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ALLOCATION OF BUDGETARY RESOURCES IN AGRICULTURAL RESEARCH*

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ALLOCATION OF BUDGETARY RESOURCES IN AGRICULTURAL RESEARCH

The increasing cost of performing research and expanding it in developing countries has caused the agricultural leaders and other decision makers to ask more frequently, "what are we going to get from our investment"? Famous examples of pay-offs in agricultural research have been treated in other presentations during this workshop and there is a large number of case studies indicating that investment in research has higher pay-offs than most of the other investments.

Still there is no reasonably precise method of determining how much money should be invested in agricultural research in a given country to achieve a certain rate of growth of agricultural productivity corresponding to development strategy or rate of growth of a given country.

At the present time there are no known relationships between optimum allocation of research funds among various programs and projects and other single variables which can be used to divide the research budget with a sufficiently reliable degree of accuracy. Thus, the budgetary determination by top line officials in most cases is in a matter of tradition, following the allocations made in previous years[1/]. In other words, techniques like "zero base budgeting" have not been introduced to research and increamental budget procedures still dominate.

It has already been indicated that there is a general concensus that very little investments are made in agricultural research in nearly all developing countries[1/]. Still the decision makers of both developing and developed countries are not in a position to know what is the optimum level of investment in agricultural research.

1/ James K. Boyce and Robert Evenson, National and International Agricultural Research and Extension Programs, New York Agricultural Development Council, 1975, p. 17.

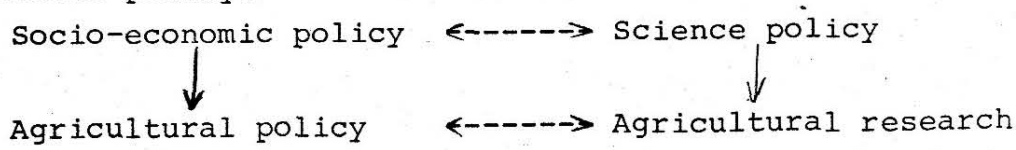
To permit penetration into complex issues and the accumulative building up of technology and knowledge, agricultural research organization require time. Furthermore, in order not only to have time but to feel secure in undertaking longer-range studies, multiple-year assurance of resources is necessary. Therefore agricultural research organization should at least for a part of its program enjoy budgetary security for three to five years at a stretch. Dependence on resource allocation by the policy makers as clients may be useful in order to assure sufficient efforts on the part of the institution to keep in contact with policymaking reality and try to make their studies salient to the need of policymaking.

It takes a period between 3 to 5 years and more between starting research and achieving certain economic impact at the same time, protection from short-range financial pressure is essential to achieve the necessary freedom of research, the required time perspective, and a suitable research climate.

Policy Considerations

Resource Allocation and budgetary decisions dealing with agricultural research can not be kept away from the various policies established by the government.

Ideally the system of relationships between agricultural research and the various policies should be as illustrated below. Agricultural policy appearing as a sub-system of socio-economic policy.



In view of the increasing interdependence between agriculture and other national economics and the relative scarcity of resources to meet future needs for food and other products and services, a closer integration of science policy, agricultural policy and agricultural research is essential to development of better national and international public policies.

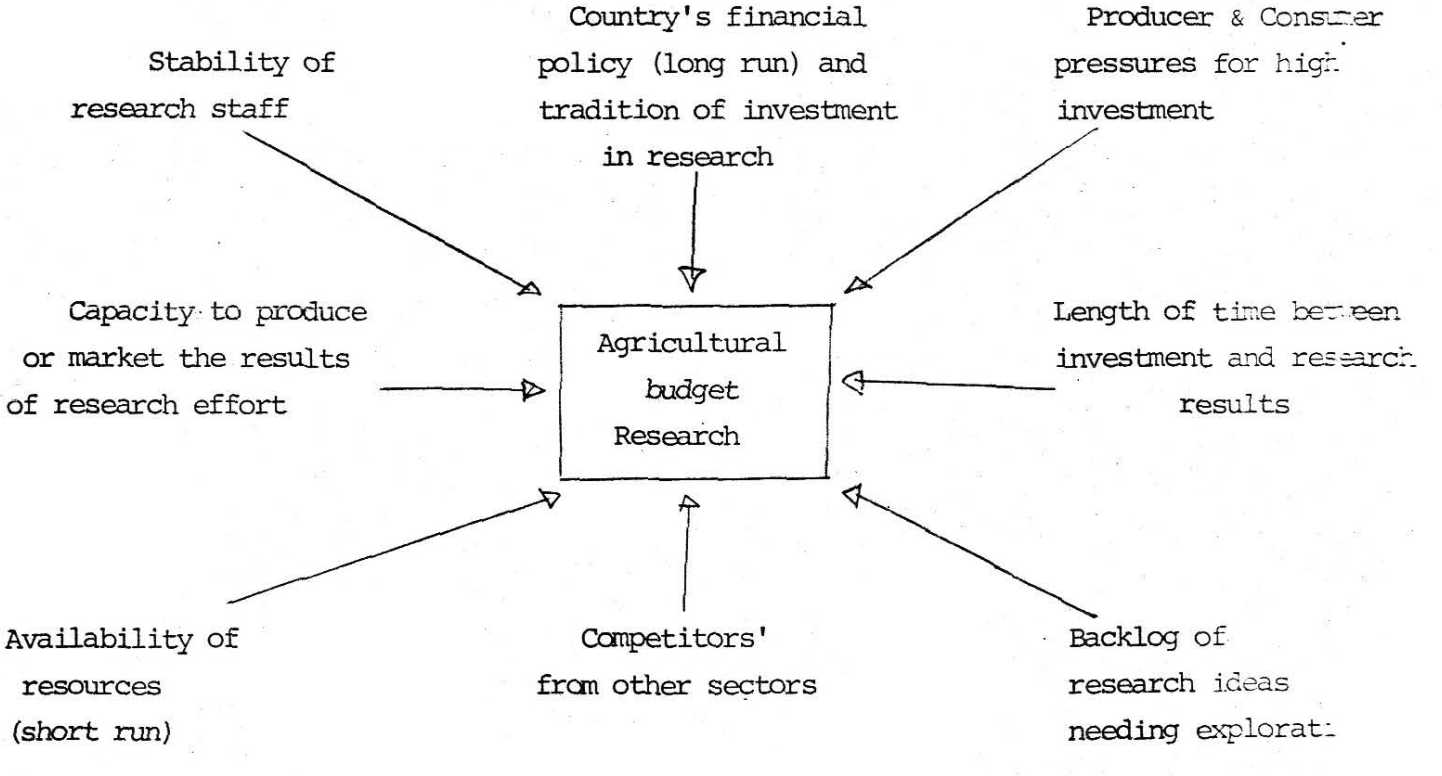
In practice, as in most countries science policies are ill-defined, it is extremely difficult to formulate an agricultural research policy based on the national science policy. Although long-term agricultural policies are also ill-defined, short-term sectoral policies do exist and it is possible, at least in principle, to link research to them.

Although in some countries agricultural research is considered to be one of the instruments of science policy, in most countries the relationship between agricultural research and science policy has been unsatisfactory for the reasons given above. It was generally agreed that the implications of agricultural research for the economy and society had been neglected because of the lack of explicit policies and in particular because of the lack of long-term agricultural policies.

Research workers often oppose a closer link between research and socio-economic policy because they fear that it would lead to rigid and unenlightened control of their work. However, a well-organized relation between research and socio-economic policy, involving regular dialogue between those responsible for socio-

The most effective policy research is that which focuses on specific program or policy decisions. Most issues of public policy, and particularly those of a social nature, involve extremely subtle and complex objectives and values. Though one can hypothesize a global issue and undertake an analysis of it in the abstract, somehow the results nearly always come off oversimplified and impractical. It seems, Schultze has noted, that "We discover our objectives and the intensity that we assign to them only in the process of considering particular programs or policies"

FORCES ACTING ON THE DETERMINATION OF THE TOTAL AGRICULTURAL RESEARCH BUDGET



economic policy and those responsible for organizing research would benefit both sides. It would improve the planning and budgeting of research, since it could be better oriented to long -term national needs and make the research sector more aware of these needs; it would improve policy, since the policy-makers would be more aware of the economic, social and environmental implications of the research budget. Such developments may show the need for alternative or, indeed, for completely new appropriations.

The inexplicit nature of socio-economic policies makes relations difficult between socio-economic policy, science policy and research, but a way of improving this situation would be precisely through the establishment of better relations between the three.

In order to make proper allocation of resources to agricultural research the national policies need to be more clearly defined. What is regarded as of primary national importance? Is it land use, or employment, or import saving or self-sufficiency, or food quality? Are there "targets" in each, or only some of these? Once such policies are defined, one can consider how far research can contribute to these targets and how far existing technology is adequate, and what new technology has to be generated?

From the standpoint of applying knowledge to the formation of national rural development policy, the past record is not good. Patrick Madden contents that (1) even with adequate funding, our efforts will prove to be futile unless we avoid scattering our research resources too thinly or (2) learn to organize ourselves into effective research efforts with well developed research problems and (3) remain in rapport with local community and the rural development practioner 1/.

1/ PATRICK J. MADDEN. Evolution of rural development programs: Toward a paradigm to guide the implementation and evolution of rural development programs. Presented at workshop on Title V (research sponsered by the North east Regional Rural Development Center), Ithaca, 1974.

RESEARCH NEEDS FOR IMPROVED RESEARCH DIRECTION

Because of our minimal background of knowledge and experience, the allocation of research resources offers in its own right an area ripe for research. Research in the social sciences to support optimal decision-making in allocation of production research resources needs to emphasize definition of societal objetives; sources and means of income by income class; the consumption pattern of various income classes; and the factor share bias of innovations.

Social scientists could contribute substantially to increased efficiency in this most crucial area of development. To do so, they must verse themselves in the technology of agriculture to grasp somewhat more fully the constraints that delineate the art of the possible. They must recognize the impracticality of a general equilibrium approach in this extraordinarily complex area and settle for numerous partial approaches and consequent doubt of whether or not they have even an approximation of a correct answer. Finally, they must immerse themselves in the operational context of the real world so that they may choose economically among the many possible "partial" problems in allocating their own potentially valuable resources.

Only when it is known how much income each income class generates through what production means can research policy be designed to improve income distribution. Innovation affects income distribution through its effect on demand for factors of production and supply of consumer goods. Generally the poor provide labor, and relative increase in demand for labor increases their income in relation to that of others. Effective policy demands knowledge of the precise nature of labor supply and demand, including elasticity of labor supply. Such knowledge provides a base for estimating returns to increased demand for labor and probable wage behavior. Similary, consumption patterns of the low-and high-income classes differ greatly. Research concentrated on goods the poor consume will benefit them relative to the more well-to do. Despite this obvious fact little detail is available on the precise nature of consumption patterns of the poor.

While it may be interesting and useful to know the magnitude of the pay-off from past investment in research, the real challenge with which we are faced is that of providing management tools that will assure an efficient allocation of limited resources to an almost unlimited number of research possibilities.

If research is viewed as a social investment, the criterion for selecting a specific research investment is the greatest social return possible for total investment funds available. The criterion is implemented by estimating the expected rate of return for resources to be used in each alternative and selecting enough of those research investment alternatives with the most favorable benefits relative to costs to utilize the available budget. But difficulties are encountered (1) in getting acceptance of the view that research is a social investment (2) in specifying the substance of social return, (3) in estimating the expected rate of social return, and (4) in implementing the resulting research investment plan.

1/ ANTHONY, Robert, Planning and Control Systems, New Haven, Conn., Harvard University Press, 1965.

2/ Association of State Universities and Land-Grant Colleges and United States Department of Agriculture, A National Program of Research for Agriculture, Oct. 1966.

3/ Committee on Science and Astronautics, Technology Assessment Seminar, Washington, Government Printing Office, Sept. 1967.

4/ GRILIGHES, Zvi, "Research Expenditures, Education, and the Aggregate Agricultural Production Function," Am. Econ. Rev. 54:961-974, Dec. 1964.

Factor Endowment

Generally speaking, resources should be allocated to research based on production factors where the results will increase the productivity of those factors in relatively short supply more so than the productivity of those in relatively abundant supply. On these grounds labor-saving innovations in a densely populated country with a low and relatively stagnant wage rate cannot be justified on either efficiency or equity grounds.

Formal Decision Models

Most economic investigations into the ex ante research resource allocation problems have been concerned with formal decision models. Such models have been created and sometimes computerized for some agricultural research stations, and even for entire agricultural research systems. Most of these models take as their objective the maximization of returns to research for investments without looking at other social goals. However, as the general emphasis in economics is shifting from national income to income distribution, nutrition and other quality aspects of life, research resource allocation models taking these aspects into account have been constructed.

Welfare and Equity Consideration

The distribution of gains between agricultural producers and consumers has been a major controversy in Europe and North America. It is usually analyzed in comparative static partial equilibrium models. The basic conclusion of these consumer-producer surplus models is that under perfectly elastic commodity demand producers capture all the gains, whereas under very inelastic demand consumers gain disproportionately at the expense of real losses to producers. The total gain is captured by consumers, with producers neither gaining nor losing when the elasticity of final demand is equal to minus 1.

Furthermore, it is clear, that whenever gains are captured by consumers the impact of most technical changes in food production on the income distribution is progressive. Poor people spend a large proportion of their budget on food and the proportional gain in their real income (deflated by a price index

using their own consumption weight) is larger than that of people who spend proportionately less on food. Furthermore, the lower the income and price elasticities of particular foods, the larger their budget shares among the poorest consumers. Research resource allocations designed to help the poorest consumers should thus stress commodities with low income and price elasticities. Such a strategy would also benefit small subsistence producers relative to large commercial farmers since the farmer stands to gain relatively more as consumers *if prices drop as a consequence of technical change.*

More complicated are distributional effects where the outcome depend on output and factor market conditions. Among these the distributional issues between producers and consumers or between foreign and domestic consumers are the most transparent ones. Approaches have been developed to study distributional impacts among consumer groups with different income levels. Most troublesome are functional income distribution issues among landowners and laborers.

Regional Considerations

In agriculture in particular, but also in other industries, technical changes are often confined to certain regions because of environmental or economic location specificity. In particular, the green revolution has been confined largely to irrigated zones with good water control. Partial equilibrium analysis of the distributional consequences of this unequal regional access is again straightforward and it is unlikely that general equilibrium analysis would change it. If two regions supply the same national market, then each region may face elastic commodity demand even if the national demand is inelastic. Thus, producers in the region experiencing technical change gain absolutely. Nevertheless, national price levels will fall, although not necessarily by much. Thus, producers in the region without access to the technology lose absolutely and relative to the gaining regions since they face reduced prices without a concommitant cost reduction.

The allocation of resources across states and regions is an important factor in determining the efficiency with which these resources will be utilized. In general one would expect a region's share of research resources to be an increasing function of size, climate variability and stability, and number and value of crops produced. All of these factors proxy for the potential return to investment in research in the region, and ignore the transferability factor. Where research performed elsewhere is applicable to a region the deviation of shift in the research effort will depend on whether regional or global welfare is being maximized and will be subject to the usual public goods considerations.

On the distributional side there are additional factors to be considered. Within a region research results may have scale biases or may advantage workers over landowners or vice versa. There are questions of regional inequalities to be considered as well as the distribution of benefits between producers and consumers.

Social Goals

Three broad social goals can be selected as most relevant to station research.[1/] These are designated growth, equity, and security. Briefly, growth was defined as increased capacity to satisfy individual and collective wants. In principle, it included both market and nonmarket Gross National Product. Quantitatively, the growth contribution can often be estimated in terms of resources saved in producing a product of equivalent total value. Resources can be saved by research by designing an improved technique or an improved product. Equity was defined as a fair or just sharing of those things available to satisfy human wants. Equity, thus, is made up of at least two important, but often conflicting, subgoals: (1) absolute equity, that is, bringing more people up to or above minimum welfare or consumption stardards, and (2) relative equity, that is, providing rewards to people more nearly in line with what each "deserves". Security was defined as the protection of life, health, personal liberties, income and property from loss or risk of loss not associated with due process of law.

1/ W.L. Fishel, ed., Resource Allocation in Agricultural Research (Minneapolis: University of Minnesota Press, 1971).

An attempt must be made to find criteria of efficiency for the improvement of welfare that are meaningful for agricultural scientists. That is a task requiring the collaboration of agricultural economists, rural sociologists and technologists involved in research. It is quite possible that better devices can be found that provide clearly formulated methodology for short-term and long term budgeting and resource allocation for agricultural research aimed at the advance of consumer and producer welfare, but very little study is being applied to the problem at the moment. To conclude one can state that a systematic approach to budgeting and allocation of resources for agricultural research is as yet in an embryonic state. Its successful birth and rapid maturation depend largely on intense and broad research.

Allocation Decisions

The economic contribution of publicly supported agricultural research to the nation's productive capacity is widely recognized, still, economic benefits from publicly supported research are not captured by the research organization which increases the difficulty of establishing operational criteria four resource-allocation decisions. At best, only applied research is likely to have a direct connection between knowledge output and social benefits.

Actually the research budget involves the joint response of legislators, research administrators, and scientists to changes in the matrix of economic, social, physical and educational circunstances.

Four categories of decision affect agricultural research budget:

Proportion of national budget devoted to research in general

This amounts to 1,5 to 2,5% of G.N.P. in advanced countries. The general tendancy is for this proportion to increase and it is estimated that this should reach 3 to 4% in the eighties. In developing countries it varies between 0.5 to 1.0% (based on UNESCO publications).

2. Total funds devoted to agricultural research

The funds applied to applied agricultural research are in proportion generally lower that all other research. The goal in the United States was 0.5 of value of agricultural sector plus 0,5 of the value of agricultural exports. This will be about 850 million dollars in case of the United States. A target that has not been reached.

In case of Brazil this will be about 100 million dollars.

The actual expenditure on agricultural research in Brazil are estimated between 260-300 million US$. This is mentioned to show that agricultural research is a rather expensive and demanding undertaking when one hopes to obtain significant results.

3. Commodity level decisions

The most common consideration in allocation of research funds is an attempt to relate the expanditure to the total value of the product discussed under "Commodity orientation". In general in most cases only a part of research expenditure can be related to individual products. A large percentage of research expenditures implicate different commodities at the same time.

4. Geographic Distribution

This distribution is mainly made on the bases of the location of various research units and centers. This constitutes the major reason for the fact that antecedent budget and tradition dominates budget allocation process. In case of federal funds passed for research to the State in addition to purely political consideration of some social parameters could be considered. The more logical approach is to take parameters like: rural population, arable land and number of rural production units in consideration for long term resource allocation.

In short term factors, like existing agricultural credit and extension system, value of agricultural product and existing road infrastructure, should be considered.

5. Precedent

To conclude, (As mentioned initially) in practice for allocation of resources and formulation of the budget, the previous years budget for each unit is used as a base. To this a fixed percentage is added or subtracted. There is no logic in assuming that the starting level was rational, or that there is a justification for perpetuating a certain relationship.

The location of each unit, specialization and geografic allocation of research workers, including their multi-year experiments in progress make the budget. This puts a straight-jacket on the administrator of research in terms of any major real location of research funds from one year to the next. On the positive side, this represents the individual choice of a large number of research workers, their conventional wisdom and convenience. It is expected that this will result in a good relationship between administrator and the research scientists and leads to maximum output and dedication of individual research workers.

Commodity Orientation

The potential contribution of Agricultural research to national output will depend in part on the present production and prospective demand for the commodity that will be affected. Returns are likely to be especially great for research directed at important commodities for which effective demand is increasing rapidly. A relatively modest increase in the yield of a major crop can result in a large increase in total production, although farmers are more likely to adopt a change that increases their own returns significantly.

The allocation of budget in proportion to the value of various commodities has its disadvantage. Under this approach a certain percentage, usually between 0.5 and 1.5% of the total gross value of annual production is devoted to research.

This solution favours the branches of production that are already well established and whose research needs are not necessarily greater than those of the less-develped branches of production. In particular new branches of production, whose potentialities cannot even be guessed at without preliminary research, are the most discriminated against, in this approach.

The criteria of the actual value of a commodity could be supplemented by the following considerations.

(a) Growth potential given the resource endowment of land capital and man power.

(b) Potential contribution to improving the trade balance by increasing export earnings or substituting imports.

(c) Processing potential and value added of processed products.

(d) Their efficient use of limiting factors like land, water & labour. This means the

productivity & value may be expressed in market value per cubic meter of irrigation water, per ton of fertilizer used, per acre if land is limited or per agricultural worker where there is a shortage of manpower.

(e) Variation of production from year to year and resulting high risk to producer

In addition to maximazing the income of various farmers based on production cost and expected price of various commodities, the allocation research budget should also consider the need to decrease the risk involved in producing various crops. The product showing large variation of yield even though the market value in some year is low, should be given due priority.

Allocation of Funds for Different Fields

Allocation of funds for different fields of agricultural research is a part of tradition and basically follows human resource policy both at the recruiting and training level. In other words the proper allocation of resources will result from training program and appropriate human development plant and not at annual budget level. In other words it is not appropriate to cut plant pathology funds, either through firing the pathologist, who had been trained at the institutions expense or let him become idle by cutting his experiment funds.

Allocation on the Basis of Proven Creativity

In addition to considering non personal factors like those identified earlier, the individual potential creativity of certain workers should be taken into consideration when making budget allocation. In other words some research

workers whose interest does not coincide with identified and agreed upon priorities should be given a chance to proceed with their work even though it does not appear to produce immediate results. This approach should be limited to a small number of well established or extremely bright young research workers oriented towards pure research. At present specific areas where brakethroughs might be expected and could be included in this case are photosynthesis, nitrogen fixation and genetic engeneering. Twinning of beef cattle and bioregulators are also considered as having great potencial for major brakethroughs. Even though scientists, within developing countries have less chance to make this brakethrough their interest and attempts in this field will facilitate their use in creating technologies based on these expected fundamental scientific discoveries whenever they happen.

Readiness for Inexpected Problems

In addition to research problems whose significance is immediately apparent, resources also should be allocated to research on problems related to certain eventualities which may or may not occur in the future. Typical examples of these are research on major plant and animals deseases that do not constitute an economic problem at a given time but could create great losses when satisfactory control or preventive measures have not been developed by research.

Also a certain amount of budget should be reserved to be assigned on a momentary notive to emergency programs during unexpected calameties like citrus canker & African swine fever if and when is needed.

The following steps describe the process of budget formulation.

1) Research Institution's executives, with the assistance of a staff planning group if available, determine by some objective means a tentative R & D budget, which is then outlined in general terms. The determination of this tentative amount is keyed to last years budget.

2) Research administrators at this point are informed of the range within which the research budget will probably fall. The overall amount is then reallocated by research management to the program or project supervisors who screen the available projects, ideas, or research proposals. Tentative selections of proposals are made in the light of the preposed financial resources available and the institutions long-range research plans. It is important that research objectives and plans be explicit and fully understood by those who undertake the first screening of research projects so that imbalance or misdirection of the research effort is avoided.

3) The projects selected in the first screening are analyzed to determine the required manpower and the expected completion dates.

4) After manpower and timing have been forecast, the projects are expressed in dollars and cents, and the breakdown of funds into payroll, travel, supplies, and similar categories is completed by program or project coordinator supervisors.

5) The departmental or units budgets are then resubmitted to top-level research management.

6) Research management accumulates all the subbudgets and consolidates them into an overall research budget proposal.

7) The research budget, as accumulated from the bottom up, must at this point be compared with the original limits indicated by top management at the beginning of the budgetary process. Depending upon how much at variance the two figures are, adjustments may now be needed. Relatively small variances may be ignored, but if they are significant, research management must decide whether to reconstruct the budget or to gather arguments in an attempt to secure approval for an increased amount.

8) After having reconciled the two amounts, research management prepares the formal budget request for submission to top line management. A sizable brochure, usually including a thorough description of the research plan and, in some cases, details of the proposed projects, is sometimes prepared to back up the budget request.

9) If the proposal as submitted by research management is accepted, the budget is put in to final form. If corporate management does not accept research management's proposal, the process is repeated until the budget has finally been approved.

ncentives, encouragement and participation in lecision making. Creation of nonpecuaninary ncentive and their proper distribution may be as important as budget allocation.

Concluding Remarks

1) Utilization of well known capital-budgeting and other quantitative project-selection techniques in allocation of resources to agricultural research is not common.

2) Although attempts had been made to formulate A quantitative ex ante approach to resource allocation there is no satisfactory methodology developed for practical application as yet and further work is needed.

3) Another obstacle to the development of specialized techniques and methodology for the allocation of budget is a long-standing "hands-off" Attitude. This attitude is based upon a fear that tight controls may reduce the "creativeness" of research personnel. Since creative persons are being managed unless the atmosphere in which they work is conductive to creativity, their effectiveness and efficiency are inevitably lessened. The creativity of research workers may look to be a rather abstract and irrelevant concept to some research administrators and public investment decision makers. This is because large number of agricultural experiment work, may look as routine particularly to those without experience in agricultural research.

4) The major resource of any agricultural research organization is the time of its professional staff.