao SU[b]	4	3	7	17	9	26	10	9	19	31	21	52
Central Luzon SU	9	8	17	16	10	26	15	6	21	40	24	64
Benguet SU	1	7	8	16	7	23	13	6	19	30	20	50
Mariano Marcos SU[c]	2	4	6	12	11	23	25	7	32	39	22	61
U of Southern Mindanao	1	9	10	4	17	21	4	4	8	9	30	39
Pangasinan SU	-	5	5	-	10	10	9	6	15	9	21	30
Don Severino AC (now CvSU)[d]	-	7	7	1	6	7	13	2	15	14	15	29
Isabela SU	4	5	9	3	15	18	24	3	27	31	23	54
Bicol U	1	5	6	-	11	11	1	11	12	2	27	29
Central Mindanao U	-	7	7	-	15	15	-	7	7	-	29	29
Camarines Sur SAC	-	3	3	-	10	10	-	3	3	-	16	16
Total	**136**	**151**	**287**	**257**	**200**	**457**	**272**	**115**	**387**	**665**	**466**	**1,131**

[a] College of Agriculture Dean's Office is included under Research and Teaching.

[b] Includes Marawi and Naawan Campuses only.

[c] Extension Office is included under under Research.

[d] Office of the President is included under Research and Teaching.

Table 24. Country source of MS and PhD degrees of all technical manpower in agricultural and natural resources research and development.

	PhD	%	MS	%	Total	%
Philippines	**560**	52.78	**1,720**	80.19	**2,280**	71.12
UPLB	**343**	32.33	**798**	37.20	**1,141**	35.59
Araneta U	**31**	2.92	**52**	2.42	**83**	2.59
Other UP	**27**	2.54	**153**	7.13	**180**	5.61
CLSU	**26**	2.45	**83**	3.87	**109**	3.40
DMMMSU	**18**	1.70	**53**	2.47	**71**	2.21
BSU	**15**	1.41	**60**	2.80	**75**	2.34
UPLB*	**10**	0.94	**4**	0.19	**14**	0.44
PSU	**9**	0.85	**18**	0.84	**27**	0.84
USM	**6**	0.57	**77**	3.59	**83**	2.59
BU	**5**	0.47	**21**	0.98	**26**	0.81
ISU	**5**	0.47	**45**	2.10	**50**	1.56
De La Salle U	**5**	0.47	**9**	0.42	**14**	0.44
CMU	**4**	0.38	**33**	1.54	**37**	1.15
MMSU	**3**	0.28	**33**	1.54	**36**	1.12
Araneta U*	**2**	0.19	**-**	-	**2**	0.06
DMMMSU*	**1**	0.09	**-**	-	**1**	0.03
DSAC	**1**	0.09	**1**	0.05	**2**	0.06
UP System*	**-**	-	**1**	0.05	**1**	0.03
CSSAC	**-**	-	**24**	1.12	**24**	0.75
CSSAC*	**-**	-	**1**	0.05	**1**	0.03
MSU	**-**	-	**12**	0.56	**12**	0.37
CLSU*	**-**	-	**2**	0.09	**2**	0.06
VISCA	**-**	-	**38**	1.77	**38**	1.19
Others	**49**	4.62	**202**	9.42	**251**	7.83
Foreign	**460**	43.36	**243**	11.33	**703**	21.93
USA	**257**	24.22	**54**	2.52	**311**	9.70
Japan	**77**	7.26	**18**	0.84	**95**	2.96
Australia	**55**	5.18	**58**	2.70	**113**	3.52
UK	**19**	1.79	**27**	1.26	**46**	1.43
Canada	**14**	1.32	**6**	0.28	**20**	0.62
Germany	**10**	0.94	**3**	0.14	**13**	0.41
Belgium	**7**	0.66	**11**	0.51	**18**	0.56
New Zealand	**7**	0.66	**12**	0.56	**19**	0.59
Malaysia	**6**	0.57	**10**	0.47	**16**	0.50
Thailand	**2**	0.19	**32**	1.49	**34**	1.06
Hongkong	**1**	0.09	**1**	0.05	**2**	0.06
India	**1**	0.09	**-**	-	**1**	0.03
Ireland	**1**	0.09	**-**	-	**1**	0.03
Netherlands	**1**	0.09	**8**	0.37	**9**	0.28
Singapore	**1**	0.09	**1**	0.05	**2**	0.06
Sweden	**1**	0.09	**-**	-	**1**	0.03
Norway	**-**	-	**1**	0.05	**1**	0.03
Pakistan	**-**	-	**1**	0.05	**1**	0.03
Not indicated	**41**	3.86	**182**	8.48	**223**	6.96
Total	**1,061**	**100.00**	**2,145**	**100.00**	**3,206**	**100.00**

* With enhancement component from a foreign university.

Table 25. Country sources of PhD degree of technical manpower of the Department of Agriculture, 1998.

	Total DA	Regional Offices	Staff Bureaus						Attached Agencies								
			BAI	BAR	BFAR	BPI	BPRE	BSWM	CRDI	FIDA	NFA	NIA	NTA	PCA	PCC	Philrice	SRA
Philippines	**55**	**9**	**1**	**-**	**-**	**5**	**3**	**6**	**10**	**-**	**-**	**-**	**2**	**-**	**6**	**6**	**7**
UPLB	38	6	-	-	-	-	1	3	9	-	-	-	2	-	6	5	6
Other UP	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Araneta U	6	-	1	-	-	3	-	2	-	-	-	-	-	-	-	-	-
Araneta U*	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CLSU	3	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-
BSU	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
ISU	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Others	3	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
Foreign	**33**	**2**	**-**	**1**	**2**	**1**	**3**	**3**	**1**	**1**	**1**	**-**	**1**	**3**	**4**	**10**	**-**
USA	14	-	-	1	-	-	1	1	-	-	1	-	-	1	1	8	-
Japan	10	1	-	-	1	1	-	-	1	1	-	-	-	-	3	2	-
Australia	4	-	-	-	-	-	2	1	-	-	-	-	-	1	-	-	-
New Zealand	3	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-	-
UK	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Not Indicated	8	7	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Total	**96**	**18**	**1**	**1**	**2**	**6**	**6**	**9**	**11**	**1**	**1**	**-**	**3**	**3**	**11**	**16**	**7**

Table 26. Country sources of MS degree of technical manpower of the Department of Agriculture

	Total DA	Regional	Staff Bureaus						Attached Agencies								
		Offices	BAI	BAR	BFAR	BPI	BPRE	BSWM	CRDI	FIDA	NFA	NIA	NTA	PCA	PCC	Philrice	SRA
Philippines	**488**	**167**	**13**	**12**	**14**	**41**	**13**	**12**	**37**	**9**	**5**	**5**	**28**	**25**	**28**	**51**	**28**
UPLB	192	29	3	6	-	13	5	5	17	3	1	1	24	18	9	39	19
Other UP	31	5	1	4	6	-	-	2	1	-	2	-	1	4	-	3	2
USM	31	17	-	-	-	-	-	-	7	-	-	-	-	1	4	2	-
Araneta U	26	3	3	-	1	12	1	3	-	-	1	1	-	-	-	-	1
CLSU	26	4	-	-	2	-	6	-	4	-	-	3	-	-	4	3	-
CLSU*	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VISCA	13	12	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
MMSU	12	5	-	-	-	-	-	-	4	-	-	-	2	-	1	-	-
BSU	9	2	-	1	-	4	1	-	1	-	-	-	-	-	-	-	-
DMMMSU	9	6	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-
ISU	9	8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BU	5	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CMU	5	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-
MSU	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CSSAC	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PSU	2	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
DSAC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Others	107	59	5	1	4	12	-	2	-	6	1	-	1	1	5	4	6
Foreign	**58**	**6**	**5**	**2**	**10**	**1**	**9**	**9**	**1**	**-**	**3**	**4**	**1**	**3**	**2**	**2**	**-**
USA	6	1	-	-	2	-	-	-	-	-	-	2	-	-	-	1	-
Japan	7	1	-	-	1	-	1	-	-	-	-	-	1	-	2	1	-
Australia	12	1	1	-	-	-	6	3	-	-	1	-	-	-	-	-	-
UK	12	-	3	1	2	-	-	3	-	-	-	-	-	3	-	-	-
New Zealand	3	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-
Malaysia	4	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Thailand	8	3	-	-	-	-	2	1	-	-	-	2	-	-	-	-	-
Belgium	3	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-
Canada	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Germany	1	-	1		-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Not indicated	53	48	-	-	-	-	-	1	2	-	-	-	-	1	-	1	-
Total	**599**	**221**	**18**	**14**	**24**	**42**	**22**	**22**	**40**	**9**	**8**	**9**	**29**	**29**	**30**	**54**	**28**

Table 27. Country sources of PhD and MS degree of technical manpower at the Department of Environment and Natural Resources.

	PhD				MS			
	Total	ERDB	ERDS	PAWB	Total	ERDB	ERDS	PAWB
Philippines	**25**	**15**	**10**	**-**	**125**	**43**	**77**	**5**
UPLB	**22**	15	7	-	**77**	35	40	2
Other UP	**1**	-	1	-	**7**	2	2	3
CMU	**-**	-	-	-	**3**	-	3	-
PSU	**-**	-	-	-	**1**	-	1	-
USM	**-**	-	-	-	**2**	-	2	-
VISCA	**-**	-	-	-	**2**	-	2	-
Araneta U	**-**	-	-	-	**8**	2	6	-
Others	**2**	-	2	-	**25**	4	21	-
Foreign	**5**	**4**	**1**	**-**	**4**	**-**	**3**	**1**
USA	**4**	3	1	-	**2**	1	1	-
Canada	**1**	1	-	-	**1**	-	1	-
Australia	**-**	**-**	**-**	-	**1**	-	-	1
Singapore	**-**	-	-	-	**1**	-	1	-
Thailand	**-**	-	-	-	**1**	-	1	-
Not indicated	**1**	-	1	-	**4**	-	4	-
Total	**31**	**19**	**12**	**-**	**133**	**43**	**84**	**6**

Table 28. Country sources of PhD and MS degree of technical manpower at the Department of Science and Technology.

	PhD				MS			
	Total	PCARRD	PCAMRD	FPRDI	Total	PCARRD	PCAMRD	FPRDI
Philippines	**21**	**14**	**3**	**4**	**97**	**52**	**9**	**36**
UPLB	19	12	3	4	80	50	3	27
Other UP	2	2	-	-	6	1	5	-
CLSU	-	-	-	-	1	-	1	-
Araneta U	-	-	-	-	4	1	-	3
Others	-	-	-	-	6	-	-	6
Foreign	**12**	**6**	**1**	**5**	**14**	**7**	**2**	**5**
USA	8	5	1	2	3	1	1	1
Japan	2	-	-	2	1	1	-	-
Australia	1	1	-	-	2	2	-	-
UK	1	-	-	1	1	-	-	1
Canada	-	-	-		1	-	1	-
Malaysia	-	-	-	-	2	-	-	2
Netherlands	-	-	-	-	1	1	-	-
Norway	-	-	-	-	1	-	-	1
Thailand	-	-	-	-	2	2	-	-
Not indicated	-	-	-	-	1	1	-	-
Total	**33**	**20**	**4**	**9**	**112**	**60**	**11**	**41**

Table 29. Country sources of PhD degree of technical manpower in public agricultural and natural resources research in selected SCUs, 1997.

	Total	UPLB	UPV	UPMSI	DMMMSU	VISCA	MSU	CLSU	BSU
Philippines	**458**	**120**	**-**	**3**	**42**	**38**	**15**	**27**	**25**
UPLB	**264**	107	-	-	7	26	10	14	11
Araneta U	**25**	-	-	-	7	-	1	2	2
CLSU	**23**	-	-	-	1	-	-	10	-
Other UP	**22**	9	-	3	-	1	2	-	-
DMMMSU	**18**	-	-	-	18	-	-	-	-
BSU	**13**	-	-	-	3	-	-	-	10
UPLB*	**10**	1	-	-	-	8	-	-	-
PSU	**9**	-	-	-	-	-	-	-	-
USM	**6**	-	-	-	-	-	-	-	-
BU	**5**	-	-	-	-	-	-	-	-
De La Salle U	**5**	1	-	-	-	-	-	1	1
CMU	**4**	-	-	-	-	-	1	-	-
ISU	**4**	-	-	-	-	-	-	-	-
MMSU	**3**	-	-	-	-	-	-	-	-
DMMMSU*	**1**	-	-	-	1	-	-	-	-
DSAC	**1**	-	-	-	-	-	-	-	-
MSU	**1**	1	-	-	-	-	-	-	-
Others	**44**	1	-	-	5	3	1	-	1
Foreign	**390**	**254**	**22**	**16**	**5**	**39**	**3**	**18**	**9**
USA	**227**	170	9	8	-	23	-	9	2
Japan	**55**	31	6	-	3	5	1	2	1
Australia	**49**	31	-	5	1	2	-	3	2
UK	**16**	4	6	1	-	1	-	3	-
Canada	**10**	7	-	1	-	1	-	1	-
Germany	**10**	3	1	1	-	5	-	-	-
Belgium	**7**	-	-	-	-	-	2	-	4
Malaysia	**5**	1	-	-	-	1	-	-	-
New Zealand	**4**	1	-	-	-	1	-	-	-
Thailand	**2**	1	-	-	1	-	-	-	-
Hongkong	**1**	1	-	-	-	-	-	-	-
India	**1**	1	-	-	-	-	-	-	-
Ireland	**1**	1	-	-	-	-	-	-	-
Netherlands	**1**	1	-	-	-	-	-	-	-
Sweden	**1**	1	-	-	-	-	-	-	-
Not indicated	**32**	13	-	-	2	-	-	2	-
Total	**880**	**387**	**22**	**19**	**49**	**77**	**18**	**47**	**34**

* With enhancement or with second degree abroad.

Table 29. Country sources of PhD degree of technical manpower in public agricultural and natural resources research in selected SCUs, 1997.
con't

	MMSU	USM	PSU	DSAC	ISU	BU	CMU	CSSAC
Philippines	**19**	**35**	**24**	**29**	**27**	**16**	**25**	**13**
UPLB	11	19	4	17	13	-	17	8
Araneta U	-	-	3	4	4	-	-	2
CLSU	2	-	5	4	1	-	-	-
Other UP	2	2	-	-	-	-	3	-
DMMMSU	-	-	-	-	-	-	-	-
BSU	-	-	-	-	-	-	-	-
UPLB*	-	-	-	1	-	-	-	-
PSU	-	-	9	-	-	-	-	-
USM	-	6	-	-	-	-	-	-
BU	-	-	-	-	-	5	-	-
De La Salle U	1	-	-	-	1	-	-	-
CMU	-	-	-	-	-	-	3	-
ISU	-	-	-	-	4	-	-	-
MMSU	3	-	-	-	-	-	-	-
DMMMSU*	-	-	-	-	-	-	-	-
DSAC	-	-	-	1	-	-	-	-
MSU	-	-	-	-	-	-	-	-
Others	-	8	3	2	4	11	2	3
Foreign	**4**	**6**	**-**	**1**	**2**	**1**	**9**	**1**
USA	1	1	-	1	-	-	3	-
Japan	1	-	-	-	1	-	3	1
Australia	1	1	-	-	1	1	1	-
UK	1	-	-	-	-	-	-	-
Canada	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	1	-
Malaysia	-	2	-	-	-	-	1	-
New Zealand	-	2	-	-	-	-	-	-
Thailand	-	-	-	-	-	-	-	-
Hongkong	-	-	-	-	-	-	-	-
India	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-
Not included	-	3	-	3	-	9	-	-
Total	**23**	**44**	**24**	**33**	**29**	**26**	**34**	**14**

* With enhancement or with second degree abroad.

Table 30. Country sources of MS degree of technical manpower in SCUs involved in agricultural and natural research in selected SCUs, 1997.

	Total	UPLB	UPV	UPMSI	DMMMSU	VISCA	MSU	CLSU	BSU
Philippines	**979**	**269**	**17**	**1**	**85**	**56**	**57**	**52**	**46**
UPLB	**447**	230	1	-	8	38	16	13	9
Other UP	**85**	24	16	1	3	2	14	3	3
CLSU	**55**	-	-	-	6	-	5	29	1
BSU	**51**	-	-	-	12	-	-	-	31
DMMMSU	**44**	-	-	-	43	-	-	-	-
USM	**44**	-	-	-	-	-	-	-	-
ISU	**36**	-	-	-	-	-	-	-	-
CMU	**25**	-	-	-	-	-	3	-	-
VISCA	**23**	-	-	-	-	15	-	-	-
MMSU	**21**	-	-	-	-	-	-	-	-
CSSAC	**20**	-	-	-	-	-	-	-	-
BU	**16**	-	-	-	-	-	-	-	-
PSU	**15**	-	-	-	1	-	1	-	-
Araneta U	**14**	-	-	-	4	-	4	1	-
De La Salle U	**9**	2	-	-	2	-	1	1	-
MSU	**7**	1	-	-	-	-	6	-	-
UPLB*	**4**	2	-	-	1	1	-	-	-
CLSU*	**1**	-	-	-	-	-	-	1	-
CSSAC*	**1**	-	-	-	-	-	-	-	-
Others	**61**	10	-	-	5	-	7	4	2
Foreign	**152**	**60**	**11**	**1**	**3**	**15**	**7**	**15**	**3**
Australia	**43**	15	-	-	-	5	2	5	2
USA	**42**	24	5	1	-	3	-	2	-
Thailand	**20**	6	1	-	1	1	4	2	-
UK	**13**	3	3	-	1	1	-	3	-
New Zealand	**9**	1		-	-	3	1	-	-
Japan	**7**	4	1	-	1	-	-	1	-
Netherlands	**6**	3	-	-	-	-	-	-	-
Belgium	**3**	1	-	-	-	1	-	1	-
Malaysia	**3**	1	-	-	-	1	-	1	-
Canada	**2**	1	-	-	-	-	-	-	-
Germany	**2**	1	1	-	-	-	-	-	-
Hongkong	**1**	-	-	-	-	-	-	-	1
Pakistan	**1**	-	-	-	-	-	-	-	-
Not indicated	**124**	59	-	-	2	-	-	-	-
Total	**1,255**	**388**	**28**	**2**	**90**	**71**	**64**	**67**	**49**

* With enhancement or with second degree abroad.

Table 30. Country sources of MS degree of technical manpower in SCUs involved in agricultural and natural research in selected SCUs, 1997.

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	MMSU	USM	PSU	DSAC	ISU	BU	CMU	CSSAC
Philippines	**64**	**76**	**32**	**19**	**54**	**39**	**63**	**49**
UPLB	21	26	1	16	16	4	35	13
Other UP	6	-	4	-	-	4	4	1
CLSU	3	-	5	2	-	4	-	-
BSU	5	-	3	-	-	-	-	-
DMMMSU	1	-	-	-	-	-	-	-
USM	-	44	-	-	-	-	-	-
ISU	-	-	-	-	36	-	-	-
CMU	-	2	-	-	-	-	20	-
VISCA	-	-	-	-	-	5	-	3
MMSU	21	-	-	-	-	-	-	-
CSSAC	-	-	-	-	-	-	-	20
BU	-	-	-	-	-	15	-	1
PSU	-	-	13	-	-	-	-	-
Araneta U	1	-	-	-	-	-	-	4
De La Salle U	1	-	-	1	-	-	1	-
MSU	-	-	-	-	-	-	-	-
UPLB*	-	-	-	-	-	-	-	-
CLSU*	-	-	-	-	-	-	-	-
CSSAC*	-	-	-	-	-	-	-	1
Others	5	4	6	-	2	7	3	6
Foreign	**3**	**5**	**1**	**3**	**8**	**2**	**12**	**3**
Australia	1	4	-	-	3	1	3	2
USA	2	-	1	1	-	1	1	1
Thailand	-	-	-	-	1	-	4	-
UK	-	-	-	-	2	-	-	-
New Zealand	-	-	-	1	2	-	1	-
Japan	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	3	-
Belgium	-	-	-	-	-	-	-	-
Malaysia	-	-	-	-	-	-	-	-
Canada	-	-	-	1	-	-	-	-
Germany	-	-	-	-	-	-	-	-
Hongkong	-	-	-	-	-	-	-	-
Pakistan	-	1	-	-	-	-	-	-
Not indicated	-	8	15	8	17	14	1	-
Total	**67**	**89**	**48**	**30**	**79**	**55**	**76**	**52**

* With enhancement or with second degree abroad.

Table 31. Country sources of PhD and MS degree of technical manpower of the SEAFDEC-AQD.

	PhD			MS			Total		
	M	F	All	M	F	All	M	F	Total
Philippines	**-**	**1**	**1**	**9**	**22**	**31**	**9**	**23**	**32**
Other UP	-	1	1	8	16	24	8	17	25
UPLB	-	-	-	-	2	2	-	2	2
UP Systems*	-	-	-	-	1	1	-	1	1
CLSU	-	-	-	1	-	1	1	-	1
Others	-	-	-	-	3	3	-	3	3
Foreign	**7**	**13**	**20**	**7**	**6**	**13**	**14**	**19**	**33**
Japan	4	6	10	2	1	3	6	7	13
USA	2	2	4	-	1	1	2	3	5
Canada	1	2	3	1	-	1	2	2	4
Australia	-	1	1	-	-	-	-	1	1
Malaysia	-	1	1	-	1	1	-	2	2
Singapore	-	1	1	-	-	-	-	1	1
Belgium	-	-	-	4	1	5	4	1	5
Thailand	-	-	-	-	1	1	-	1	1
UK	-	-	-	-	1	1	-	1	1
Total	**7**	**14**	**21**	**16**	**28**	**44**	**23**	**42**	**65**

Table 32. Value of production of agriculture (crops, livestock, fishery) average of 1994 to 1996 (In million pesos)

	Value of production (₱ million)	% Share to subsector (1994-1996)	% Share to agriculture (1994-1996)
A. Crops	**233,246**	**100**	**53.5**
Rice	76,029	32.6	17.4
Corn	25,313	10.9	5.8
Coconut	23,738	10.2	5.4
Sugarcane	14,054	6.0	3.2
Banana	12,661	5.4	2.9
Other crops	**81,450**	**34.9**	**18.7**
Coffee	**5,974**	**2.6**	**1.4**
Cacao	**288**	**0.1**	**0.1**
Fruits	**32,037**	**13.7**	**7.4**
Pineapple	6,101	2.6	1.4
Mango	10,170	4.4	2.3
Citrus	1,726	0.7	0.4
Other fruits	14,040	6.0	3.2
Rootcrops & Tubers	**9,261**	**4.0**	**2.1**
Cassava	5,205	2.2	1.2
Camote	2,585	1.1	0.6
Other rootcrops	807	0.3	0.2
Tubers	664	0.3	0.2
Vegetables	**19,909**	**8.5**	**4.6**
Onion	1,176	0.5	0.3
Eggplant	1,098	0.5	0.3
Cabbage	835	0.4	0.2
Garlic	1,124	0.5	0.3
Tomato	856	0.4	0.2
Fruit-bearing vegetables	10,875	4.7	2.5
Leafy/Stem vegetables	3,946	1.7	0.9
Legumes	**1,369**	**0.6**	**0.3**
Peanut	478	0.2	0.1
Mongo	520	0.2	0.1
Other Legumes	371	0.2	0.1
Spices	**1,878**	**0.8**	**0.4**
Tobacco	**1,525**	**0.7**	**0.3**
Fibercrops	**2,089**	**0.9**	**0.5**
Abaca	1,411	0.6	0.3
Cotton	88	0.04	0.02
Other fibercrops	590	0.3	0.1
Rubber	**2,632**	**1.1**	**0.6**
Others	**4,489**	**1.9**	**1.0**
B. Livestock & Poultry	**120,321**	**100**	**27.6**
Livestock	**69,276**	**57.6**	**15.9**
Carabao	3,387	2.8	0.8
Cattle	9,159	7.6	2.1
Hog	54,164	45.0	12.4
Goat	2,468	2.1	0.6
Dairy	98	0.1	0.02
Poultry	**51,045**	**42.4**	**11.7**
Chicken	38,355	31.9	8.8
Duck	2,395	2.0	0.5
Chicken Eggs	8,470	7.0	1.9
Duck Eggs	1,825	1.5	0.4
C. Fishery	**82,137**	**100**	**18.9**
Commercial	22,778	27.7	5.2
Municipal	25,437	31.0	5.8
Aquaculture	33,921	41.3	7.8
Total	**435,704**		**100**

Table 33. Distribution of average gross value added in agriculture, fishery, & forestry by region, 1995-97 (In Million Pesos)

REGION	Philippines	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ARMM
Total	417,132 (100)	8,484 (100)	25,752 (100)	22,622 (100)	41,372 (100)	62,828 (100)	20,559 (100)	44,015 (100)	19,020 (100)	15,640 (100)	25,940 (100)	34,902 (100)	51,207 (100)	19,390 (100)	10,514 (100)
Crops	258,765 (62.0)	6,483 (76.4)	19,332 (75.1)	17,797 (78.7)	23,638 (57.1)	13,051 (20.8)	13,153 (64.0)	24,112 (54.8)	9,188 (48.3)	10,305 (65.9)	13,463 (51.9)	27,787 (79.6)	41,802 (81.6)	14,538 (75.0)	9,226 (87.7)
Palay	72,157 (17.3)	1,629 (19.2)	6,243 (24.2)	10,999 (48.6)	14,542 (35.2)	5,734 (9.1)	3,466 (16.9)	8,511 (19.3)	1,251 (6.6)	2,416 (15.4)	2,030 (7.8)	3,214 (9.2)	5,499 (10.7)	4,709 (24.3)	1,915 (18.2)
Corn	22,022 (5.3)	357 (4.2)	1,212 (4.7)	3,878 (17.1)	279 (0.7)	587 (0.9)	530 (2.6)	401 (0.9)	1,180 (6.2)	283 (1.8)	893 (3.4)	2,684 (7.7)	4,172 (8.1)	3,164 (16.3)	2,402 (22.8)
Coconut	24,561 (5.9)	14 (0.2)	783 (3.0)	273 (1.2)	88 (0.2)	4,251 (6.8)	1,209 (5.9)	1,022 (2.3)	843 (4.4)	1,966 (12.6)	2,048 (7.9)	1,505 (4.3)	8,420 (16.4)	741 (3.8)	1,399 (13.3)
Sugarcane	12,880 (3.1)	- -	22 (0.1)	411 (1.8)	843 (2.0)	1,587 (2.5)	213 (1.0)	6,835 (15.5)	2,080 (10.9)	447 (2.9)	2 (0.0)	130 (0.4)	137 (0.3)	281 (1.4)	- -
Banana	12,000 (2.9)	240 (2.8)	586 (2.3)	187 (0.8)	486 (1.2)	892 (1.4)	323 (1.6)	1,910 (4.3)	415 (2.2)	616 (3.9)	262 (1.0)	1,038 (3.0)	3,392 (6.6)	1,116 (5.8)	536 (5.1)
Other crops	115,144 (27.6)	4,243 (50.0)	10,487 (40.7)	2,050 (9.1)	7,399 (17.9)	14,996 (23.9)	7,412 (36.1)	5,433 (12.3)	3,418 (18.0)	4,578 (29.3)	8,227 (31.7)	19,217 (55.1)	20,183 (39.4)	4,526 (23.3)	2,975 (28.3)
Livestock & poultry	88,352 (21.2)	1,698 (20.0)	4,035 (15.7)	3,542 (15.7)	10,947 (26.5)	29,341 (46.7)	3,303 (16.1)	8,454 (19.2)	7,978 (41.9)	3,251 (20.8)	2,288 (8.8)	4,563 (13.1)	6,132 (12.0)	2,075 (10.7)	745 (7.1)
Livestock	55,819 (13.4)	1,228 (14.5)	2,854 (11.1)	2,868 (12.7)	5,744 (13.9)	16,505 (26.3)	2,608 (12.7)	5,526 (12.6)	5,448 (28.6)	2,416 (15.4)	1,630 (6.3)	3,511 (10.1)	3,413 (6.7)	1,560 (8.0)	508 (4.8)
Poultry	32,533 (7.8)	470 (5.5)	1,181 (4.6)	674 (3.0)	5,203 (12.6)	12,836 (20.4)	694 (3.4)	2,928 (6.7)	2,530 (13.3)	835 (5.3)	659 (2.5)	1,052 (3.0)	2,718 (5.3)	515 (2.7)	237 (2.3)
Fishery	66,170 (15.9)	20 (0.2)	2,384 (9.3)	626 (2.8)	6,786 (16.4)	19,658 (31.3)	4,103 (20.0)	11,449 (26.0)	1,854 (9.7)	2,084 (13.3)	9,833 (37.9)	2,343 (6.7)	3,169 (6.2)	1,650 (8.5)	210 (2.0)
Forestry	3,846 (0.9)	283 (3.3)	- -	656 (2.9)	- -	779 (1.2)	- -	- -	- -	- -	355 (1.4)	209 (0.6)	103 (0.2)	1,127 (5.8)	334 (3.2)