

Report to the
Government of Ghana

PA-ABI-865

ISNAR R52

REVIEW OF THE GHANA AGRICULTURAL RESEARCH SYSTEM

Volume I: Report

Joint Review by
National Team Selected by the Council
for Scientific and Industrial Research
and
International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, the Netherlands, on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting governments of developing countries to strengthen their agricultural research. It is a nonprofit autonomous agency, international in character, and nonpolitical in management, staffing, and operations.

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LIST OF ACRONYMS

AGDP or AgGDP	Agricultural Part of Gross Domestic Product
AGRICOLA	Agricultural On-Line Access
AGRIS	International Information System for the Agricultural Sciences and Technology
AHPD	Animal Health and Production Department
APCC	Agricultural Policy Coordinating Committee
ARDAC	Agricultural Research and Development Advisory Committee
ARI	Animal Research Institute
ARO	Assistant Research Officer
CABI	Commonwealth Agricultural Bureau International
CARIS	Current Agricultural Research Information System
CDROM	Compact Disc Read Only Memory
CIDA	Canadian International Development Agency
CIMMYT	International Maize and Wheat Improvement Center
COCOBOD	Ghana Cocoa Marketing Board
CRI	Crops Research Institute
CRIG	Cocoa Research Institute of Ghana
CRO	Chief Research Officer
CSIR	Council for Scientific and Industrial Research
CTO	Chief Technical Officer (Principal, Senior, etc.)
FAO	Food and Agriculture Organization of the United Nations
FASCOM	Farmers' Services Company
FOA	Faculty of Agriculture
FPRI	Forest Products Research Institute
FRI	Food Research Institute
GAEC	Ghana Atomic Energy Commission
GDP	Gross Domestic Product
GGDP	Ghana Grains Development Project
GHASTINET	Ghana National Scientific and Technological Information Network
GLDB	Grains and Legumes Development Board
GOG	Government of Ghana
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
Global 2000	Sasakawa Global 2000 Agricultural Project
IAB	Institute for Aquatic Biology
IITA	International Institute for Tropical Agriculture
ILCA	International Livestock Centre for Africa
IRHO	Institut Recherche pour les Huiles et les Oleagineux
IRR	Institute of Renewable Resources
ISNAR	International Service for National Agricultural Research
MFEP	Ministry of Finance and Economic Planning
MIST	Ministry of Industry, Science and Technology
MLNR	Ministry of Lands and Natural Resources
MOA	Ministry of Agriculture
MOHEC	Ministry of Higher Education and Culture
MTC	Ministry of Transport and Communications
NAES	Nyankpala Agricultural Experiment Station
NARP	National Agricultural Research Policy (or Plan)
NARS	National Agricultural Research Services

NORRIP	Northern Regional Rural Integration Program
OPRI	Oil Palm Research Institute
PAG	Planning and Analysis Group
PNDC	Provisional National Defence Council
PPMED	Policy Planning Monitoring and Evaluation Division
PRO	Principal Research Officer
RO	Research Officer
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SOE	State Owned Enterprise
SRI	Soils Research Institute
SRO	Senior Research Officer
STA	Senior Technical Assistant
TA	Technical Assistant
TCAFF	Technical Committee for Agriculture, Forestry and Fisheries
UCC	University of Cape Coast
UGL	University of Ghana, Legon
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
URADEP	Upper Region Agricultural Development Project
UST	University of Science and Technology, Kumasi
VORADEP	Volta Region Agricultural Development Project
WAS	West African Shorthorn
WRRI	Water Resources Research Institute

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SUMMARY

REVIEW OF THE GHANA AGRICULTURAL RESEARCH SYSTEM

A review of the agricultural research system of Ghana was carried out as part of the Agricultural Services Rehabilitation Project, by a team made up of national consultants appointed by the Council for Scientific and Industrial Research and a group from the International Service for National Agricultural Research, approved by CSIR. A plan of action was developed between the local team and ISNAR representatives in December 1988, and the bulk of the information gathering and interviewing of research groups was done by the local team members between January and April 1989. The ISNAR group joined in the final stages of review and analysis of the gathered information, April 17 to May 5, 1989.

The coverage of the research system was as comprehensive as possible, involving visits to 57 research institutions and units within CSIR research institutes, universities, Ministry of Agriculture departmental units, and other government and quasi-government institutions.

Because research is essentially done by researchers, individual returns to a questionnaire were requested from all professional personnel involved in active research. Three hundred returns were available for analysis (about 40 staff were on study leave). Some analysis was also included on 23 research staff at the Cocoa Research Institute of Ghana (CRIG), where no personnel returns were completed. A detailed analysis of how research staff allocated their time for research among commodities and production factors was possible on the 300 researchers, which is believed to cover almost all the research activity in agriculture. On average, about half of the researcher's total time was spent on research (60% for research institute staff, 25% for university staff). The rest of the time was spent on teaching, administration, extension, and study leave.

In addition, directors, deans, department heads and officers-in-charge responded to a questionnaire requesting details of staff, facilities, and research projects for each research unit. CSIR headquarters collected information on finances of institutions, and provided details of the operation of the CSIR system. A brief account of research institutions, their mandates, and research capacity in terms of facilities and staff is given in the text, and fuller details are available on file.

In general overview, agricultural research activity falls into three main categories of institutions: the national research institutes (most under CSIR); the universities; and institutes and units under other ministries and quasi-government organizations. The distribution of professional researchers involved shows that almost half of the current agricultural research capability of 150 person years is in the CSIR institutes, with a further 16% in other national research institutes (Cocoa and Forest Products). The universities contribute about 15%, while research in the Ministry of Agriculture, other ministries, and quasi-government organizations accounts for 22% of researcher time.

The research effort is spread over a wide range of commodities and production factors. The current *de facto* research priorities are best expressed quantitatively in how researcher time is applied to different commodities. Details are given in Table 17 in the text. In summary, 11% of researcher time is devoted to cocoa (with coffee, cola, and shea nut); 51% on other crop production; 17% on livestock; 6% on forest products; 4% on fisheries; 10% on food processing; and 2% on residual general supporting topics.

The highest allocations of research time are currently to cocoa (16 person years per year), maize (11 person years), cowpea (more than 5 person years), and oil palm (6 person years per year). No other commodity receives as much research effort as 3 person years per year out of the remaining 112 person years. (The impact of the concentration of research effort on maize and cowpea on the improved potential of the production technology now available for extension on these crops is well recognized.)

The analysis of the research system was approached along three main themes: the status and management of the means of carrying out research, how the research capability is developed and maintained; the management of the program, how the research program is decided; and the maintenance of linkages with clients of research, especially how research conclusions are communicated to clients.

MEANS OF CARRYING OUT RESEARCH

Research depends primarily on professional researchers, who must be well trained in research methodology, and must have adequate facilities and conditions for carrying out research.

The overall level of qualifications of research staff is good compared to many countries in Africa: on average three-quarters have postgraduate degrees, of which one third have Ph.Ds. The universities have more than 40% with Ph.Ds., and only 4% of staff at graduate level. The experience profile is less satisfactory. Only 30% of institute staff have more than 10 years of professional experience (50% for universities). Continuing training in research methodology and special fields to upgrade graduates is essential, and training courses in management for senior staff are desirable. However, the research cadre is well capable of effectively utilizing substantial increases in funding for research operations.

The scheme of service for national institute research staff is very suitable for research organizations. Although salaries are low compared to world standards for internationally qualified staff, they are comparable with equivalent professionals in other civil service positions. The promotion process in CSIR is well conceived and based on meritocratic performance criteria, however, the criteria may need to be reconsidered as decisions on research policy are made.

From financial returns for 1986 and 1987, national funding for agricultural research was about 0.80% of AGDP (the agricultural part of GDP). Cocoa is a special case. If cocoa is omitted from research and GDP, then residual funding for the agricultural research was about 0.57% AGDP, which is low compared to the World Bank's immediate recommendation of 1% AGDP.

The outstanding shortage in most research institutions is for operational funds (total recurrent funds, excluding salaries). In 1974, when it is generally agreed research was moderately well funded, operational funding at CSIR institutes averaged US\$ 20,500 per scientist (expressed in 1987 dollars). In 1986/87 the average level had fallen to \$ 10,000, with some institutes below \$ 3000, and only those research activities backed by external projects were funded at reasonably efficient levels. Such low levels of funding for operations preclude research output of high quality and quantity, and do not effectively utilize the investment made in well qualified staff. There is an urgent need to improve the level of operating funds per scientist to at least that applied in 1974. This would require an increase of overall funding for research (excluding cocoa) from 0.57% AGDP to 0.68% AGDP. The relative autonomy of the directors of CSIR research institutes in defending and managing their own budgets is a good feature of the research system.

Funding for research in the universities is very low, and should be increased at least to the same rate as in the institutes. The universities not only must have research facilities to produce well-trained recruits for research, but also to fully exploit the pool of highly qualified faculty in the service of the national agricultural research effort.

Agricultural research in Ghana is well endowed with numbers of research stations and trial sites, well distributed around the country. However, facilities have been neglected over several years, and few research stations are in good condition with respect to land, office, and laboratory buildings, staff housing, laboratory and field equipment, vehicles, and library services. Details are given in the report-file. There is an urgent need for rehabilitation of research facilities at some selected stations. However, the team recommends that the operation of research stations be rationalized so that while one organization is responsible for maintaining any station, collaborative national research activities by university, institute, or ministry researchers can be accommodated on each station. Refurbishment of vehicles and equipment is urgently required to make efficient research possible.

Good research is highly dependent on good library and information services. In the last decade, agricultural research library facilities, from being among the best in Africa, have deteriorated seriously, and deserve high priority for rehabilitation and re-equipping with modern information technologies that can be very cost-effective.

DETERMINING THE RESEARCH POLICY AND PROGRAM

The immediate objective of the national agricultural research system is to carry out a research program that will yield new information required by the clients of the research system. No agricultural research system can meet all of the requirements of clients in a short time, and the choice of the most urgent and important problems to be addressed is critical for the efficiency of the operation of the research system. There was some criticism from Ministry of Agriculture staff that the research conclusions and information coming from CSIR institutes were not meeting the main problems of the producers and extension, and that the Ministry of

Agriculture did not have sufficient input into the content of the research program. The team therefore carefully examined how the research program was determined at research institutes. A six-stage model for program formulation was used as a basis for comparison.

Three stages of planning include:

- * at national level, determining agriculture research policy and priorities for major research areas (commodities and production factors);
- * at institute level (or equivalent), identifying within a commodity the main constraints that can be reduced by research;
- * at station level, devising and selecting the best experiments and studies that will lead most quickly to reducing the constraints.

These are followed by three reviewing stages, reviewing research proposals at

- * station level, for relevance and quality;
- * institute level, for compatibility with the planned guidelines and likely resources of funds and researcher time;
- * national level, for agreement with priority guidelines, budget, and national objectives.

In general, the review team concluded that most research institutes and institutions had a fairly clearly defined and satisfactory procedure for the reviewing of research proposals from individual researchers up to the review of aggregated programs at institute level, and from there to CSIR (for CSIR institutes), and on to the Ministry of Finance and Economic Planning.

However, the research planning process is much less clearly defined, and currently there is no recognized national body for guiding agricultural research policy and advising on program formulation. While the Ministry of Agriculture is represented on the reviewing committees and boards, it does not have much input into the planning and focussing stages of program formulation.

The team therefore has recommended that a senior body be established to formulate national agricultural research policy, based on merging national science and technology policy with national agricultural development policy. The body should establish the national agricultural research strategy, and should have authority to decide on major priorities for agricultural research, and to advise the Ministry of Finance and Economic Planning on the allocation of resources (especially researcher-years) to these main research areas.

The team recognized that steps had already been taken to meet this need, and reviewed the possible alternatives for carrying out this important role.

Of the three likely alternatives—CSIR's Technical Committee for Agriculture, Forestry and Fisheries; MoA's Agricultural Research Development and Advisory Committee; and MFEP's Agricultural Policy

Coordinating Committee - the team concluded that a modified form of the TCAFF with revised terms of reference, would be the most suitable. It should report to APCC in addition to CSIR.

Within policy guidelines from this body, management boards of institutes should plan which major constraints could be addressed with the resources available, and senior Ministry of Agriculture staff should be heavily involved in such planning sessions. More junior MoA staff should also be involved in station-level decisions on short-term studies to be included in the research program.

Where several institutions are involved in research on a commodity (e.g., university, CSIR institute, and MoA in improvement of cattle) a nationally coordinated program should be set up.

The apex body for establishing national agricultural research policy will have primary effect on determining guidelines for research program development, but the research strategy will be the basis for the development of a long-term plan which will include plans for staff recruitment and training, as well as station rationalization and development. Proposed membership and functions of the apex body are discussed in the report.

COMMUNICATING CONCLUSIONS TO CLIENTS OF RESEARCH

Linkage mechanisms between the agricultural research system and its surrounding organizations and communities are very important for bringing planning information into the system, and communicating conclusions out from the system. The team collected information from research institutions of linkages maintained, with special reference to research/extension linkages. Since all linkages cost time and money, not all desirable linkages can be maintained and inevitably there were instances where linkages between research institutions and development agencies and their clients could be improved. However, there were instances where research/extension linkages have been very good, as in the Ghana Grains Development Program and the VORADEP project. These have been well funded, but can serve as guides for research/extension collaboration, if the principles of the linkages used, and less expensive mechanisms are followed.

ISSUES

It is widely agreed that:

- the research system has run down from its earlier capability in physical facilities, equipment, human resources, and funding of operations;
- there is an urgent need for rehabilitation of the system;
- it is important to retain the system's internationally qualified staff;
- it is essential to get the system more nearly fully effective again by strengthening the means of carrying out research.

There may be some issue of policy about where the funds to sustain a rehabilitated system might come from, and what the size and "scope" of a sustainable research system should be. If a decision is taken to increase operating funding per scientist to the level of 1974, then there must be either a sustained increase in overall funding from 0.57% AGDP to at least 0.68% AGDP, or a reduction in the number of researchers.

There has been less consensus about how the national research program should be determined, and there are important policy issues to be resolved in this respect. Central to the issue is how national agricultural research policy should be determined. If it is decided to establish an apex body for determining agricultural research policy, then an appropriate affiliation must be chosen. Three alternatives have been discussed. A suitable technical secretariat would be needed to service the body.

The policy body should give clear guidance on what is expected from the national research system - what its "mission" is. This is very important for orienting and motivating national researchers. The criteria for research and promotion must reflect the values and purpose of the "mission", for the system to be internally consistent. The importance for reward for time spent on research/extension interaction should be made clear.

The role of the universities in the national agricultural research system should be clarified. If it is to play a part in national research in addition to generating new recruits to the research system, then adequate funding for research operations must be channeled to the universities.

Linkages consume resources. A decision on what share of resources important linkages should have will help guide management practices and decision-making.

All of these decisions will be important in shaping the development of a long-term national agricultural research plan.

CHAPTER I

INTRODUCTION AND REVIEW PROCEDURE

The Government of Ghana recognizes that the development of agriculture must be a major element in its economic reform program. An important part of this process is the strengthening of agricultural services. An initial step has been made in the Agricultural Services Rehabilitation Project (ASRP) of the Ministry of Agriculture, supported by financing from the World Bank.

Part of the Project involves the preparation of a national master plan for research in support of expanded agricultural production. The plan is expected to provide guidelines for a medium-term project to strengthen the national agricultural research capability. As a basis for the research plan, a review of the current structure, organization and management, programs and resources of the national agricultural research system was called for in the ASRP. The Council for Scientific and Industrial Research (CSIR) which has national responsibility for the coordination of all research, and which operates the largest group of agricultural research stations, was assigned responsibility for the review and for the development of the plan. The detailed Terms of Reference for the review are given in Annex 1.

The review has been carried out by a joint team of national consultants appointed by CSIR and from the International Service for National Agricultural Research (ISNAR). Details of the team's membership are given in Annex 2. A plan of action was developed by the national members of the team and ISNAR representatives in December 1988. Questionnaires were prepared, to be completed by individual researchers and by institution, faculty, or research station leaders, and a systematic set of topics for direct interviews was drawn up (see Annex 3). The bulk of the information gathering and interviewing of research groups was done by local team members intermittently between January and April 1989. The ISNAR team joined in the final stages of review and analysis in Ghana from April 17 to May 5, 1989.

The leader of the national team joined staff at ISNAR in drafting initial components of the report. These were reviewed by the full local team when the national and ISNAR team leaders participated in the Seminar on Research and Extensions Linkages in Agriculture, May 30 to June 1, 1989. The team co-leaders again collaborated in the final drafting of the review report at ISNAR.

The range of the review was as comprehensive as possible, involving visits to 57 research institutions and units within CSIR research institutes, universities, Ministry of Agriculture departments, and other Government and quasi-Government research institutes and organizations. The individual returns on qualifications and research activities from 300 researchers are believed to have covered almost all of those currently involved in agricultural research to at least 20% of their time, except for those on study leave, and those in the Cocoa Research Institute of

Ghana (CRIG). The returns on financial allocations to research were good for the discrete research institutes, but were less precise for research units within larger departments with broader responsibilities. Details of the main research projects were available for the CSIR institutes, and some detail of research projects from other organizations was gathered during interviews. The discussion in the review is focused on the means or capability for carrying out research in support of agriculture in Ghana, rather than on the specific program (which is more particularly the concern of a subsequent planning exercise).

After a short chapter on the role and development of agricultural research in Ghana, there is a concise description of the current research system in Chapter III, supplemented by more detail in Annex 4 and a separate file document on individual institutions and units. Chapter IV is introduced by a brief note on the framework of organization and management of national agricultural research in general. It is followed by the main discussion on the means of carrying out research, including human resources, physical facilities, and financial resources.

Chapter V reviews the management of the research program, including policy and program formulation at all levels, and the linkages of the research system, with external agencies and organizations. It also briefly considers the broad research program areas in terms of the researcher time allocated to each area. Chapter VI discusses some major policy issues arising from the review. The final chapter summarizes the conclusions and recommendations.

CHAPTER II

DEVELOPMENT OF AGRICULTURAL RESEARCH IN GHANA

2.1 RECENT PERFORMANCE OF THE AGRICULTURAL SECTOR

2.1.1 Situation

Agriculture is the mainstay of the Ghanaian economy. It contributes about half of the Gross Domestic Product (GDP), depending on the year, and absorbs approximately 66% of the total labor force. Over the last four years (1984-88) cocoa, and timber and wood products, supplied 70% of total merchandise exports (respectively 62% and 8%).

Throughout the country, rainfall is the principal determinant of cultivation. Two main agroecological zones can be distinguished: 1) the forest zone, which covers about one-third of the land and supports the cultivation of tree crops such as cocoa, coffee, oil palm, kola nut, and rubber; fibres, such as jute and sugar cane; and staples, such as yam, cassava, plantain, and banana; and 2) the Savanna Zone, which is well-suited for other basic food crops: sorghum, millet, maize, rice, and cowpeas, and potentially important cash crops: tobacco, groundnuts, and cotton.

The performance of Ghana's agricultural sector has been severely hindered during the seventies and early eighties by discriminatory monetary, trade, and macro-economic policies. This, combined with a succession of years of poor rainfall, resulted in food and cash crop outputs steadily declining at a rate of roughly 0.3% per annum throughout the 1970s. Compounded with population growth (2.6% per annum between 1970 and 1984), per capita figures are even more alarming: the per capita food index declined from 100 in 1974-76 to 62 in 1983.

Under the combined effect of return-to-normal weather and the incentives offered in the policies of the Economic Recovery Program (1983), agricultural output grew at a rate of 10% in 1984, 1% in 1985, and 4% in 1986; no further growth was recorded in 1987. In spite of these improvements, the country is far from reaching its potential. Given its resource base and the fact that only 30% of the 13 million hectares of cultivable land is actually under cultivation, Ghana could meet most of its domestic food requirements and export surpluses.

Hindering the realization of this potential is the low productivity of the Ghanaian smallholder, who accounts for 80% of agricultural production. This is largely attributable to the limited use or non-availability of improved technology, untimely delivery of inputs (particularly fertilizer), weak agricultural services, limited availability of credit, and poor infrastructure. Ghanaian agricultural productivity is lower than in other African countries under similar circumstances.

2.1.2 Agricultural Policy and Strategy

During recent years there has been increasing recognition by the Government of Ghana (GOG) of the potential role of agriculture as an engine for development. A strategy for rehabilitation, based on considerations of competitiveness, efficiency, and equity, has been identified. It focuses on the basic services and other activities which offer the greatest potential to increase smallholder production. This includes establishing the means to deliver proven technical packages, improving logistical support for the extension service, ensuring minimum input requirements, particularly fertilizer and seed, and increasing investments in rural infrastructure, particularly feeder roads.

To provide an adequate framework for the rehabilitation of the agricultural sector, the MoA is pursuing major policy measures in the domain of trade and export, pricing, rationalization of the public sector role, and national resource conservation.

Export and Trade Policy. Promotion of exports will be based upon increased competitiveness of Ghana's products on the world market. Where imports are necessary, protection tariffs will be systematically lowered to force producers to become more efficient. The present narrow export base will also be expanded and diversified.

Producer Prices. Considerable progress has been made in liberalizing producer prices in order to improve incentives to producers. Cocoa prices will remain in the hands of the government, but they will be increased annually to an indicative target of 55% of world prices. For cotton, tobacco, and palm oil, monopolies purchase the outputs, and the MoA will monitor proposed prices to ensure that farmers are offered adequate remuneration. Subsidies for producer inputs are being phased out.

Rationalizing the Public Sector. The actions aimed at rationalizing the public sector involve:

1. A better coordination of the institutions involved in the sector through, in particular, setting up the Agricultural Policy Coordinating Committee for policy-making purposes; improving coordination of research and extension is another important objective of the Ministry of Agriculture (MoA). To this end, the creation of the Agricultural Research and Development Advisory Committee (ARDAC) has been envisioned (see chapter on Policy and Planning).
2. The privatization of the state-owned enterprises, where warranted (as in the case of fertilizers), and the improvement in the efficiency of those which, because of their strategic importance will have to remain state-owned. All of these will be expected to operate without government subsidies. In addition to the state-owned enterprises, all remaining government investment in agriculture will be reassessed, based on efficiency criteria.

National Resource Conservation Strategy. Protection of the environment has become a serious concern of the GOG. Land management is a priority issue. Another is the protection of Ghana's forests, which are undergoing increased pressure from farming practices and fuel-wood demand, as well as an increase in exports from this sector.

A National Plan of Action to Combat Desertification has been prepared (1987) by the Environmental Protection Council. The MoA has set up a special agroforestry department. .. national policy for resource conservation will be elaborated jointly by the MoA and the Forestry Department of the Ministry of Lands and Natural Resources.

2.2 ROLE OF RESEARCH

To realize the substantial potential that exists, constraints on several fronts must be surmounted. The MoA is working on alleviation of various constraints in the policy environment, and the provision of necessary services and infrastructure. However, agricultural production increases will also depend on the development and diffusion of improved technologies appropriate for the socioeconomic conditions of the farmers and taking into account the concern for environment conservation. Hence it is necessary to improve the efficiency and effectiveness of the agricultural research system.

The contribution scientific research could make to agricultural development in Ghana by supplying new information and pointing to fresh opportunities was recognized at a very early stage. Agricultural research can be said to have commenced in 1890 with the establishment of the Aburi Botanical Garden. It developed steadily, if in an uncoordinated manner, throughout the first half of the century, being concentrated in a national Department of Agriculture and the West African inter-territorial research system, with smaller contributions from the University of Ghana and other departments.

Immediately after independence, steps were taken to integrate all research activities, and a National Research Council (NRC) was established (August 1958) to organize and coordinate all aspects of research, significantly reflecting the new leaders' awareness of the crucial importance of scientific research. Further changes followed; the Ghana Academy of Learning was set up as a learned society (November 1959) which became the Ghana Academy of Sciences (GAS) in 1961. Meanwhile, the West African inter-territorial research organization was dissolved (1960), and the NRC became a de facto division of GAS. In 1962 the agricultural research conducted by the Scientific Services of the Ministry of Agriculture was transferred to GAS, and in January 1963 the formal merger of NRC into GAS was completed, GAS combining the functions of a learned society and an executive research organization. Most of the current research institutes were created by GAS at this time.

However, the overall combination proved unsatisfactory, and in 1966 a distinguished Committee of Experts, chaired by Sir John Cockcroft, advised that the GAS should be divided into two components, a learned society and a national science council to plan and organize research. These were finally established in 1968 as the Ghana Academy of Arts and Sciences and the Council for Scientific and Industrial Research (CSIR), the latter being formally inaugurated in January 1969. In addition to having the bulk of national research staff under its direct control, the CSIR was given the responsibility for coordination of research in all its aspects in the country, as there was a substantial research capability in the universities and in other ministries.

Agricultural research has continued to develop under this framework, with a considerable increase in capacity over the following two decades. The national research institutes responsible for agriculture (including the Forest Products Research Institute and the Cocoa Research Institute of Ghana, in addition to those in CSIR) were increased in strength from 86 researchers in 1965 to 201 researchers in 1985 (ISNAR Data Base), while the faculties of agriculture in the universities showed a similar rate of growth in research capacity. The transfer of its research wing severely reduced the capability for research within the Ministry of Agriculture, but the subsequent, and especially the recent, development of the Extension and Crop Services Divisions has created a significant capability for research in certain categories: in the present review 35 Ministry of Agriculture professional staff reported spending about half of their time on research.

CHAPTER III

CURRENT NATIONAL AGRICULTURAL RESEARCH SYSTEM

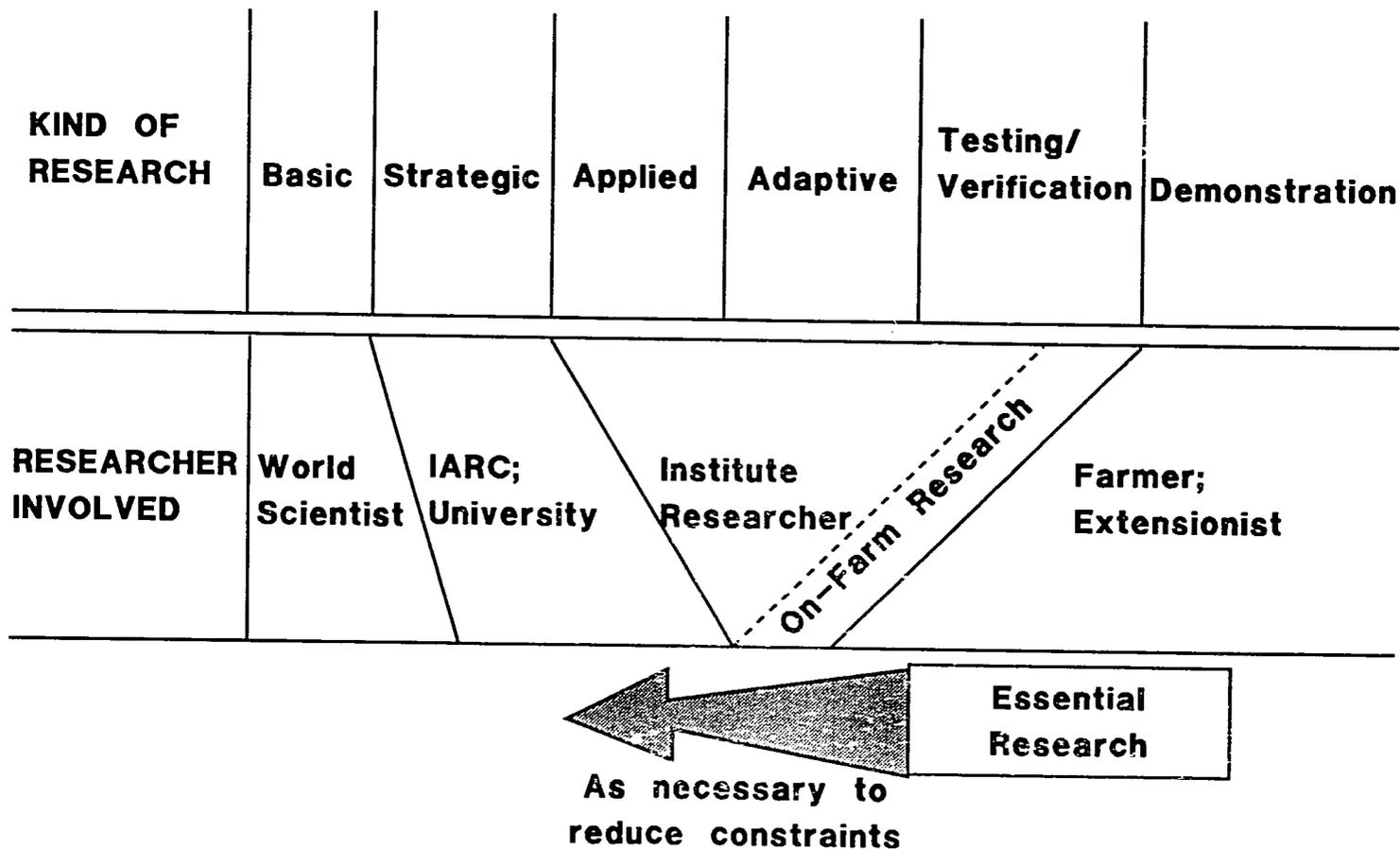
The national agricultural research system (NARS) is a broad concept that can vary substantially from country to country. It is probably best defined in terms of its purposes or the expectations from it. In general, the purpose of a NARS is to provide reliable new information and materials for the benefit of its main clients: national producers, processors, consumers, government, planners, extension and other development agencies, national and international research colleagues, etc. The emphasis in any country will depend on the balance of clients to be served - which is a significant policy decision.

Again in general, an immediate objective of research is to provide information and materials that will help increase or maintain the productivity of a commodity in the face of constraints. And this must improve the well-being of the producer; otherwise there is unlikely to be any increase in productivity or production.

The irreducible minimal research effort of a NARS is therefore to ensure that new technology is profitable (or otherwise beneficial) to the producer (testing and demonstration research). If it is not, then some component of the technology may need to be modified by introducing an alternative available component (adaptive research). If no alternative is available, a new component in the technology may have to be generated using existing research techniques and knowledge (applied research). If no appropriate technique or knowledge is available, it may be necessary to carry out some basic research or long-term strategic applied research. All national agricultural research systems must consider the whole spectrum of kinds of research to ascertain what research is most urgently needed. Again, in all countries, large and small, different groups or institutions are responsible for carrying out different, often overlapping, kinds of research. Fig. 1 shows approximately the groups of researchers in Ghana that appear to have responsibilities for different kinds of research.

In Ghana the various research groups include the farmers, the extensionists and MoA development staff, other units in development ministries, the private sector (and NGOs), development project staff, the national research institutes, and the universities. The review captured information on the universities, national research institutes, development project staff, and some of the MoA and other ministry staff involved in research. These are the public-sector groups that can probably be brought into planning processes and into any future project to strengthen research. The research groups are not, of course, isolated and must maintain linkages with any outside organizations that might have no active agricultural research capability, but remain part of the larger agricultural research system influencing the active research studies that are carried out.

Fig. 1: Spectrum of kinds of research in a national agricultural research system: indication of kinds of researcher involved in Ghana.



3.1 OVERVIEW OF THE PUBLIC SECTOR OF THE AGRICULTURAL RESEARCH SYSTEM

Agricultural research in the public sector is carried out in several ministries, including the Ministry of Industry, Science and Technology; the Ministry of Agriculture; the Ministry of Education and Culture; the Ministry of Lands and Natural Resources; and several quasi-government organizations, such as the Ghana Cocoa Board, the Ghana Atomic Energy Commission, and the Forestry Commission. The bulk of the research is carried out in specific national research institutes for groups of agricultural commodities or production factors, but significant contributions are made in institutions whose central purpose is not research, such as the universities and the Ministry of Agriculture. Precise allocations of resources to research are difficult to ascertain in the latter cases.

Because research is essentially initiated and directed by professional researchers, the initial overview is based on the detail supplied by researchers on how they allocated their time. Researchers in the public sector were asked to assess how their time was allocated among agricultural research operations, other research, administration, teaching and extension, production activities, and leave and study leave. Furthermore, they were asked to assess how their research time was allocated in 1988 to different commodities (or to production factors covering several commodities, such as fertilizers, water, soil survey, if allocation to a specific commodity was not possible). The response from 300 researchers was considered to be a very large sample of the researchers not on study leave, if not absolutely complete. (Details were not available for those on study leave, about 40 scientists.) No returns were completed by researchers at CRIG, but supplementary information on the 29 researchers (six on study leave) has been included, all the time being allocated to cocoa (although some of this time would undoubtedly have been spent on coffee, cola, and shea nut).

Broad conclusions are presented in Tables 1 and 2 and figures 2 and 3. More than half of the researcher time is spent in eight CSIR research institutes and FPRI (almost two-thirds if CRIG is included), with about 15% and 22% of the total research time contributed by the universities and ministry and quasi-government units respectively.

Almost two-thirds of the total research time is directed towards crop production research, and two-thirds of that is on food crops. Livestock, with 17% of research time, is allocated an appreciably larger share than livestock's nominal contribution of 9% to AGDP. Forestry and fisheries research receives smaller shares. The 10% share of researcher time donated to food processing is spread over a wide range of commodities.

Fig. 2. DISTRIBUTION OF RESEARCHERS AND RESEARCHER TIME AMONG CATEGORIES OF INSTITUTIONS

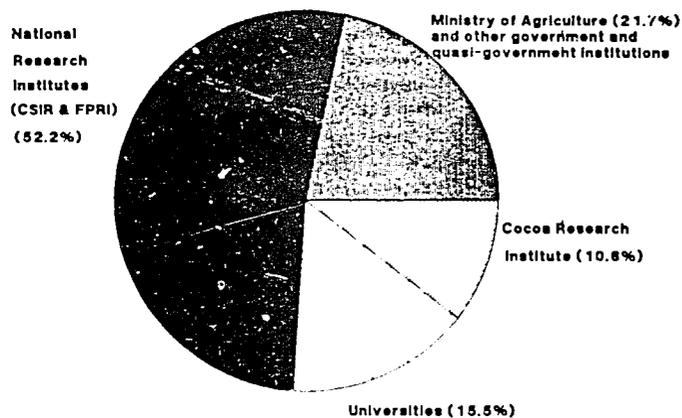


Fig. 3. DISTRIBUTION OF RESEARCHER TIME OVER BROAD CLASSES OF COMMODITIES & SUPPORTING TOPICS

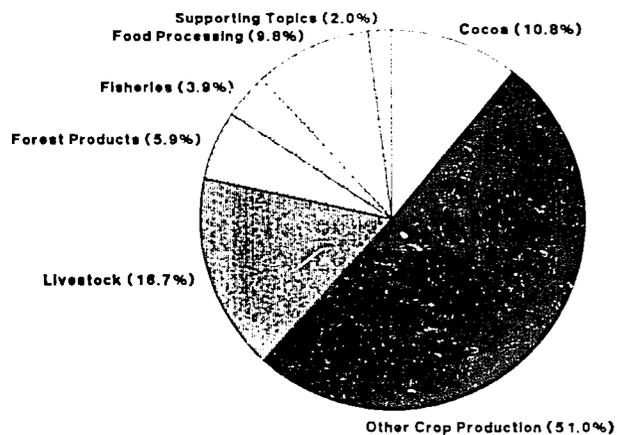


Table 1: Distribution of Researchers and Researcher Time Among Categories of Institutions (based on questionnaires)

Institution	Number of Personnel Completing Questionnaire	Person Years of Research Activity		
		%	%	%
Universities	91	28.2	23.6	15.5
Nat. Research Institutes (CSIR and FPRI)	148	45.8	79.6	52.1
Ministry of Agriculture, Other Government and Quasi-government Institutions	61	18.9	33.1	21.7
Cocoa Research Institute	23	7.1	16.2	10.6
	323	100.0	152.6	100.0

Table 2: Distribution of Researcher Time Over Broad Classes of Commodities & Supporting Topics

Commodity	Distribution Researcher Time
	%
Cocoa	11
Other Crop Production	51
Livestock	17
Forest Products	6
Fisheries	4
Food Processing	10
Supporting Topics	2
	100

Indeed, the national research effort is spread over a very wide range of individual commodities. Returns suggested at least 40 commodities. The main concentration of researcher time on the individual commodities of cocoa, maize, cowpea, and oil palm is illustrated in Table 3 (with food processing added). No other individual commodity receives as much as three person years. More detail is given in Chapter V.

Table 3: Concentration of Researcher Time on Individual Commodities in 1988

Commodity	Person Years
Cocoa	16
Maize	11
Cowpea	6
Oil Palm	6
(Food Processing	15)

3.2 AGRICULTURAL RESEARCH INSTITUTIONS

A brief resumé is given here; more detail is given in the Project File and Annex 4.

3.2.1 COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

CSIR carries the heaviest responsibility for national agricultural research. It has a mandate to advise the Government on the use of science and technology for development, to coordinate all research, and to promote research in any area that will advance development; and to establish and operate research institutes. It has 12 research institutes, five of which are entirely devoted to agricultural research and two of which are substantially involved with agricultural research.

The chief executive of the 26-member Council is the Director General who administers the research institutes with the aid of a headquarters' Secretariat. Five Technical Committees for specific sectors were established by the Council in 1986 to help formulate science and technology policy in their sector and to coordinate corresponding research nationwide. The Technical Committee for Agriculture, Forestry and Fisheries has a broad membership covering relevant areas and has recently prepared a draft document on science and technology policy in the sector.

The central permanent Secretariat and Information Center of CSIR has about 27 senior staff for a wide variety of tasks. The Secretaries of the Technical Committees constitute a Planning and Analysis Group (PAG) under the chairmanship of the Director General.

Each component institute has a Management Board appointed by the Council and a Director - also appointed by the Council.

3.2.1.1 Animal Research Institute (ARI)

The Animal Research Institute has its origins in the Zoological Research Unit at Achimota College, Accra, where it is still housed, inadequately, pending the completion of a large new building at Katamanso. ARI has a broad mandate to conduct research on all problems of animal production, both ruminant and non-ruminant, and work is in hand on breeding, disease, nutrition, and farm survey aspects.

The Institute operates through five divisions: Breeding and Genetics; Nutrition and Husbandry; Animal Diseases and Veterinary Services; Pasture; and Farm Management and Economics.

Currently there are 13 professional research staff on-station and three on study-leave, contributing currently about nine person years per year to research. There is therefore a limited capacity in-house for in-depth research on more than one or two commodities. But there is sufficient capacity to give leadership to coordinated livestock research in the country, where there is currently a further 15 person years of research effort.

However, current research facilities for ARI have deteriorated seriously in many respects and are in great need of rehabilitation. Funding for research operations is currently at a very low level. The new farm at Katamanso offers good prospects as a facility for research, but the new building and services are still far from completion.

3.2.1.2 Crops Research Institute

The Crops Research Institute developed from the old Agricultural Research Institute. It is the largest of the institutes, with some 50 professional research staff, and has a mandate to conduct research on all food, industrial, and horticultural crops in Ghana, except cocoa, coffee, cola, shea nut, and oil palm. Its main research station is at Kwadaso, Kumasi, currently with about 36 research staff. The buildings and equipment there are inadequate and in need of rehabilitation, but a fine new research headquarters building is nearing completion on a new farm at Fumesua, Kumasi. CRI has many other stations and substations, but the only one with permanent resident professional research staff is the Nyankpala Agriculture Experiment Station (NAES) near Tamale. NAES has been developed with the aid of German Technical Assistance in a substantial research station for the northern savannah zone and has good laboratory facilities. Many other buildings there need rehabilitation. The other substations offer well-distributed sampling sites for different ecological regions, but are permanently staffed only by technical support staff.

CRI is organized into nine mainly disciplinary divisions and contributes about 30 researcher years per year to direct research

activity. With the support of the Ghana Grains Development Project, the research program is heavily concentrated on maize and cowpea, utilizing 7.5 person years and 5.4 person years per year respectively. CRI staff also guide the research programs of a number of researchers on maize and cowpea in other organizations (especially those of the Grains and Legumes Development Board and Extension Division of the MOA). There is a growing focus of work on cassava, with about 2.5 person years per year of research effort. The rest of the researcher time is spread over a range of at least 25 crops and production factors.

3.2.1.3 The Food Research Institute

This institute was established in 1963 in Accra to undertake research on food processing, preservation, storage, marketing, and distribution. The current professional staff of 30 contributing 15 person years per year are reasonably accommodated in prefabricated laboratories built in 1975/76, but much of the laboratory equipment is obsolete and in need of rehabilitation or replacement. The institute is organized in five specialist divisions, undertaking research work on a broad range of commodities, including cereals, legumes, roots and tubers, fish, meat, and eggs.

3.2.1.4 The Institute of Aquatic Biology

Established in 1965, the institute conducts research into the biology of inland and coastal water resources and offers advisory services on the management of these resources. It is housed in temporary prefabricated buildings in Accra, with a scientific staff of about 20 organized in five divisions: limno-chemistry; aquatic plants; hydrobiology; fisheries; and parasitology, and entomology and microbiology. Studies and services range over fishfarming, water quality, aquatic weeds, and control measures for water-borne diseases. Of the total staff, only four researchers returned questionnaires indicating they were involved in specifically agricultural research, contributing 2.8 person years per year; these were mainly concerned with fisheries and aquaculture.

3.2.1.5 Oil Palm Research Institute

The Oil Palm Research Institute at Kusi-Kade had its origins as a branch of the West African Institute for Oilpalm Research. It was reestablished as a section within the Crops Research Institute in 1964, and became a self-standing research institute in CSIR in 1988, with the mandate to provide scientific and technical support for the oil palm industry and to maintain a supply of improved seedlings.

Nine research officers operate in six disciplinary divisions, providing 4.2 person years per year of research effort. The institute has adequate farm, laboratory, and office facilities and is reasonably well equipped, thanks to project funding supported by the World Bank.

3.2.1.6 Soil Research Institute

The Soil Research Institute became an independent institute within CSIR in 1964, but a unit for soil and vegetation survey and land-use assessment had existed since 1951. The institute's mandate is reflected in its four divisions of soil genesis, survey and classification; soil chemistry and mineralogy; soil fertility; and soil conservation and erosion. The institute has had as many as 20 research staff in the past, but currently 11 researchers completed questionnaires showing a contribution of 8.2 researcher years per year. Most of the research time is spent on survey and general fertilizer studies, but 2.5 person years can be associated with specific crops, especially maize and cowpea. The institute has adequate office and laboratory accommodation and reasonable field facilities, but the buildings are in need of maintenance and rehabilitation, and most equipment is obsolete or needs replacement, especially vehicles, which severely hampers survey activities.

3.2.1.7 Water Resources Research Institute

The Water Resources Research Institute was not formally upgraded to an institute until 1982, but began work as a unit in 1966. Its mandate is broadly to appraise the water resources in Ghana, both surface and groundwater; to carry out and coordinate all research on water resource development; and to help formulate a national water policy. The research and advisory services are organized in five program areas rather than disciplinary specialities: surface water; groundwater; water quality; sediment transport; and water resources planning. Returns from 20 research staff showed that most of the staff did not regard their work as agricultural research; only 2.6 person years per year in agricultural research was indicated, mainly in the areas of water inventory, use, and quality. Buildings and equipment were generally rated to be adequate and in good condition, but some repairs and replacements were needed.

3.2.2 The Universities

The Ministry of Education and Culture maintains faculties of agriculture at the University of Ghana, Legon (1959), and at the University of Science and Technology, Kumasi (1961), and a School of Agriculture at Cape Coast University (established 1975). Their primary responsibility is to educate and train persons for the application of agricultural sciences in Ghana. In this they play an important role in the national agricultural research system in the supply of professional recruits for the research system. However, the universities also have important supplementary responsibilities that include advising the Government and others on the up-to-date status of world knowledge in agricultural science; and carrying out direct research towards a variety of objectives. The University of Ghana offers a 3-year B.Sc.(Agric.), with an academic and research staff of 49, and the University of Science and Technology, a 4-year honours B.Sc. (Agric.), with a staff of 57. Between them the two faculties graduate 80-90 students per

year, mainly in crop science and animal science. The School of Agriculture, Cape Coast, provides a degree in general agriculture, with a specialist Diploma in Agricultural Education. It has 18 academic staff and graduates about 30 students annually. Currently there are only 10 postgraduate students (in plant science) at UST. There are six postgraduate students in animal science, ten in crop science, and two in soil science in the University of Ghana. The body of well-qualified professional agricultural scientists in the Faculties and School represents a considerable potential for national research, but the amount of research carried out depends critically on the time available after direct teaching duties, and on other factors, including the availability of funds, number of undergraduate and postgraduate students, etc.

In practice, out of 124 faculty members who received questionnaires, 91 responded indicating a significant allocation of time to research; the average was about 25% of total time available, a total of 24 person years per year. Faculty of Agriculture staff also play a considerable role on the Council, on management boards of CSIR research institutes, and on other Ministry committees.

The University of Ghana and UST have been well equipped to carry out research, but have experienced a prolonged period of underfunding that has resulted in poor maintenance of building facilities and equipment that is old or obsolete, except where replenished through externally funded projects. The School of Agriculture, Cape Coast, is due to move into a new building soon, for which it has new equipment. All the faculties have access to teaching farms. The Faculty of Agriculture, Legon, maintains three substantial research stations with permanent professional research staff: at Kade (forest); at Nungua (coastal savannah, livestock); and at Kpong (irrigation). The Institute of Renewable Resources is based at UST; research activity is planned, but teaching duties currently restrict research effort to about 10% of professional time, a total of 0.7 person years per year on forestry and other topics.

The Faculties and School of Agriculture have broad geographic areas of interest: University of Ghana, Legon, with the Accra Plains and Forest Belt; UST Kumasi, with Forest and Transition Zones; and Cape Coast with high rainforest and coastal scrub and thicket belts. But research topics range very widely. Both UG, Legon, and UST, Kumasi have significant capabilities in livestock research, and all have research activity in grains, legume and vegetable research, spread rather thinly.

3.2.3 OTHER NATIONAL RESEARCH INSTITUTES

3.2.3.1 Cocoa Research Institute of Ghana

There has been a national cocoa research station since 1938 for such an important economic crop. It was the headquarters of the international West African Cocoa Research Institute from 1944 to 1962, after which it was an institute in GAS and CSIR, until in 1973 it came under the management of the cocoa industry, now the

Ghana Cocoa Board. CRIG has substantial offices, laboratories, and plantations at headquarters at Tafo and at three substations. In addition to cocoa, there are smaller research programs on coffee, cola, shea nut, and tallow.

Cocoa has the strongest and most thorough program of any commodity in Ghana; with 29 professional research staff (including six on study leave) at CRIG and additional support in the universities, an estimated 16 person years per year is being applied in research, sufficient for a substantial program, including strategic and applied research, in addition to adaptive and testing research, and a very significant role in world research on cocoa.

In view of its position in the economy, and the biological problems it faces, cocoa research is relatively well supported (receiving more than 40% of the total national allocation to agricultural research) and has recently been reviewed by a team from the Overseas Development Administration (UK) that has developed plans for strengthening cocoa research. No further comment will be made in this report except to set cocoa research in the context of the national agricultural research system.

3.2.3.2 Forest Products Research Institute

The FPRI was formed in 1963 from a merger of the Forestry Department specialist divisions of Silviculture and Utilization with the former West African Timber Borer Research Unit. It remained one of the CSIP institutes until 1980, when it was transferred to the management of the newly formed Forestry Commission, without any change in its national role. The institute has continued to be housed in the old Forestry Department buildings and converted buildings at UST Kumasi, pending completion of new permanent laboratories at Fumesua, that has not yet been accomplished. Accommodation is inadequate and equipment obsolete. The institute has about 12 field stations in various ecological zones, but only two have reasonably good facilities, and no professional staff are out-posted.

Research work is organized in three departments: Silviculture and Management; Processing and Utilization; and Protection. A total of 35 projects (plus 42 anatomical studies of hardwoods) is listed, but many are in abeyance for lack of staff. In 1977 research staff reached 26, but the total is now 14, of which 12 returns of questionnaires showed about eight person years per year being applied to research, about half of which was on wood utilization.

3.2.4 MINISTRY OF AGRICULTURE AND OTHER MINISTRIES AND QUASI-GOVERNMENT ORGANIZATIONS

Departments and divisions of the Ministry of Agriculture and other ministries and quasi-government organizations conduct agricultural research work at varying levels of intensity. In some, research is a formal commitment in the organization, in others it is an incidental activity accompanying a major development activity. In attempting to capture the reality of what research contribution was

being made, personal questionnaires were sent to a very wide range of institutions, and were followed up with visits. Some institutions reported firmly that no research was being carried out, but completed questionnaires were received from 59 scientists, indicating a contribution of 33 person years of research effort from 14 divisions or institutions, a considerable share of the total national research activity. The estimate does not pretend to be exact; it is difficult to estimate research time when the major task is development. But the figure given will tend to be an underestimate because of some part-time researchers not filling in the questionnaires.

The units are too numerous to review individually. More detail can be found in the companion file of brief reports on institutes, and the bare numbers are given in Table 4.

3.2.4.1 Ministry of Agriculture

The Department of Animal Health and Production indicated 13 staff contributing 6.7 person years of research effort, mainly concerning animal health, disease surveys, and trials associated with vaccine production. Less than 1 person year was allocated to livestock production research, but the Department has several strategically placed stations that could play a critical role in any nationally coordinated livestock improvement collaborative research program. Any such participating stations would need rehabilitating.

The VORADEP project has a substantial research program in hand at the Kpeve Agricultural Station and several substations. Office, laboratory, and farm facilities at Kpeve are reasonably good but require renovation. Housing is poor. Twelve professional scientists are estimated to contribute seven person years per year, mainly on adaptive and testing research on cereals and root crops, but including some research on tree crops, vegetables, and livestock. The research group keep in touch with CRI, the universities, LITA, and ICRISAT about the research program.

The former URADEP project used to have a research component, but currently the staff in the region considered the work in hand to be mainly extension and training.

The Fisheries Research Department indicated that four scientists were involved in research contributing 2.5 person years per year, mainly on fish statistics, fishing gear, and plankton studies.

The Crops Services Department returned only three completed questionnaires showing 0.8 person years per year of professional research effort. This may have been an underestimate.

The Extension Services Department sent no returns, perhaps reflecting that most of the support work in adaptive and testing research is carried out by technical officers.

Table 4: Total Person Years Applied to Research Activity by Institution

Institution	No. of Staff Returns	Total Weeks in Research	Ttl. Person Yrs. in Research	
<u>CSIR</u>				
Animal Research Institute	(13)	470	9.04	
Crops Research Institute	(36)	978	18.81	
Food Research Institute	(24)	760	14.62	
Institute of Aquatic Biology	(4)	145	2.78	
Nyankpala	(15)	533	10.25	
Oil Palm Research Institute	(9)	219	4.21	
Plant Genetic Resource Unit	(2)	65	1.25	
Soil Research Institute	(11)	426	8.19	
Water Resources Research Inst.	(20)	133	<u>2.56</u>	71.69
<u>FOREST PRODUCTS RESEARCH INST.</u>	(12)	408	7.85	7.85
<u>UNIVERSITIES</u>				
University of Cape Coast	(15)	172	3.31	
University of Ghana				
Kade	(5)	148	2.85	
Faculty	(28)	361	6.94	
Kpong	(3)	67	1.29	
Nungua	(4)	89	1.71	
Uni. of Science & Technology				
Institute of Renewable				
Natural Resources	(7)	36	0.69	
Faculty	(28)	354	<u>6.81</u>	23.6
<u>MINISTRY OF AGRICULTURE</u>				
Animal Health & Production Div.	(9)	256	4.92	
Central Veterinary Laboratory	(4)	90	1.73	
Crop Services Division	(3)	40	0.77	
Fisheries Research Division	(4)	128	2.46	
VORADEP	(12)	359	<u>6.90</u>	16.78
<u>OTHER GOVERNMENT & QUASI- GOVERNMENT INSTITUTIONS</u>				
Forestry Department	(1)	13	0.25	
Ghana Atomic Energy Commission	(8)	289	5.56	
Ghana Seed Company	(1)	9	0.17	
Ghana Grains & Legume Dev. Board	(7)	209	4.02	
ICOUR	(1)	38	0.73	
Meteorological Department	(1)	44	0.85	
Nat. Oil Palm Plantations Ltd.	(2)	27	0.52	
Timber Export & Dev. Board	(4)	200	3.84	
Twifo Oil Palm	(2)	19	<u>0.36</u>	16.30
<u>COCOA</u>				
Cocoa Research Inst. of Ghana	(23)		<u>14.95</u>	<u>14.95</u>
TOTAL				151.19

3.2.4.2 Other Ministries and Quasi-Government Organizations

The Ghana Grains and Legumes Development Board maintains a significant capacity for adaptive research activities, mainly in maize and cowpeas and associated farming systems studies: seven professional scientists contribute four person years per year, working closely with CRI and the Extension Department in the GGDP.

The Forestry Department of the Ministry of Lands and Natural Resources currently has only one officer working on trees valuable for nitrogen fixation. The work is linked to agroforestry systems studies in other research institutions.

The Ghana Atomic Energy Commission supports research in a variety of areas concerning agriculture, eight scientists contributing 5.6 person years per year. In addition to coordinating the work on the use of sterile males in the control of tsetse flies, radioactive techniques are applied in international studies in livestock and in tissue culture studies.

The Timber Export Development Board has a research group of four scientists working mainly on export statistics, pricing, and market research.

Other private companies have one or two scientists involved in testing work on individual crops.

3.3 NATIONAL COORDINATION OF RESEARCH

The survey shows a wide range of organizations involved in agricultural research. Central coordination by organizations would be a very difficult task. A more fruitful approach might be to decentralize the main task to national commodity or production factor research committees, and to review centrally the balance among these coordinated programs.

CHAPTER IV

MANAGEMENT OF MEANS OF CARRYING OUT THE RESEARCH PROGRAM:

HUMAN, PHYSICAL, AND FINANCIAL RESOURCES

The general purpose of NARS is to generate and deliver to national clients information that offers new potential for increasing the rate of development, usually through demonstrating new opportunities for increasing productivity or maintaining productivity in the face of constraints. As indicated earlier, what kind of information is to be produced, and for which balance of possible clients, are policy issues to be decided at a high government level.

Thereafter, the research process is fairly standard. Within its likely resources, a research unit must decide what it is going to do to generate the required information; implement the program; and communicate the conclusions to those clients that need the information. Each of these steps involves substantial expenditures of resources in time and money.

No country, however large, can hope to carry out all of the research needed to solve the problems of producers and processors in a reasonable time frame; some problems are of greater urgency than others, and in general only a few can be attacked at one time.

The decision on what research programs to implement is therefore crucial for the efficiency of the whole research process, and hard choices on priorities have to be made.

However, to implement any research program it is necessary to develop and maintain a capacity for research of well-trained researchers, with adequate support staff, physical facilities, equipment, and operational resources. How large this capacity is will, to a considerable extent, determine the "scope" of the research system, both in the range of topics covered and the kind and depth of research that is feasible and realistic.

The effectiveness of the research system depends on the communication of conclusions to clients, but this is part of a broader network of linkages that must be maintained, both to bring information into the system (to help reach decisions on program) and to take new information to clients. As all linkages cost time and money, not all desirable linkage mechanisms can be adopted; again, hard choices on highest priority must be made.

The analysis of the organization and management of the research system will follow these three main aspects (in a slightly different order): how the resources for research are being applied to develop and maintain a research capability; how the research program is determined; and how linkages are maintained with clients of research.

As more than half of the research work is carried out in CSIR and FPRI, which have research as their primary purpose, and as these institutes are expected to give national leadership in the research programs, the discussion that follows is focused heavily on these.

4.1 STRUCTURE AND ORGANIZATION

In general, the basic structure and organization for national agricultural research that has been built up in Ghana is appropriate to its tasks:

- A. A set of universities with faculties producing adequate numbers of graduates with basic qualifications for recruiting into research services, which also carries out direct research and provides a well-informed pool of advisors.
- B. A set of national research institutes, responsible for guiding research in commodities and production factors, with reasonable autonomy of operation under a central council. The CSIR organization has many attributes that are generally considered very desirable in national agricultural research systems.
 - i) It maintains a good research environment for creative scientists, with a value system appreciative of the role of research and science.
 - ii) It has a scheme of service and promotional system based on proficiency and productivity in research rather than simply hierarchical responsibility.
 - iii) It gives directors reasonable autonomy in financial management, with direct budgets to institutes.
 - iv) It encourages a collegial style of management, so important for research where the young specialist researcher may be a greater authority in his/her field than the head of department or director.
 - v) It avoids the heavy bureaucratic control so characteristic of large development-oriented or regulatory ministries, where research is often treated as a minor division within a value system heavily weighted to short-term development achievement. CRIG and FPRI have similar advantages in their roles as national research institutes.
- C. A set of development ministries, agencies, and quasi-government organizations with primary responsibility for promoting agricultural production (and conservation of resources) that are widely distributed in the country and are concerned with the stages of research closest to validating the opportunity offered by new technology, and convincing producers of their value in overcoming constraints to productivity.

The basic structure of the research system has high potential for effectiveness, compared to that in many other countries. Whether the potential is realized or not depends on the provision of facilities and resources, and the management of both the means of carrying out research, and of research program formulation, implementation, and communication of conclusions.

4.2 HUMAN RESOURCES

The prime requirement for carrying out agricultural research is a cadre of well-trained research scientists. In overview, the returned questionnaires suggest that about 320 professional

researchers are involved in agricultural research in Ghana, with about a further 40 scientists on study leave. The overall level of qualifications of research staff is quite good compared to many countries in Africa, despite the serious attrition of experienced staff in the early 1980s and difficulties faced by institutions in obtaining funding for postgraduate training. But there is still a lot of room for improvement in training in research methodology. The overall spread of disciplinary training is reasonably wide, but there are some noteworthy gaps in some institutions. The terms of service for researchers in CSIR are reasonably good and appropriate; salaries are low by international standards for equivalent qualifications, but not by equivalent positions in public service in Ghana. In the past, criteria for promotion have been heavily oriented to peer review of formal scientific publications. Recently, changes have been made, and further changes may be called for after reconsideration of the national agricultural research policy.

4.2.1 Research Scientist Skill Profiles

From the wide sample of research staff it was possible to draw up national and institute profiles of staff by qualifications and specialization. Table 5 shows the qualifications of research staff by research institution (with a broadly grouped summary in Table 5a).

Table 5a: Summary of Distribution of Qualifications by Institutional Group

Institutional Group	Number in Sample	Percentages with		
		Ph.D.	M.Sc.	B.Sc.
Universities	91	47	48	5
CSIR	126	18	48	33
Ministry & Quasi-Govt.	52	6	44	50
TOTAL	269	26	47	27

Virtually all agricultural scientists employed at the universities of Ghana, Science and Technology (Kumasi), and Cape Coast have postgraduate degrees, and 47% of these are at the Ph.D. level.

Twothirds of the respondents from CSIR agriculture-related research institutes have a postgraduate degree, but only 23 (18%) have a Ph.D. degree or its equivalent. Ministry and quasi-government research staff have a lower proportion of Ph.D.s but still a good overall 50% with postgraduate degrees. The comparatively high number of Ph.D.s at the three universities highlights the importance of ensuring that they are effectively integrated into the national agricultural research program after their teaching duties have been met.

Table 5: Qualifications & Experience Profiles of National Agricultural Scientists, Based on Questionnaire Survey

Institution	Number Respondents	Number Women	% scientists in post	Qualification			% Post Grad. Degrees	Experience (years)					
				Ph.D.	M.Sc.	B.Sc.		0-5	6-10	11-15	16-20	21+	% 11+
CSIR													
ARI	14	2	87	3	8	3	78	5	2	5	0	2	50
CRI -Kumasi	33	0	90	7	15	11	67	17	7	2	3	4	27
CRI -Myankpala	9	0	100	3	5	1	90	6	2	0	0	1	11
FRI	24	11	77	2	10	12	50	8	6	2	4	4	42
IAB ¹	6	0	86	3	3	0	50	5	1	0	0	0	0
OPRI	9	0	100	2	3	4	55	5	1	2	1	0	33
SRI	11	0	92	0	6	5	54	7	1	2	0	1	43
WRIRI	20	1	83	3	11	6	70	11	6	2	0	1	15
Subtotal	126	14	78	23	61	42	67	64	26	15	8	13	29
University													
FoA/UG	28	6	?	13	15	0	100	8	6	7	3	4	50
FoA/UST	28	4	67	16	11	1	95	6	1	7	7	7	50
SoA/UCC	16	1	?	8	7	1	94	8	4	2	1	1	25
IRNR/UST	7	0	100	2	5	0	100	3	2	1	1	0	29
Mungua farms/UG	4	0	?	2	1	1	25	1	1	0	1	1	50
Kpong R.S./UG	3	0	?	1	2	0	100	0	2	1	0	0	33
ARS Kade/UG	5	0	?	1	3	1	80	0	3	1	1	0	40
Subtotal	91	11		43	44	4	96	26	19	19	14	13	51
Min. of Agriculture													
AHPD	13	0	64	0	8	5	62	6	5	1	1	0	15
Forestry Department	1	0	?	1	0	0	100	0	0	1	0	0	100
Fisheries Res. Unit	4	1	?	0	2	2	50	1	0	1	2	0	75
Citrus&Tree Crops R.S.	2	0	na ?	0	0	2	0	1	0	1	0	0	50
VORADEP	7	0	na ?	0	5	2	71	3	2	1	0	1	29
Subtotal	27	1	64	1	15	11	61	11	7	5	3	1	33
Forestry Commission													
FPRI	14	2	82	5	6	3	79	3	3	3	3	2	57
COCOBOD													
CRIG	na	na	na	na	na	na	na	na	na	na	na	na	na
Quasi-govt. Institutes													
Grain & Legume Dev. Board	7	0	na	0	2	5	29	4	3	0	0	0	0
Ghana Atomic Energy Commission	8	2	na	2	4	2	75	2	3	3	0	0	50
Twifo Oil Palm Plant.	2	0	na	0	0	2	0	0	2	0	0	0	0
Ghana Seed Company	1	0	na	0	0	1	0	0	1	0	0	0	0
ICOUR	1	0	na	0	0	1	0	1	0	0	0	0	0
Mat. Oil Palm Ltd.	2	0	na	0	1	1	50	0	1	1	0	0	50
Timber Exp. Dev. Board	4	0	na	0	1	3	25	2	2	0	0	0	0
Subtotal	25	2	na	2	8	15	47	9	12	4	0	0	16
Grand Total	283	30	na	74	134	75	75	113	67	46	28	29	36

Source: CSIR/ISNAR Individual Scientist Questionnaire Survey
Notes : 1 Fisheries Division, IAB only

The breakdown of scientists by specialization and category of institution is given in Table 6. There are no outstanding gaps overall. Within CSIR institutes there is an apparent shortage of biometricians and rather low numbers of horticulturists, animal nutritionists, and social scientists (for research on socioeconomic constraints at farmer level). However, close consideration of the size of specific disciplinary groupings must be deferred until a comprehensive strategic plan for agricultural research in Ghana has been developed.

The experience profiles of agricultural scientists in non-university institutions in Ghana is less than satisfactory. Only one-third of these scientists have more than ten years of research experience (see Table 5). While experience is a crude proxy for research productivity, nevertheless the high proportion of inexperienced scientists creates serious problems in ensuring that they are effectively supervised and trained on the job. The situation of CRI is particularly worrying, probably reflecting losses of senior staff and new recruitment in recent years. The faculties of agriculture have a more satisfactory experience profile. Within CSIR, the limited experience of many agricultural scientists is also indicated by the fact that 75% are assistant research officers or research officers (see Table 7). In light of the significant role of women in agriculture, it is probably less than satisfactory that fewer than 10% of agricultural scientists in Ghana are women (Table 5).

The comparative failure to develop a sizeable group of experienced scientists is almost certainly attributable to persistently high rates of attrition. Up to the late 1970s considerable progress had been made in building up the size and experience profiles of agricultural scientists employed by CSIR and at the universities. However, this was dramatically reversed with the deepening of the economic crisis in the early 1980s. The core CSIR agricultural research institutes (ARI, CRI and SRI) lost more than 60% of their scientists employed between 1980 and 1985 (see Table 8) and the total number of scientists employed fell by nearly 40%. There has been a slight improvement in the rates of attrition since then, but the situation remains fragile.

Fifteen years of institution building efforts have been jeopardized as a result of the prolonged economic crisis during the 1970s and 1980s. That the situation is still as good as it is (in comparison with most African countries) reflects very favorably on the earlier phase of development of human resources for research.

The research cadre is still capable of effectively utilizing substantial increases in funding for research operations.

4.2.2 Other Skill Profiles: Technical Support Staff

Few data are available on the numbers and skills of technical officers and technical assistants working in agricultural research in Ghana.

Table 6: Discipline of Agricultural Scientists in Ghana by Main Category of Institution, 1989

Specialization Discipline	CSIR	Universities	Ministry of Agriculture	Government and Quasi-government Institutions	Total
Agricultural Science	10	2	3	2	17
<u>CROPS</u>					
Genetics/Breeding	6	3	0	1	10
Agronomy/Crop Science	20	7	2	8	37
Horticulture	3	4	2	0	9
Entomology/Protection	10	8	1	3	22
Pathology	5	2	0	0	7
Chemistry/Soil Science	13	7	3	1	24
Physiology	4	2	3	0	9
Soil Physics	0	0	1	1	2
Subtotal	61	33	12	14	120
<u>LIVESTOCK (incl. 5 poultry)</u>					
Animal Science	1	8	1	1	11
Veterinary Medicine	3	4	11	0	18
Breeding	3	3	0	0	6
Nutrition	2	5	0	0	7
Physiology	0	1	0	0	1
Dairy	0	1	0	0	1
Subtotal	9	22	12	1	44
<u>FISHERIES</u>					
	3	1	1	0	5
<u>FORESTRY</u>					
Silviculture	0	2	1	1	4
Wood Technology	0	1	0	5	6
Subtotal	0	3	1	6	10
Food	14	1	0	1	16
Agricultural Economics	7	11	1	3	22
Farming Systems	1	1	0	0	2
Extension/Rural Development	1	9	0	0	10
Agri. Engineering/Other Engineering	6	2	0	0	8
Irrigation	4	2	0	0	6
Subtotal	33	26	1	4	64
<u>OTHER SCIENCES</u>					
Water Resources	8	2	0	0	10
Statistics/Maths	0	3	1	3	7
Biology/Botany	12	2	4	2	20
Chemistry, etc.	5	0	0	0	5
Subtotal	25	7	5	5	42
<u>GRAND TOTAL</u>	148	91	35	26	300

Table 7: Grades of Scientists and Technical Officers at CSIR Agricultural Institutes, 1989.

Institute	Scientists ¹					Total	Technical Officers				
	D/CRO ²	PRO	SRO	RO	ARO		CTO	PTO	STO	TO	Total
ARI	-	1	3	9	3	16	3	1	4	4	12
CRI-Kumasi	-	4	7	23	15	49	7	9	11	18	45
CRI-Nyankpala	-	1	0	8	4	13	1	1	2	4	8
FRI	2	5	3	10	11	31	3	4	7	5	19
IAB	1	0	8	7	4	20	0	1	1	2	4
OPRI	1	0	1	4	4	10	0	1	1	0	2
SRI	1	0	2	3	6	15	4	6	6	12	28
WRI	1	2	2	14	10	29	0	1	3	5	9
TOTAL	6	13	26	78	57	183	18	24	33	50	127

Source: CSIR/ISNAR Institution Questionnaires and 1989 Estimate of Expenditure.

Notes : 1 Includes positions of scientists who are undertaking in-service training.

- 2 D/CRO = Director/Chief Research Officer
 PRO = Principal Research Officer
 SRO = Senior Research Officer
 RO = Research Officer
 ARO = Assistant Research Officer
 CTO = Chief Technical Officer
 PTO = Principal Technical Officer
 STO = Senior Technical Officer
 TO = Technical Officer

Table 8: Percentage Attrition of Scientists and Technical Officers from CSIR Agricultural Institutes, 1975.

Institute	Year							
	1975 - 1980		1980 - 1985		1985 - 1988		1975 - 1988	
	S*	T*	S	T	S	T	S	T
ARI	33	0	68	0	0	0	83	0
CRI, Kumasi	14	41	58	46	na	na		
CRI, Nyankpala	-	-	-	-	0	11	na	na
CRI-GGDP	na	na	na	na	11	0	-	-
FRI	na	na	na	na	8	19	58	50
IAB	na	na	na	na	22	0	42	1
OPRC/I	-	-	33	50	25	25	-	-
SRI	23	16	68	72	11	21	77	79
WRI	na	na	na	na	0	0	-	-

Source: Staff lists and Estimates of Expenditures (various)

Notes : * S = Scientist T = Technical Officer

1 No technical officers in post in 1975

In CSIR, a total of 127 technical officers are currently employed in the agricultural research institutes (see Table 7). The overall ratio of scientists to technical officers is 1:0.8, which is low compared with what would be considered desirable. Many scientists interviewed complained that they spent too much time on tasks that should be undertaken by technical officers.

From the grade breakdown of CSIR technical officers it would appear that they are a relatively experienced and well-trained group. However, rates of attrition for technical officers in some institutes have been as high as for scientists during the last ten years (see Table 8).

4.2.3 Managers

The task of managing a CSIR institute is one of considerable complexity, especially in times when the economic environment is harsh and the ability to obtain and utilize both national and donor resources is critical. Few research staff reported that they had any training in management, especially management of research. Some supplementary training in management skills should be considered.

4.2.4 Strategic Human Resource Planning

Little or no strategic human resource planning at either the national agricultural research system or institution level has been undertaken in Ghana for at least twenty years. This is despite the fact that the numbers of agricultural scientists employed have more than doubled during this period (see Annex 5 Table A3).

The development of a comprehensive human resource plan for the NARS in Ghana will be an essential component of the proposed medium-long-term agricultural research plan. A detailed job evaluation also needs to be undertaken, particularly at the CSIR institutes. Establishment totals have remained largely unchanged for many years, and there seem to be excessive numbers of some lower-level support staff at some institutes who should perhaps be redeployed (see Table 9).

Table 9: Distribution of Total Establishment of Staff at CSIR Institutes

Institute	Senior Staff	Junior Staff	Other Staff (monthly rated)	Total
ARI	39	108	165	312
CRI (Kumasi)	56	223	587	866
CRI (Nyankpala)	32	73	366	471
FRI	59	66	27	152
IAB	58	70	38	166
OPRI	14	179	325	518
SRI	66	136	317	519
WRII	48	65	24	137

Source: 1989 Estimates by Institutes

4.2.5 Human Resource Development (See Annex 5 for more detailed discussion.)

The importance of further training for research staff beyond basic qualifications is well recognized in CSIR, and requirements for postgraduate training for research officers is written into the scheme of service. Implementation is limited by available resources, but within the medium-to-long-term plan CSIR should take the lead in developing a comprehensive training strategy and plan for national agricultural research in Ghana that clearly spells out training policies, procedures, and estimates for training requirements at all levels of research personnel. Consideration should be given to appointing a Training Officer reporting to a Training Committee to ensure due prominence and attention to this vital sector of activity.

The role of the universities, both in providing high-quality graduates for recruitment into research services and for subsequent postgraduate training in specialized areas, is extremely important in the long run. Currently, the physical facilities in the Faculties of Agriculture at both UG, Legon and UST Kumasi are seriously run down due to a long period of neglect and deterioration. There is an urgent need for rehabilitation of faculty facilities to maintain the quality of graduates, not only for research but for service to agriculture in general. Rehabilitation of research facilities at the universities, and especially the up-dating of the library services, will be vital if effective postgraduate training is again to be offered in a range of specializations. All current postgraduate training for about 30 CSIR research institute personnel is based in overseas institutions. At present, this leaves about 40 research staff in CSIR agricultural research institutions that are less than 35 years old, and who should be started on postgraduate degree courses in the next 2-3 years, not an unreasonable target.

The value of short-term in-career technical training opportunities is also recognized by senior management, but there have been very few such courses in Ghana in recent years, either for professional research or technical support staff. Provisions for such short-term training opportunities should be included in future planning.

4.2.6 Motivation: Benefits and Career Advancement

The serious decline since the mid 1970s in the real value of salaries constitutes a major threat to researcher productivity in various ways. The low level of salaries by world standards makes it difficult to retain good scientists with internationally recognized qualifications. Moreover, the perceived need to carry on secondary income-generating activities is a significant constraint to the intensity of the research effort.

However, within Ghana, salaries of university and CSIR professional research staff are at least comparable with equivalent professionals in other civil service positions, and given the realities of current public-sector policy, there is little scope

for early increases in pay. Special attention should be given to possible improvement of non-salary benefits.

The overall promotion process in CSIR is well conceived, in particular in the reliance placed on Promotion Panels and meritocratic performance criteria. However, many CSIR research scientists have reservations about the prevailing criteria for promotion, in which excessive reliance is placed on refereed publications that may not be the appropriate outcome of their research work. It is recommended that new criteria should be developed, based on the performance of the individual in reaching well-defined research objectives in line with national agricultural research policy as interpreted in the particular institute, and supported by evidence of positive impact on appropriate client groups.

4.3 FINANCIAL RESOURCES

Funding comes to the agricultural research services through a variety of channels: from the Government of Ghana, via the Ministry of Industry, Science and Technology and CSIR, via the Ministries of Agriculture, and Education and Culture, and other ministries and parastatals; and from external donors. For the national research institutes, whose main purpose is research, it is relatively straightforward to determine the financial resources applied to research, and this accounts for most public agricultural research funding. However, financial data on research carried out by other ministries, parastatals, and universities cannot be obtained directly, as none of these organizations separates agricultural research from the rest of their activities in their budget. (The research stations of the universities, and the Grain and Legumes Development Board, are exceptions.) For these organizations, intelligent estimates have had to be made. The professional staff time allocated to research has been taken as the main guide towards estimating financial allocations, together with current levels of funding per researcher at CSIR institutes. Details are given in the notes to Table 1 in Annex 6. A summary of the funding for research in 1986 and 1987 is given in Table 10.

Table 10: Funding for Agricultural Research 1986 & 1987 (in current millions of Cedis)

	1986	1987
CSIR Institutes (for agricultural research)	597	919
CSIR Secretariat (share of agriculture)	36	48
Forest Products Research Institute	75	101
Cocoa Research Institute of Ghana	<u>1,037</u>	<u>1,141</u>
Total national research institutes	1,745	2,209
Universities	130	180
Other Ministries and parastatals	<u>281</u>	<u>380</u>
Grand Total	2,156	2,769
	=====	=====
(Grand Total in constant 1987 million Cedis)	(3,018	2,769)

4.3.1 Overall Funding Level

The total level of funding reflects the current investment in support of agriculture through agricultural research. This is often expressed in relation to the agricultural contribution to the Gross Domestic Product (AGDP), or to the area of arable land. The averages of 1986/87, in constant 1987 prices, show overall funding at 0.80% AGDP and US\$ 1.30 per hectare of arable land. (See Tables 11 and 12.) Cocoa research presents a special case: it receives special funding as a result of cocoa's importance in the economy as an export crop. Omitting cocoa from both research funding and AGDP, the overall value of research funding is 0.57% AGDP and US\$ 0.72 per hectare of arable land.

How can these levels be interpreted? Levels of investment in agricultural research in developed countries are about 2% of AGDP. The World Bank has recommended that developing countries increase research funding levels rapidly to 1% AGDP and raise this to 2% AGDP by 1994 if this is feasible, in terms of financial capabilities of the country and of the capacity of the research system to absorb such rates of funding effectively.

Certainly, in contrast to some other countries short of trained manpower, Ghana has the capacity to absorb additional funding for research. On this score, the average Ghana level of funding is low, and the research funding per hectare of arable land is lower than average.

However, research funding in developing countries in comparable circumstances averaged only 0.29% AGDP and US\$ 0.96 per hectare of arable land¹ in the period 1980-85 for developing countries with 10-15 million inhabitants; indicating that the level of funding in Ghana may be better than average. However, this might be misleading since, as indicated in the footnote, the other developing countries may be underestimated; and Ghana's AGDP has been depressed recently, leading to apparently higher rates of investment in terms of AGDP.

4.3.2 Funding Level per Scientist

The overall funding level reflects the national investment in research, but the level of operating funds per scientist is a good indicator of whether the research scientists have adequate financial resources to work with. While salary rates vary greatly from one country to another, the costs of research equipment and supplies are much less variable; vehicles, fuel, chemicals, fertilizers, laboratory and field materials and equipment, utilities, building and road maintenance, etc. tend to be more expensive in developing countries than in developed, even if casual labor is cheaper. The "operating cost" is taken broadly as those research costs other than salaries, salary-related allowances, and

1. Figures from ISNAR data base; they may be low since, often, only the funding of research institutions is detailed in government budgets, but not research at universities, parastatals, and ministries.

Table 11: Summary Statistics on Agricultural Part of Gross Domestic Product

A. In millions 1986 & 1987 current Cedis

	Ag. GDP		Ag. Research		Ag. Res. Exp. as a share of Ag. GDP ¹	
	1986 (a)	1987 (b)	1986 (c)	1987 (d)	1986 (e)	1987 (f)
Total						
Agriculture	244,317	377,481	2,155.8	2,768.6	0.88	0.73
Agriculture & Livestock	175,621	266,077	1,027.4	1,492.2	0.58	0.56
Cocoa	41,017	66,030	1,037.1	1,140.9	2.53	1.72
Forestry	18,870	34,607	74.7	100.9	0.40	0.29
Fishing	8,809	10,768	16.7	34.6	0.19	0.32

B. In millions 1986 & 1987 constant Cedis (at 1987 prices)

	Ag. GDP		Ag. Research		% ² Change (k)	As a % of Ag. GDP ³ 1986-87 (l)	Res. Exp. as a % of total 1986+87 ⁴ (m)	Contri- bution to Ag. GDP (%) ⁵ (n)
	1986 (g)	1987 (h)	1986 (i)	1987 (j)				
Total								
Agriculture	342,044	377,481	3,018.1	2,768.6	-8.3	0.80	100.0	100.0
Agriculture & Livestock	245,869	266,077	1,438.4	1,492.2	+3.7	0.57	50.6	71.2
Cocoa	57,424	66,030	1,451.9	1,140.9	-21.4	2.10	44.8	17.2
Forestry	26,418	34,607	104.6	100.9	-3.5	0.34	3.6	8.5
Fishing	12,333	10,768	23.3	34.6	+48.5	0.25	1.0	3.2

Notes:

- 1 (e) = (c):(a); (f) = (d): (b)
- 2 (k) = [(j)-(i)]:(i)
- 3 (l) = (i+j):(g+h)
- 4 Calculated in columns i + j
- 5 Calculated in columns g + h

Sources:

- Agricultural research expenditures are from Tables 1 and 2 (Annex 6).
- Agricultural GDP figures are from Quarterly Digest of Statistics, June 1988, as quoted in: World Bank, Ghana: Structural Adjustment for Growth, January 23, 1989, p. 120-121.

Table 12: Ghana's Agricultural Research Expenditures Compared with a Sample of Developing and Developed Countries (Ghana 1986-87⁴; others 1980-85)

	Ghana	Developing Countries ²	Developed Countries
AG. RESEARCH EXPENDITURES			
As a % of Ag. GDP ¹			
• excluding cocoa	0.57%		
• including cocoa	0.80%		2.04%
• CSIR only	0.36%	0.29%	

Per hectare of arable land ³			
• excluding cocoa	0.72 US\$	0.96 US\$	1.74 US\$
• including cocoa	1.30 US\$		

Number of scientists per million ha of ag. land	25	29.6	19.4

Number of researchers per US\$ billion of Ag. GDP	120	89.2	226.6

Notes:

- 1 Average of 1986/87 calculated using 1987 constant prices.
- 2 The comparison is made with "medium-large" developing countries (10 to 15 million inhabitants), of which Ghana belongs. As pointed out in the text, the comparison is biased, as figures for developing countries may underestimate research funding. Thus, the comparison is valid only with CSIR funding. Figures for developed countries are likely to be more accurate.
- 3 Agricultural land area is estimated at 13,700,000 hectares: Policy Planning, Monitoring and Evaluation Division, "Agricultural Land Base of Ghana", Ministry of Agriculture, 1988.
- 4 Calculated at constant 1987 prices.

major capital expenditures. Experience from general crops research stations in other developing countries where research work is proceeding reasonably smoothly suggests that, in current prices, operating funds should be at least US\$ 20,000 - 25,000 per research scientist, irrespective of whether salary rates are high or low. Internal comparisons within Ghana's recent history support this contention.

Tables 13 and 14 (and in Annex 6, Tables 3 and 4) show funding details for CSIR research institutes in 1987 and 1974, all expressed in 1987 cedis and dollars. The average operational funding per scientist in 1987 in CSIR institutes and FPRI, when operational funding was a serious constraint to effective research, was US\$ 10,100 per year. In 1974, when it is acknowledged that research stations were running reasonably well but not extravagantly, the average operational funding per scientist was (1987) US\$ 20,500 per year.

Table 13: 1987 Funding of Agricultural Research: Operating Funds and Total Recurrent Costs Per Scientist (in Cedis and US\$)

	Number of Scientists	Operating Funds per scientist		Total Recurrent Costs per scientist	
		Cedis	US \$	Cedis	US \$
CSIR					
ARI	15	470,000	2,900	3,200,000	19,600
SRI	10	1,190,000	7,300	7,900,000	48,600
OPRI	8	2,630,000	16,200	12,100,000	74,700
FRI	26	330,000	2,000	1,300,000	8,100
IAB	11	690,000	4,200	1,900,000	11,700
CRI					
Nyankpala	13	5,230,000	32,300	9,100,000	56,000
GGDP	22	2,630,000	16,200	5,860,000	36,000
Others	14	1,770,000	10,900	8,500,000	52,400
FPRI	18	1,010,000	6,200	5,200,000	32,100

Average per Scientist	137	1,640,000	10,100	5,400,000	33,140

Table 14: 1974 Funding of Agricultural Research: Operating Funds and Total Recurrent Costs per Scientist in CSIR (converted in 1987 Cedis and US Dollars)

	Number of Scientists	Salaries as share of recurrent costs	Operating Funds per scientist 1987 Value		Total Recurrent Costs per scientist 1987 Value		Ratio of 19 funding lev over 1974
			Cedis	US \$	Cedis	US \$	
CSIR							
ARI	12	.58	4,000,000	24,800	9,500,000	58,900	.12
SRI	16	.75	2,200,000	13,400	8,700,000	53,500	.54
IAB	11	.25	2,200,000	13,800	3,000,000	18,500	.31
CRI	29	.67	4,200,000	25,800	12,500,000	77,400	.42 ²
FPRI	16	.59	3,200,000	19,900	7,900,000	48,600	.31
Average per Scientist ¹	84	.64	3,300,000	20,500	9,200,000	56,700	.49

Notes:

¹Weighted average

²Ratio calculated for CRI excluding Nyankpala and GGDP

The comparison among institutes is also informative. Current operating funds range from US\$ 2,000 per scientist in FRI, and US\$ 2,900 for ARI, up to US\$ 16,200 in OPRI and GGDP, and US\$ 32,300 in Nyankpala. In 1974, operational funding per scientist at ARI was comparable with that at CRI at about US\$ 25,000.

Even in this rapid, broad assessment, it is evident that several research institutes do not receive adequate operating funds to be effective, the exceptions being the institutes with projects that receive extra backing from supplementary external funding. While it is recognized that different types of research need different levels of operating funds, it is obvious that some institutes cannot be expected to operate efficiently, given their present low level of operating funds.

Some difficult choices are implied; either to increase the level of operating funds to appropriate minimum levels by increasing the overall national recurrent investment in agricultural research; or, if operating funds are to be kept constant, to reduce the size of programs and staff so that the remaining scientists have adequate resources to work with. But it is unrealistic to expect research output of high quality and quantity if operating funds are inadequate.

The implications for the size of the research system of various levels of overall rates of funding for agricultural research, combined with the different rates of funding per scientist, are discussed in Annex 6 and summarized in Table 15.

Table 15: Number of Full-time Scientists Sustainable at Different Levels of Overall Support for Agricultural Research (Illustrated for 1987 AGDP)

Total Funding per Scientist		Total Funding (excluding Cocoa)		
		0.5% AGDP Cedis 1557 mill.	1.0% AGDP Cedis 3115 mill.	1.5% AGDP Cedis 4672 mill.
1987	<u>Average level of</u> US\$ 33,000	290	580	870
	US\$ 43,000	223	445	668
	US\$ 48,000	200	400	600
1974	<u>Average level of</u> US\$ 57,000	168	336	504

* As indicated earlier, the overall rate of national funding for research should reasonably be increased to reach the 1974 level of operating fund per scientist; that is, US\$ 20,000 instead of the

current US\$ 10,000. This would raise the total funding per scientist to about US\$ 43,000, resulting in agricultural research investment representing 0.68% of the 1987 Ag GDP instead of the current 0.57% (excluding cocoa), and a 19% increase over the present level of funding.

4.3.3 Distribution of Funding between Operating Expenditures and Salaries

A high share of all recurrent expenditures is absorbed by salaries, leaving very little for operating funds: salaries constitute 71% of the total expenditure for CSIR and FPRI as a whole and over 80% for FPRI, SRI, ARI, and the non-project part of CRI (see Annex 6 Table 5). Of all the research institutes, only the Nyankpala station and the GGDP show more reasonable funding distributions (42% and 55% to salaries respectively), because external funding complements the national contribution.

However, the large proportion of recurrent expenditures going to personnel cannot be entirely explained by the low funding of operations alone, nor by the levels of salaries, which are already quite low. Table 9 shows that on the average level of establishment for staff at CSIR research institutes, each senior staff is supported by more than seven junior and other permanent staff. Not all senior staff are professional researchers, so the establishment level of support per researcher is appreciably higher than seven; and probably more than 12. This ratio is higher than might have been expected from experience elsewhere, and there may be a case for some reduction in the number of junior and other support staff per researcher (i.e. the existing number of support staff could probably support more researchers).

4.3.4 Funding per Commodity Grouping, and between Institutions

Tables 10 and 11 (and Annex 6, Tables 1, 2, and 5) give some detail of the funding for research among groups of research institutions and commodities. It is immediately apparent that cocoa research at CRIG received in 1986/87 45% of national research funding, while contributing only 17% to AGDP. But cocoa is a very special case, discussed briefly below.

Applying a very approximate congruence test on the other groups of commodities, agriculture and livestock research received 51% of all funding, while contributing 71% to AGDP; while forestry and fisheries received 3.6% and 1.0% of research funding but contributed 8.5% and 3.2% to AGDP respectively. Expressed differently, cocoa research received 2.1% of cocoa's contribution to AGDP; agriculture and livestock 0.57%; forestry, 0.34%; and fisheries 0.25% of fisheries contribution to AGDP.

Cocoa deserves special mention. Although it has lost ground in the Ghana economy recently, both because of a substantial fall in production and as a result of unfavorable market prices, cocoa still occupies a dominant position in agriculture and in its

capacity for earning foreign exchange. It also has a lot of productivity problems that are hopefully amenable to reduction by agricultural research, and worth a considerable research effort. Unfortunately, there is not a lot of research information or new technology to borrow from other countries, and Ghana must mount a large enough research team (currently 29) to cover the full spectrum of research from testing and demonstration, through applied, up to long-term strategic and even some basic research.

A recurrent research investment of 2.1% of the value of the commodity is not at all large in light of the program to be implemented and the strategic importance of the crop. Moreover, the production of cocoa is currently depressed; as the production and value of the crop increases, then the current levels of expenditure on 29 scientists and their support staff will represent a smaller percentage of cocoa ACDP, which will drop back towards 1%. Meanwhile, the research effort at CRIG is to be strengthened separately by a considerable addition of Technical Assistance from external donors.

4.3.5 Evolution of Funding Levels

Table 8 of Annex 6 compares the 1974 funding of CSIR research institutes with the 1985 to 1987 ones, all expressed in constant 1987 cedis. ARI, SRI, FRI, and FPRI receive less real funding than they did in 1974. The situation for the CSIR secretariat is extreme, since its funding is only 33% of what it used to be. This is bound to have had a serious effect on its capability for central planning and monitoring. IAB, CRIG, and WRRRI are all receiving more now than in 1974. Table 14 also looks at the evolution of operating funds: on the average the 1987 operating funds are half of what they used to be, the worst case being ARI, with 1987 operating funds representing only 12% of the 1974 level.

4.4 PHYSICAL FACILITIES

Agricultural research in Ghana is well endowed with numbers of research stations and trial sites, fairly well distributed around the country. However, few government research stations are in uniformly good condition with respect to land, office and laboratory buildings, staff housing, laboratory and field equipment, vehicles, and library services. Details of the physical facilities at the 57 institutes, stations, and sites visited by the team are included in the report file. A brief summary is given in Table 16. Many of the organizations listed have several substations and testing sites. Few of the substations have graduate research staff permanently based at the substations. Ownership of some of the substations was in dispute between different organizations.

4.4.1 Stations and Substations

Almost all research stations and substations are in need of extensive rehabilitation and refurbishment in one way or another, following several years of neglect and low levels of maintenance.

However, the team concluded that there are probably too many stations to maintain them well, and that in a subsequent planning phase, there was a great need for rationalization of facilities needed by different research organizations, and careful selection made of stations for rehabilitation and improvement. Institutes, ministries, and universities have stations that have overlapped in ecological and experimental coverage, each group having evolved and expanded independently.

The team recommends that in any reasonably defined agro-ecological zone, one organization, whichever is most convenient, should be responsible for the basic operation of any one research station or substation (the maintenance of all buildings, laboratories, farms, administration, etc.). Experiments and studies from other organizations (universities, institutes or ministries) would be made welcome, within the limits of the station and with a joint planning process. Operational costs for running experiments would have to be contributed from a visiting organization to the host organization. In many cases the host organization would be the Ministry of Agriculture or Regional Agricultural Office, the station being involved with other activities as well as research, but with general facilities that could be equally well used for research activities. Some of the GGD Project operates effectively in this way. It would be a valuable step towards nationally coordinated commodity studies (as for example, in a national livestock breeding program that would involve university, institute, and ministry staff and stations in necessary collaboration to ensure a large enough base for effective studies (see Annex 11)).

When mutual agreement has been reached on which substations are most important to maintain, a well-focussed national rehabilitation program can be put into effect, covering selected university, national institute, and ministry stations. An important incidental requirement for such an arrangement would be the provision of adequate transport and travel allowances for national research institute staff, who would probably have the most distance to travel to monitor experiments. Vehicles are also vital for travelling off-station to carry out valuable on-farm trials that test technologies under farmers' socio-economic conditions.

4.4.2 Buildings

The buildings housing offices and laboratories at main stations for the most part are sound, some even good, but most are in need of some refurbishing or renovation. Four institutes have new facilities either under construction or at the planning stage. These include the new CRI and FPRI facilities at Fumisua, a new ARI facility at Katamanso, and a proposed facility for the Institute for Renewable Natural Resources (IRNR) at UST. Many buildings lack adequate air-conditioning to accommodate electronic laboratory instrumentation or even simple seed storage. Out-stations are in a greater state of disrepair than main stations.

Table 16: Institutional Physical Resources Available for Agricultural Research in Ghana

PLACE	LANDS	OFFICE/LAB BUILDINGS	HOUSING		EQUIPMENT			VEHICLES			LIBRARY FACILITIES ²
			Research Staff	Other Staff	Laboratory	Field	Office	Motorcars Lorries	Tractors	Others ¹	
1. CSIR INSTITUTES											
CRI (Kwadoso)	A	IN	IN	P	P	P	IN	P	P	L	A
CRI (GGDP)	A	IN	IN	P	G	G	G	G	G	G	IN
CRI (Nyankpala)	A	G/IN	G/IN	G/IN	G	G	G	G	G	G	L
CRI (Kpeve)	A	G/NR	P/IN	P/IN	L	L	L	P	L	L	L
CRI (Aiyinase)	A	P/IN/NR	IN/NR	IN/NR	L	L	L	L	L	L	L
CRI (Ohawu)	A	P/IN	IN	P/IN	L	IN	L	L	A	L	L
CRI (Bunso)	A	A	G	P	G	G	IN	P	IN/NR	L	L
SRI	A	G	IN	IN	G/O	O/NR	P	P	P	L	G
ARI	IN	P	IN	P	P	P	P	P	P	L	G
FRI	NI	P/IN	G	P	P/O/IN	NA	G	A	NA	L	IN
IAB	NI	A	IN	P	G	IN	G	P	P	L	IN
WRRI	NI	G	G	P	G	G	G	P/NR	NA	NI	G
OPRI	A	A	IN	P	G	G	G	G	G	A	G
FPRI	A	P	L	IN	IN	L	P	IN	L	L	IN
2. UNIVERSITIES											
UST (Faculty)	A	G	G	P	O/NR	P	IN	P	IN	L	G
UST (IRNR)	A	P	G	P	P	P	IN	G	L	L	IN
UG (Legon)	A	G/NR	G	P	IN/L	IN	IN	P	P	L	G
UG (Kade)	A	A/NR	IN	P	O/IN	IN	IN	IN	IN	L	IN
UG (Kpong)	A	P/IN	IN/NR	P/IN	P/IN	P	P	IN	P	L	IN
UCC	A	IN	G	P	IN	A	A	P/U	G	L	IN
3. MINISTRY OF AGRICULTURE											
Crop Services	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
IDA (Afife)	A	A	IN/P	IN/P	L	A	A	NI	NI	NI	NI
IDA (Aveyime)	A	IN	IN	P	L	IN	IN	O	IN	L	L
IDA (Dawenyah)	A	P/IN	NI	NI	NI	NI	NI	NI	NI	NI	NI
IDA (Asutuare)	A	P	P	P	L	A	A	IN	A	L	L
Bast Fibre	A	P/L	P	P	L	P	P	P/IN	P/IN	L	L
Asuansi	A	P	P	P	L	IN	P	L	P/IN	L	L
Sheep Farm (Ejura)	A	P	IN	IN	L	P	P	IN	NI	L	L
Ejura Farms	A	G	G	NI	L	G	A	A	G	L	L
GLDB (GGDP)	A	G	G	NI	L	G	G	G	G	G	L
GLDB (Ghana Govt.)	A	G	G	NI	L	G	A	G	G	G	L
VORADEP (Kpeve)	A	G/NR	NI	NI	L	P	P	P	P	P	L
			P/IN	L	L	L	P	L	L	L	L

Notes: 1 - Motorcycles & Bicycles
 2 - Excluding books
 IN - Inadequate

NI - No information
 NA - Not applicable
 PU - Poor/Unserviceable
 G - Good
 A - Adequate
 P - Poor

O - Obsolete
 L - Lacking
 NR - Needs Renovation, Replacement, or Rehabilitation

Continuation Table 16

PLACE	LANDS	OFFICE/LAB BUILDINGS	HOUSING		EQUIPMENT			VEHICLES			LIBRARY FACILITIES ²
			Research Staff	Other Staff	Laboratory	Field	Office	Motorcars Lorries	Tractors	Others ¹	
4. GOVERNMENT & QUASI GOVT. INSTITUTIONS											
Forestry (Accra)	A	G	IN	P	L	NI	P	IN	IN	L	P
Forestry (Takoradi)	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Game (Accra)	A	P	NI	NI	NI	NI	NI	NI	NI	NI	NI
Mole National Park	A	G	P	P	L	P	P	IN	NI	L	L
FDC Rice Mill	L	P	NI	NI	L	P (Mill)	P	P	P	L	L
Meteorological	NI	G	IN	P	A	G	G	IN	NI	L	NI
Vet. (Pong Tamale)	NI	G	G	NI	G	G	G	IN	NI	NI	IN
5. PRIVATE INSTITUTIONS											
Akropong Farms	A	G	G	G	L	A	G	G	G	L	L
Darko Farms	A	G	G	G	G	G	G	G	G	NI	L
Kpong Farms	A	G	G	G	L	G	G	A	A	A	IN
BOPP	A	G	G	G	A	G	G	A	A	NI	IN
Agro Industries	A	G	G	G	G	G	G	G	A	NI	IN
Nasia Rice Mill	A	G	NI	NI	A	G (Mill)	A	A	G	NI	L
Cotton Company	L	G	NI	NI	IN	G Ginnery	G	G	G	NI	L
Subri Ind. Project	A	G	A	NI	G	A	G	A	G	L	L
PTC	A	G	G	NI	G	G	G	G	G	NI	NI
GOPDC	A	G	G	G	A	G	G	A	A	NI	NI
Ghana Rubber Estate	A	G	G	G	A	A	A	A	A	NI	L
Aveyime Cattle Ranch	A	A	NI	NI	A	A	A	NI	NI	NI	L
Ghana Seed Company	L	IN	NI	NI	L	P	P	P?	P?	NI	L
GAEC	A	G	G	G	G	G	G	IN	L	L	G
ICOUR	A	G	G	G	A	G	G	G	G	G	IN
Komenda Sugar Factory	A	P	NI	NI	NI	NI	NI	NI	NI	NI	NI
National Palm Oil Ltd	A	NI	NI	NI	IN	IN	P	IN	IN	L	L
TOPP	A	G	G	G	G	G	G	G	A	NI	IN
NORRIP	NA	G	G	NI	NA	NA	G	G	NA	NA	L
TVLC	A	G	NI	NI	NI	NI	G	A	A	NI	NI

Notes: 1 - Motorcycles & Bicycles
 2 - Excluding books
 IN - Inadequate

NI - No information
 NA - Not applicable
 PU - Poor/Unserviceable
 G - Good
 A - Adequate
 P - Poor

O - Obsolete
 L - Lacking
 NR - Needs Renovation, Replacement, or Rehabilitation

Research staff housing ranges from good to poor to completely lacking. Where accommodation is not available, institutes provide a rental allowance towards rented accommodation, although these are frequently deemed by the recipients and their directors to be inadequate. Other staff housing in almost all cases was assessed as poor and inadequate, except where donor groups or private industry were involved.

4.4.3 Equipment

In general, the situation with regard to laboratory equipment is extremely serious for the research system, except where donor groups are involved, and for some of the laboratory-orientated institutes. Most laboratories are equipped with obsolete, and frequently, unserviceable equipment. Most operating equipment is of a simple nature, effective but out-of-date by modern standards. Very little state-of-the-art equipment was found on inventory. The university situation is particularly critical in that undergraduates have little opportunity for hands-on experience in using the modern tools appropriate to their disciplines, and academic staff and graduate students may be constrained in their choice of research area by the lack of appropriate equipment.

With similar exceptions, field equipment is lacking or in a poor state of repair; the same situation exists insofar as tractors are concerned. It is true that many organizations can substitute, in part, labor for machines, but in many cases this is not possible, and timeliness of the operations may be compromised. Lack of spare parts, inadequate servicing, and unavailability of expertise for repair and maintenance exacerbate the situation at most locations. The situation with office equipment is similar. Most typing is conducted on old manual typewriters; few offices have facilities for photocopying and those that do have ongoing maintenance problems.

A major limitation to most institutions is vehicles for travel. Most institutes lack cars for movement of personnel to off-station research areas or meetings. Stations with requirements for lorries for support of their field research are poorly serviced as well. The overall state is one of general lack of mobility of several research groups.

The detailed requirements for new equipment and replacements would, of course, depend on the research programs to be followed within a medium-term national agricultural research plan yet to be developed.

4.5 LIBRARY SERVICES

The library and information service is one general facility that is common to all research activities and programs.

One of the major tasks of the research service is to provide well-digested information to its clients. If trained manpower for experimental work is in short supply, often the only information

that can be provided is world knowledge carefully interpreted to match the local situation. Access to up-to-date world information indeed is important in almost all of the tasks of agricultural research at all levels: drawing up policies; deciding priorities; planning research; training research scientists for higher degrees in universities; designing and executing appropriate (and non-replicatory) research programs in research institutes; and communicating results to extension workers and farmers.

The special importance of library services for agriculture was apparently well recognized from earliest times: the first special library was established in 1890 for the Ministry of Agriculture. Ghana's public library services were described by UNESCO in the 1950s as the best in Africa, and scientific and technical information services were very good in the 1970s.

Unfortunately, it has not been possible to maintain good library services since 1978, and the situation in the late 1980s is one of under-funded, under-resourced, under-equipped libraries (see Annex 7). There is an urgent need for rehabilitation that will benefit services across the whole agricultural sector, training, research, extension, and development. It is difficult to think of any project element that would merit higher priority for improving agricultural research capability, and there are good opportunities for introducing modern information technologies in a very cost-effective way.

The existing library facilities, manpower, and literature resources cannot support the existing research system, and would be unable to offer adequate services to complement any proposals for reorganization of the national agricultural research system.

In the universities, too, library resources are sorely depleted. Both academic staff and students lack current literature, to the extent that the viability of offering postgraduate courses in agriculture is seriously in doubt.

4.5.1 Plans and Problems

Despite the run-down state of many libraries, there remains a valuable professional cohesiveness among librarians as a group, and a detailed and well-conceived project, GHASTINET, (Ghana National Scientific and Technological Information Network) has been drawn up to develop a computerized technology information network with CSIR as its focal point. However, the fulfillment of these plans faces some formidable obstacles.

With regard to physical facilities, while a few buildings are inadequate or in a poor state of repair, most are either good (notably the universities and SRI); being replaced by new buildings (CSIR, CRI, ARI); or undergoing repair or refurbishment (Ministry of Agriculture).

However, some libraries are inadequately furnished and do not even have basic desks and seating for users, cannot be kept cool, and need more attention to regular maintenance and cleaning. Few libraries have adequate photocopying facilities; some have none. Those photocopiers with no maintenance contracts are now broken down and are unlikely to be repaired. Lack of typewriters contributes to the inability to produce current awareness bulletins, accessions lists, newsletters, etc.

With regard to manpower, despite the coordinated commitment of many librarians, agricultural librarians face particular problems:

- (i) The numbers and/or quality of staff appointed are sometimes inadequate for the job. Some libraries were staffed by certificate level (post 'O' level) library assistants without skills to deal with information enquiries from researchers. Catalogues, current awareness bulletins, accessions lists, the usual output of a dynamic, well-stocked library, are not produced, because of lack of original materials, and low staff motivation and morale.
- (ii) Local facilities for training professionals are already stretched to the limit. The Department of Library and Archival Studies at the University of Ghana, Legon, does not have adequate facilities for providing postgraduate training.
- (iii) There is no librarian in any of the agricultural institutions with any experience of modern information technology.
- (iv) Present provisions for overseas training (e.g., British Council) are inadequate to meet demand. Access to funding for overseas training (long-term or short courses) depends very much on the individual's initiative in approaching potential donors, or on training being included in a funded project (as with the Ministry of Agriculture library rehabilitation). There is no planning or coordination of training in relation to needs.
- (v) Salary structures and job titles differ between institutions in the agricultural sector: hence there is extreme difficulty in recruiting staff to some positions (e.g., in the Ministry of Agriculture).
- (vi) There is no special library association for the agriculture sector librarians and few, if any, are members of the International Association of Agricultural Librarians and Documentalists (IAALD). Both of these would give them regional and international contacts and access to more information.
- (vii) There is little formal contact with regional and international agricultural library personnel, e.g., those at IITA or ILCA, and little use is made of training resources nearer home, such as those of the University of Ibadan.

Finally, with regard to crucial library acquisitions, most libraries lack current literature, and very few use their own funds to pay subscriptions to scientific journals (in marked contrast to the 1970s). The lack of ability to publish local journals has reduced or removed opportunities for exchanges.

4.5.2 The Future

The introduction of modern information technology using computers with appropriate software, and "CDROM"s (Computer Disc Read Only Memory) for storing large amounts of data and information, would be a great step forward, but the lack of trained personnel in the modern technologies is a serious handicap.

Recommendations for phased improvements are well covered in the GHASTINET proposals. Short-term goals would include provision of adequate furniture and equipment, surveying manpower needs, short training courses, and providing researchers with instant access to current literature through a number of free schemes available. Medium-term goals would focus on further training plans and securing long-term funding of subscriptions. The long-term goal would see all librarians using modern information technology with full collaboration, and with a professional librarian in any institution conducting agricultural research (at a rate of about 1 librarian per 30 researchers).

CHAPTER V

MANAGEMENT OF THE RESEARCH PROGRAM

As indicated earlier, the efficiency of the national agricultural research system is critically dependent on the research program that is chosen to be carried out. The cost of the research system is more or less determined by the government decision to maintain a competent research capability in the country, whatever results are produced. The benefit to be derived by the country from the research effort is extremely sensitive to the detailed choice of experiments and studies to be carried out in the research program each year, and to the relevance of the likely conclusions to reducing important constraints to agricultural productivity. It is only possible to carry out each year a very small percentage of all those studies that might be considered likely to be beneficial. It is therefore essential that these relatively few studies and experiments (component elements of the national agricultural research program) be chosen carefully.

The process of formulation of the national agricultural research program is complex, involving choices and decision-making at several stages, each involving different personnel and different criteria for priority in choices. The process therefore requires careful management and organization. In general, the quality of research programs depends on the training and experience of the researchers putting forward proposals, and their immediate supervisors. (This is part of the management of the means of carrying out research.) But the relevance of the program depends on the management of the research planning process, from national agricultural development policy level to station researcher level.

In the review, the main criticism heard from Ministry of Agriculture staff was that research conclusions and information coming from CSIR institutes were lacking, or not particularly relevant, to the main problems of users of research, and that the Ministry of Agriculture did not have sufficient input into, and influence on, the content of the research program. It is therefore worth reviewing how agricultural research policies are elaborated and how the research programs are determined in the institutes.

5.1. FRAMEWORK FOR RESEARCH PROGRAM FORMULATION

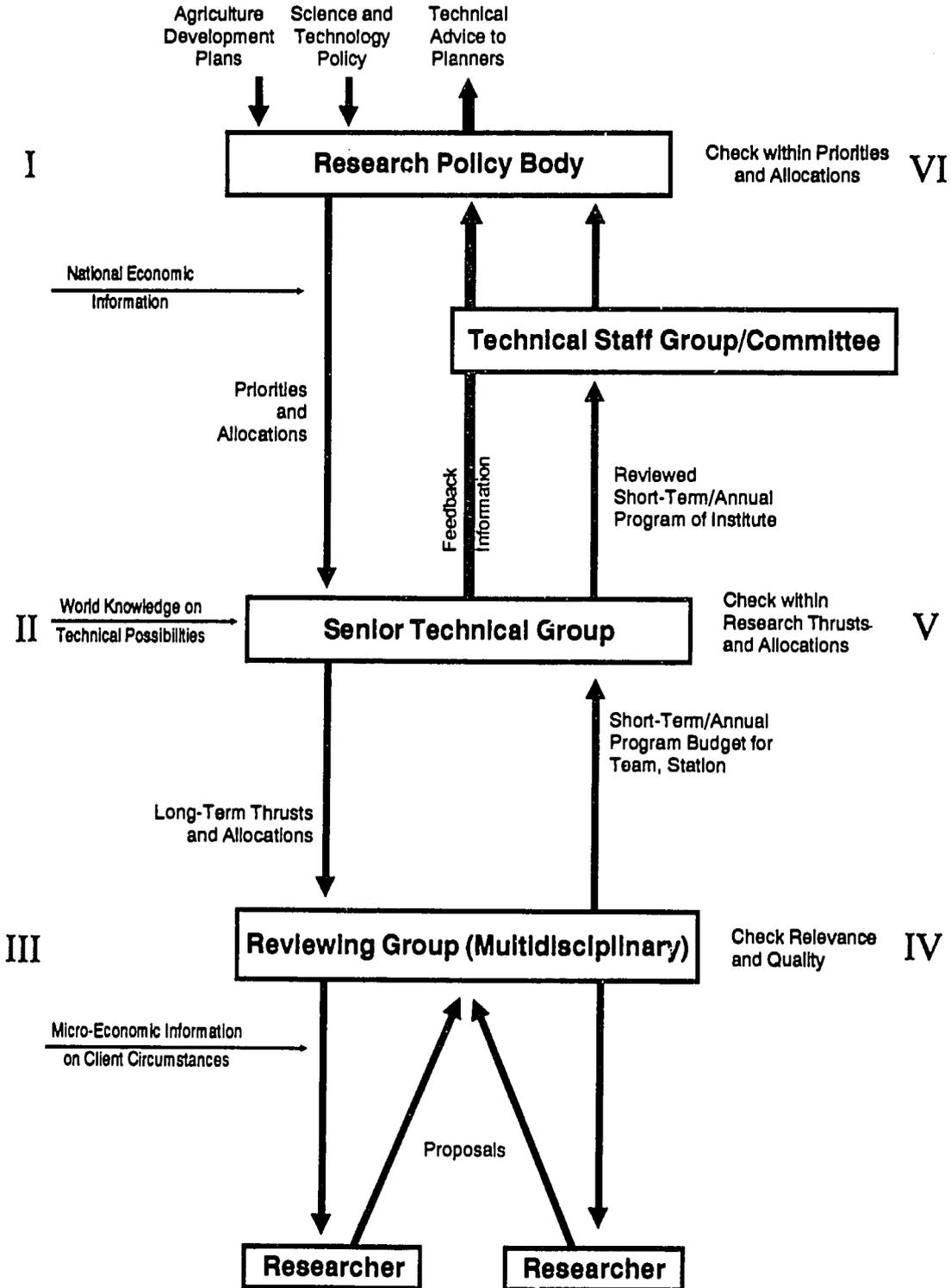
For any review it is useful to have a framework for comparison. The mission used the general six-step framework proposed by ISNAR from a synthesis of experience in several country research systems², summarized in Fig. 4.

The six steps are:

- I Broad priorities/allocation of resources at national level.
- II Research thrusts/allocation of resources at institute level.

2. M. Dagg & F. Haworth, Program Formulation in National Agricultural Research, ISNAR Working Paper No. 17, ISNAR, October 1988.

Fig. 4 : Generalized Six-Step Framework for Formulation of the National Agricultural Research Program



- III Guidance to researchers/indication of resources at station level.
- IV Review of researchers' proposals at station committee level.
- V Review of station proposals at institute level.
- VI Review of institute proposals at national level.

5.1.1. Agricultural Research Policy-Making and Planning

The starting point for the national agricultural research program must be the national agricultural development policy and plan, combined with the national policy and plan for science and technology. These need to be merged and translated into a national agricultural research policy, from which the main agricultural research priorities can be derived, and allocation of resources made to appropriate research institutes and services.

This requires a body with appropriate composition and authority to reach such decisions, preferably on agreed selection criteria for priority setting; and a servicing unit to provide the body with information on which to reach decisions, and to communicate the decisions and guidelines to research institutes. (A more detailed review of the many issues for policy and planning decisions at national and institutional level is given in Annex 9.)

At each research institution, further decisions are required on the sub-allocation of resources to attack the main constraints to productivity within a commodity or production factor. A senior technical body with competence and authority to make such sub-allocation decisions is therefore needed. Where there are several institutions concerned with the same commodity, it is valuable to have an additional senior inter-institutional body to advise on coordinated allocation of resources and programs within the commodity.

Finally, at research station level, smaller groups must decide on how to apply their suballocation of resources on a range of possible experiments and studies on a short-term basis.

This is the end of the program planning phase which involves a number of hard choices for the use of limited resources. Figs. 5 & 6 illustrate how the limited resources are focussed to specific research areas in specific research stations.

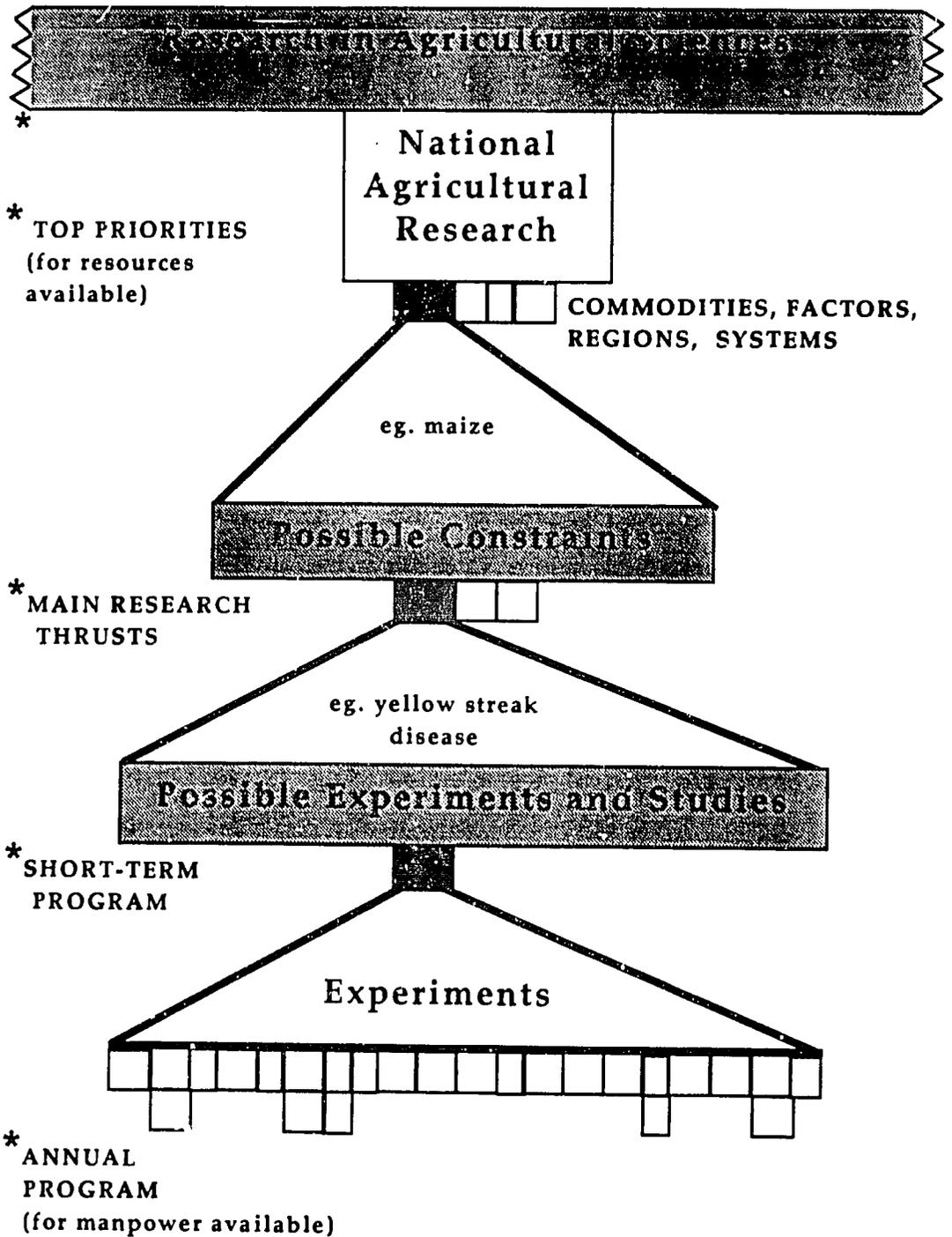
5.1.2 The Development and Review of Annual Research Programs

Within the focussed research area guidelines and likely resources available, researchers put forward proposals for experiments or studies that are reviewed for quality and relevance at the research station level, preferably by a multidisciplinary group.

Approved proposals are reviewed again by the same senior technical group responsible for identifying and planning the main research thrusts, for agreement with the initial plan.

The approved proposals may then go for review by the appropriate national commodity program committee for consideration in the national context for the commodity.

Fig. 5: Choices in Agricultural Research Planning



* Points for choice

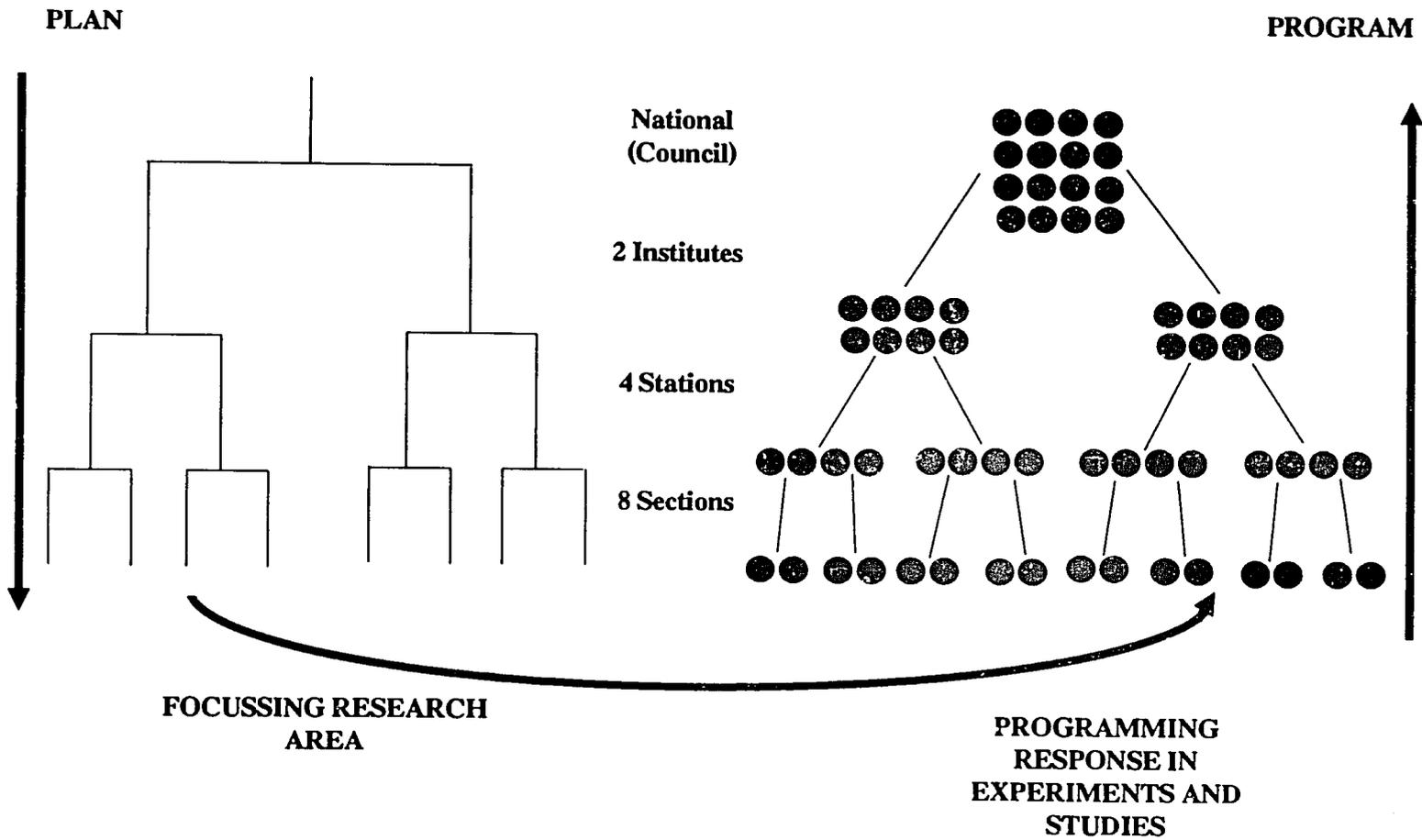


Fig. 6.: National Agricultural Research Program Formulation
(Illustrative at two experiments per section)

Finally the aggregated proposals are reviewed by the policy body, usually via a technical secretariat, to ensure that they are in line qualitatively and quantitatively with the priority guidelines laid down previously, or more specifically, with the program element of a long-term national agricultural research plan, when this has been prepared.

The reviewing phase of program formulation is also shown in Fig. 6, illustrating how the national research program to be carried out is the aggregation of individual experiments and studies proposed by scientists at stations (illustrated on the basis of two experiments per section for 8 sections). The quality and relevance of the experiments must essentially be decided at the decentralized, bottom-level reviewing groups, that can devote enough time for attention to details of design and relevance. Later, higher-level reviewing groups rarely have time for more than acceptance or rejection of proposals (according to whether they are, or are not, within plan guidelines and budget possibilities).

The most important opportunity for research-user members of groups to influence research program decisions is in the planning stages at national, institutional, and station levels, not in the reviewing phase of program formulation. (The representatives of research-user groups are likely to be different at each stage.) It is particularly important that efficient internal linkage mechanisms transmit the planning conclusions from policy level to researchers at the short-term program level.

5.2 CURRENT SITUATION

In general, most research institutes and institutions have a fairly clearly defined procedure for the reviewing of research proposals from individual researchers up to the review of aggregated programs at institute level, after which the program goes to CSIR headquarters and the Ministry of Finance and Economic Planning.

However, the research program planning process is much less clearly defined, and currently there is no recognized national body for guiding agricultural research policy and advising on program formulation.

Discussion will be focussed on the CSIR institutes, since they constitute half of the total research capability and play a central role in research coordination.

5.2.1 National Agricultural Research Policy, Priorities, and Allocation of Resources

The Council for Scientific and Industrial Research has a mandate to coordinate scientific research in the country, and to advise on science and technology policy, but its constitution does not lay any stress on the Council formulating national research policy in any sector, or on advising on allocation of resources to high-priority topics (see Annex 8). However, the CSIR has recognized

the need for planning and bringing research in line with the requirements of national development: the Planning and Analysis Group has been attached to the Director General's office to assist in identifying priority areas where scientific and technological advice is needed, and to recommend assignment of projects to research organizations best suited to deal with the problem. The PAG has had difficulties with its very limited resources, in coping with all of its coordination functions, especially in agriculture. In addition, it does not have authority over these institutions for enforcing its recommendations as to the content of the programs.

In addition, in 1985 the CSIR set up in five sectoral technical committees to elaborate on science and technology policy for each sector and develop plan options for Government's approval. The ultimate object of this will be to produce a science and technology plan that would form part of an overall national socioeconomic plan for Ghana. The Technical Committee for Agriculture, Fisheries and Forestry (TCAFF) represents one of the five committees.

This technical committee could also serve as a National Research Policy Body for Agriculture, Fisheries and Forestry, provided its terms of reference were changed to address agricultural research priorities and to advise on resource allocation for research.

The proposed Agricultural Research Development and Advisory Committee (ARDAC), in the Ministry of Agriculture, does not yet exist but is being discussed as part of the reorganization being undertaken in a World Bank-supported project. Its proposed terms of reference are very directly concerned with elaboration of agricultural research policy, broad objectives and research areas, and advice on resource allocation to research areas based on agricultural development objectives (see Annex 8). However, it is not yet in a position to give policy and research priority guidance to agricultural research institutes.

5.2.2 Management Boards of Research Institutes

The management boards of the individual institutes have had to develop research policies and priorities for the commodities under their jurisdiction. This has been done so far without much formal policy and research priority guidance.

Although Research Committees are appointed by the Boards to review and prioritize research projects, it is not certain whether these committees do not see their roles as more than reviewing the options already presented by the staff to them. In any case, this appears to be a rather late stage for the research users (farmers, Ministry of Agriculture staff) to participate in the process of identifying relevant projects. Participation of the users at this stage of reviewing proposals is not by any means as effective as participating in a systematic process of setting priority guidelines for research areas in a formal planning group, using agreed criteria for reaching priority decisions.

Institution of such a formal planning process at Board (or Research Committee) level would be of great value immediately. The impact of this would be even greater if such policy and priority guidelines had been issued earlier at the national level.

5.2.3 Research Station Meetings

Most research institutes, in describing program formulation, began with the researcher making proposals and described the sequence:

Researcher → Head of Department → Director → (Research Committee) → Management Board → CSIR → Ministry of Finance and Economic Planning (or equivalent).

Some indicated that the Head of Department or Director gave problems to researchers and awaited proposals. Others indicated that problems to researchers arose from ministries, the Board, farmers, colleagues, etc., or donor request. Yet others indicated that research priority was determined by availability of funds; others that projects were decided on general priorities, but implementation depended on funding. No research unit indicated that the likelihood of producing publishable results was a factor in choice of experiments and studies, but individuals agreed that this did exert an influence, when promotion was heavily determined by publication in refereed journals.

The Nyankpala Agricultural Experiment Station described a more formal process beginning with a "Goal-Oriented Project-Planning" exercise every three years, and each year a broad in-house reviewing group scrutinized individual or section proposals. The Ghana Grains Development Project also described a formal approach where planning extended from the Project Management Committee down to research station meetings, with active participation of research users all the way.

The Nyankpala and GGDP models both incorporate the very desirable feature of a multidisciplinary review group to consider initial proposals, as well as a blend of research users and research practitioners. This can serve as the last stage of the research planning exercise (priorities can be assessed in the group in terms of agreed criteria) and as the first stage of the review process (checking for quality and relevance). However, many other research centers did not stress prior group planning guidance or early multidisciplinary review, and relied on the accumulated knowledge and experience of researcher and supervisor to come up with proposals of high relevance and priority.

The team considered that the program formulation process was so important for research efficiency that it was worth all stations and equivalent research units adopting a more formal multidisciplinary review, with agreed criteria for priority setting. It is highly desirable to include social scientists and extension services in the multidisciplinary group at station-level meetings.

5.2.4 National Program Committees

Research work on individual commodities or production factors sometimes extends beyond the bounds of one research institution. The archetypical example is maize, where parts of the total research program take place within CRI; the universities; the Grains and Legumes Development Board; and Extension and Crop Services in MOA. The response cannot be to try to confine all the research within one institution. Some institutions are better suited for certain kinds of research than others. A more appropriate response, as exemplified for maize, is to set up a body to coordinate research work among the different institutions. The maize work is coordinated by the Project Management Committee, the technical leadership being provided by CRI. The linkages between component parts are facilitated by project funds. The Committee and its dependent subgroups form a powerful planning and review mechanism for research program formulation, which has been a great success.

The principle of a national commodity program committee could be extended to other commodities to improve the impact of an overall national program beyond the range of any one institution. Funds to facilitate linkages would have to be budgeted with each institution (or provided centrally via some new mechanism?). However, no other commodity research program currently has as many scientists involved as maize (see Table 17, p. 55).

Indeed, few single commodities would merit an individual commodity committee, as the numbers of scientists involved would be rather small. It would still be valuable to group commodities into root crops, ruminants, etc., to achieve the cross-institution linkage that could be so useful.

A possible example is discussed in some detail in Annex 11, where a case for a viable coordinated research program on ruminant breeding is considered. Table 17 shows that currently 40 scientists completed questionnaires indicating that they spent some time on ruminant research, but their combined time was only 6.54 person years per year. No group in the universities, ARI, or the Department of Animal Health and Production was applying enough time to carry out an animal breeding research program in adequate breadth and depth. However, one closely coordinated program, with each group making its distinctive contribution within a coherent program, could make a significant impact. The necessary costs of maintaining linkages could give a good return from a more integrated and incisive research thrust. There would have to be formal agreement at the highest levels of the institutions to encourage the collaboration, and to agree on the allocation of funds to implement collaboration at lower levels.

5.3. Content of National Research Programs

Brief details of research programs proposed for research centers were collected for most of the institutions visited, at least in terms of the titles of programs. They are available for reference

in the report file. However, not all of these programs are funded, and to list the total would give a misleading picture of the research in hand. Moreover, it is not the objective of this review to describe and comment on the actual program; it is rather to consider the process of determination of the research program, and the general "scope" of the program. The process of program formulation has been discussed above. The general "scope" of the program can be derived from returns to the questionnaire on how researchers applied their time to research on agricultural commodities or factors of production.

Returns showed that national research institute staff and researchers in the MOA used about 53% of their time on actual research; those in parastatals and other ministries 38%, and university staff about 25% of their time.

A summary of the findings is given in Table 17. This has been prepared by accumulating all the research time contributions on specific commodities. The number of respondents contributing to each commodity total is also included to give an idea of the spread of effort. Some of the respondents did not break down their returns into individual commodities; for example, they indicated time spent on cereals, root crops, or ruminants. However, the reality is that most trials and studies towards increasing productivity are indeed on individual crops and animals; results on cattle do not usually apply to sheep, even if the disciplinary training required for the researcher is the same. Other researchers necessarily indicated time spent on research on systems; for example, agroforestry. Others could not realistically associate some of their work with commodities and had to assign it to production factors or disciplinary work (although they had been asked to make time assignments to a commodity wherever possible).

The resultant list looks long, but even so there are some fairly drastic groupings of several commodities to leave the time allocations in realistic numbers: for example, forest biology, ruminants, fruits and vegetables, freshwater fish. The first impression must be of a widely scattered research effort, with 153 person years spread over 57 categories. Furthermore, 534 contributions are indicated, at an average rate of about 0.3 person years/per year/category. Some contributions must be so small as to be of questionable effectiveness. The overall picture does not give the impression of a national program focussing an effective quantum of research effort on a limited number of targets.

There are important concentrations of research effort, outstandingly 16 person years on cocoa; at least 11 person years on maize; six person years on oil palm; and at least five person years on cowpea. This leaves 115 person years spread fairly thinly, with implications that no other commodity has sufficient time allocation to realistically support a program that includes applied research backed by necessary adaptive, testing, and verification research. (To determine what kind of research is being done by researchers would require a more intensive questionnaire and careful definition of what constitutes different kinds of research.)

The spread of the returns raises a question about how carefully research program priorities are being set in relation to national objectives.

5.4 LINKAGES

There are very many linkages that a national research system should maintain with its environment in order to operate as efficiently and effectively as possible. Unfortunately, all linkages cost time and money, and it is in general impossible within finite resources to maintain all the linkages that might be considered desirable (just as it is impossible to carry out all the research that is desirable). It is necessary to examine the range of linkages involved, and to choose the most important, based on priorities in relation to objectives and resources available.

Linkages are required at each stage of the research process; in deciding what research to do; in implementation of the program; and in communicating conclusions to clients. In general, effective two-way linkage mechanisms for the research service with external bodies are desirable:

- for input to priority setting and programming, with policy-makers, national economic analysts, scientific community, extension agencies, micro-economic analysts, producers, processors;
- for implementation of the program, with extension, producers, university, private sector;
- for communicating conclusions, to extension, producers, policymakers, university, scientific community;
- for feedback to research after program implementation, from producers, extension.

5.4.1 Current Situation

Inevitably there were instances where linkages between research institutions and development agencies and their clients could be improved. In particular the reviewing team heard many complaints about research/extension linkages, concerning both the input from MOA and extension into research program formulation in CSIR institutes, and the output from CSIR research institutes to extension and farmers. At the same time, the team heard strong commendations about how effective research/extension collaboration had been in the Ghana Grains Development Project, and in the VORADEP project. It is useful to consider the sources of complaints, and of commendations.

The major complaint was that the Ministry of Agriculture was not receiving the information it required for its development programs, neither for macro-planning nor for micro-recommendations to solve farmers' problems. This was, it was claimed, largely due to the

Table 17: National Agricultural Research Program in Ghana, 1988. Number of Researchers Involved and Total Person Years Applied to Research on Commodity or Factor of Production

Commodity/Factor of Production	No. of Researchers Contributing	Person Years	Total
<u>FORESTRY</u>			
Forest Biology (including agroforestry)	8	2.18	
Forest Protection	4	2.40	
Utilization	8	<u>4.20</u>	
			8.78
<u>LIVESTOCK</u>			
Ruminants	40	6.54	
Non-ruminants	14	3.87	
Monitoring and Survey	6	1.70	
Diseases	10	3.69	
Vaccine Production and Trials	3	1.84	
Tse-tse	13	4.58	
Nutrition and Pastures	3	<u>3.12</u>	
			25.34
<u>CROPS</u>			
Maize	32	10.88	
Rice	6	1.10	
Cereals	17	3.72	
Cassava	10	1.78	
Root Crops	28	5.11	
Cowpea	23	5.10	
Other Legumes	32	5.88	
Fruits & Vegetables	35	5.12	
Tobacco	2	0.43	
Oil Seeds	4	0.89	
Bast Fibers	3	1.38	
Cotton	2	1.03	
Oil Palm	14	5.96	
Tree Crops	16	2.72	
Genetic Resources	2	1.25	
Farming Systems Research/Survey	10	4.08	
Fertilizers	24	5.37	
Soil Survey	8	4.04	
Plant Physiology	5	1.28	
Soil/Tillage	13	2.27	
Varietal Testing	1	0.08	
Weeds	5	0.21	
Pests	11	2.38	
Diseases	3	0.32	
Technology Transfer/Extension	5	0.41	
Macro-Economic Planning	9	<u>4.71</u>	
			77.52

Continuation Table 17

Commodity/Factor of Production	No. of Researchers Contributing	Person Years	Total
<u>COCOA</u>	27	<u>16.17</u>	16.17
<u>FISHERIES</u>			
Freshwater	6	2.60	
Marine	3	0.40	
Stock Assessment/Statistics	4	2.01	
Plankton	1	0.55	
Fish Gear	1	0.60	
Aquaculture	1	<u>0.15</u>	6.31
<u>WATER</u>			
Inventory	6	1.09	
Quality	2	1.14	
Soilwater/Physics/Agrometeorology	2	1.11	
Irrigation	1	<u>0.20</u>	3.54
<u>FOOD PROCESSING RESEARCH</u>			
Cereals	15	4.24	
Legumes	6	2.51	
Roots & Tubers	4	2.53	
Fruits & Vegetables	5	0.64	
Fats & Oils	3	0.46	
Fish/Meat/Eggs	10	1.89	
Survey	3	1.16	
Fabrication	2	1.00	
Quality Control	1	<u>0.10</u>	14.53
<u>BIOGAS/SOLAR</u>	2	<u>0.43</u>	
	<u>534</u>		<u>0.43</u>
			152.62

Ministry of Agriculture having very little influence on the research program of the CSIR research institutes; it had very little weight in the membership of the Council, or in the membership of the management boards of institutes, or in the research committees. These were all dominated, it was claimed, by university academicians and institute scientists. Beyond those committees, the Ministry of Agriculture had no formal access to program determination. CSIR management staff observed that the Ministry of Agriculture representatives often had very little to say on the Council and boards, and sometimes failed to attend meetings. Clearly, the Council and boards were not serving as efficient linkage mechanisms, and some improvement was needed to improve communications.

The earlier discussion on program formulation (p. 51) suggested that while mechanisms for the approval of research proposals were well in place, less emphasis was placed on a formal and systematic process of research program planning, and a lot of responsibility for the choice of highly relevant experiments was laid on individual scientists and their supervisors. It was suggested that a more formal process be instituted to permit a greater involvement of MOA staff (and other research users) during the planning phase, with different personnel involved at national, institute, and station or research program levels of decision. They could exercise more influence on the program during the planning phase than during the reviewing phase.

5.4.2 Research/Extension Linkages in GGDP

A closer involvement of extension with research is indeed achieved in the program formulation, implementation, and communication process in the GGDP. A national priority and commitment to a research program in maize and cowpea is expressed in the substantial allocation of research staff time in CRI, the Extension Division, and the Grains and Legumes Development Board. The Project Management Committee at research institute level, involving all three elements at a high level and the university, decides on major research objectives, and endorses the use of their farm and manpower resources in the program. The research program covers a multidisciplinary research program on maize and cowpea improvement on-station at CRI, and an extensive set of adaptive research and verification trials on regional extension sites and on-farm.

Details of the best experiments to be carried out are worked out first at a research sub-committee at CRI, with technical staff from CRI, Extension, and GLDB. The package of trials for different regions is then reviewed in detail in each region involved, by project research staff and regional staff from extension at GLDB. The actual experiments, trials, and studies are carried out on CRI stations, on MOA sites and stations, and on farmers' fields, by CRI staff, GLDB staff, extensionists, and farmers.

The interpretation of the results of the trials is done by central CRI and GLDB staff, but conclusions are communicated rapidly to the regional centers, and are discussed subsequently in a well-attended national workshop, where the published package of recommendations for growers is considered for possible revision.

5.4.3 Discussion

It is widely acknowledged in Ghana that this procedure has been very effective in producing a package of improved technology for maize and cowpea production that is ready to be used by development agencies and producers, as in Global 2000. (There are emergent marketing problems that may also need intensive research.) The procedure used in the GGDP is particularly powerful in that it not only results in a focussed, relevant program (with quality as good as the scientists making proposals), but also in establishing efficient research/extension linkages, in both directions. Because on-farm researchers and extensionists are involved in the grass-roots stage of deciding on treatments in trials, information on farmers' and extension capabilities and constraints is supplied right at the time and place most required.

Moreover, since extensionists are involved in organizing and supervising pre-designed on-farm and multi-locational verification (and some adaptive) trials, they become fully familiar with new elements of technology on-trial before they are recommended. They are ready to move into dissemination gear immediately, without any further training.

It must also be acknowledged that the procedure has involved an intensive focussing of resources of trained manpower and funds on a very few commodities. This could not be done for all commodities, or indeed for more than a handful of commodities, given the likely level of overall funding for agricultural research in Ghana. However, some important features of the procedure might be retained relatively inexpensively.

They might include:

- (i) The need to focus resources on a few commodities at a time, so that a significant quantum of research and extension effort can be applied to major constraints, over a target period. The depth of research intensity will depend on the kind of research judged to be necessary. This is essentially a policy decision on allocation of resources, not requiring extra resources, per se.
- (ii) A research and extension coordinating committee that can commit the use of resources in each collaborating institution to a specific commodity (or small system). This is again a policy decision, involving perhaps a reallocation of jurisdiction over some resources. A relatively small amount of time and funds would be required for organizing meetings. However, the expenditure would be hardly worth the effort if the total commodity research effort is less than about four person years per year. A committee for a group of similar commodities could be considered. For a large commodity program, a full-time coordinator is probably essential.

- (iii) A (different) joint research committee to develop the detailed research program for on- and off-station trials. This requires a very important expenditure to bring associated researchers together, but it is negligible in comparison with the costs of implementing a program.
- (iv) Full collaborative agreement of research with regional extension staff on trial sites in a region.³ This is an extensive and relatively expensive exercise: it cost GGDP about Cedis 200,000 for each of the 11 regional meetings in 1988. In addition, training sessions for extensionists may have to be allowed for.
- (v) Many people involved in implementing a full spectrum of trials and demonstrations that were designed by CRI scientists and associates. This is the most costly phase, in time and funds, and the phase most vulnerable to adjustment. It is also extremely important for the success of the process that research effort is eventually shared simultaneously among the different groups involved.
- (vi) Rapid communication of interpreted conclusions, not just fresh, raw results. A very important starting point (as in the case of maize and cowpea) is a full statement of the current recommended technology for production which could easily include 30 researchable components. Such a statement provides the basis for considering whether research conclusions merit changes to be made in any of the components of the recommended package of production, either nationally or regionally. It is also the basis for training courses on commodities for extension staff; and in many ways it is the definitive statement of the evolving interface between research and extension.
If there are useful conclusions to communicate, then almost any expense is justified to communicate research's output to its main clients as soon as possible.

There is some urgency involved. One measure of efficiency of the research/extension linkage can be expressed as $1/T$, where T is the time elapsed before a new research idea for improved technology has reached the stage of recommendation and been actively pushed by extensionists who understand the benefits of the new technology. The procedure used in the Project can reduce T by years because of the collaborative joint involvement and overlapping of research activities in different kinds of research by research institute and extension scientists. This overlap across adaptive, testing, and demonstration research is illustrated in Fig. 1 (p.65).

3. Not necessarily by a central group for each commodity touring all regions; the highly organized "Cropping Scheme Meeting" at Samuru, N. Nigeria, used to gather senior regional (State) extension staff together and reach agreement on details and sites for many regional trials in 10 major programs within two days following two days of review of previous results. Various models can achieve the same end in different circumstances.

5.4.4 Other Linkages

The research/extension linkage is by no means the only important linkage that requires strengthening; it is arguably the most urgent and most demanding on resources, however. The need for improved input linkages with world sources of knowledge through libraries and information services has already been discussed.

Linkages of research with policymakers and planners have been mentioned as very important in planning research programs. Linkages between the research institutes and the universities and international agricultural research centers are reasonably good if rather informal.

CHAPTER VI

ISSUES

The general picture of the public agricultural research system is of a group of research institutes carrying the main responsibility for research, supported by a research capacity in the universities oriented more towards agricultural science, and backed by a research capacity in the extension and development divisions of the Ministry of Agriculture and in other ministries and parastatals. The latter group are oriented more towards the practical contributions of research conclusions to the producer. CSIR has the general responsibility for coordinating all scientific research in the country, and of agricultural research as one sector of the whole. The Ministry of Agriculture is the greatest user of research conclusions and recommendations in support of national agricultural development.

It is widely agreed that:

- the research system has run down from its earlier capability in physical facilities, equipment, human resources, and funding of operations;
- there is an urgent need for rehabilitation of the system;
- it is important to retain the system's internationally qualified staff;
- it is essential to get the system more nearly fully effective again by strengthening the means of carrying out research.

There may be some issue of policy about where the funds to sustain a rehabilitated system might come from, and what should be the size and "scope" of a sustainable research system.

There has been less consensus about how the national research program should be determined, and there are important policy issues to be resolved in this respect. Central to the issue is how national agricultural research policy should be determined.

6.1. ORGANIZATIONAL STRUCTURE

CSIR is currently under the Ministry of Industry, Science and Technology. One intrinsic difficulty of Science and Technology (and research) being concentrated in a strategic ministry rather than being distributed as a tactical element among development ministries, such as Agriculture, is that very effective linkages need to be established between the science and technology departments and the development ministries in order that research practitioners and research users together determine the content of research programs. This is a necessary cost for the undoubted advantages of the research environment provided in CSIR.

Structurally, some misgivings were expressed about CSIR being attached to the development Ministry of Industry, Science and Technology: the MOA has restricted approach to CSIR in some instances. Adequate and well-functioning linkages between the MOA and CSIR are particularly important for the elaboration of a national agricultural research policy, which specifies priorities for agricultural research, as well as for the review of research results and technology transfer.

6.2 NATIONAL AGRICULTURAL RESEARCH POLICY

A clear statement of national agricultural research policy and of the purpose and objectives of the national agricultural research system is a basic starting point for developing a systematic program for agricultural research. The team noted the absence of any such clear research policy (see Chapter V and Annex 8) and concluded that there is an urgent need for the establishment of a body with the authority to elaborate national agricultural research policy, and hence to specify priorities for agricultural research and to advise on allocation of resources to major research areas. The team reviewed steps that are being taken in this regard, and looked into the present organizational devices as a potential basis for setting up the body needed for policy formulation (see Annex 8 for more detail).

- a. The CSIR has the general mandate for setting policy in science and technology and for the coordination of research. The TCAFF would be well placed to combine national policy for science and technology with national policy for agricultural development to produce a national policy for agricultural research if it were given those terms of reference.

Despite CSIR's comprehensive mandate to coordinate all research nationally, doubts have been expressed whether it can be fully committed to agricultural research while attached to the Ministry of Industries, Science and Technology. Perhaps the answer to this is to put CSIR in a neutral ministry or commission and make it accessible to all sectors.

- b. A new Agricultural Research, Development and Advisory Committee has been proposed by the Ministry of Agriculture, reporting to the Secretary of Agriculture. Its suggested terms of reference would certainly cover priority setting and advice on allocation of resources. However, although it is the major user of research results, the Ministry of Agriculture does not currently have the mandate for coordinating national agricultural research, and at least two-thirds of the research capability lies outside the Ministry.
- c. The Agricultural Policy Coordinating Committee in the Ministry of Finance and Economic Planning has a mandate to coordinate all agricultural activity, which could include coordination of agricultural research; a subcommittee with terms of reference as for ARDAC might be a suitable body to determine agricultural research priorities to submit to the APCC for approval and

commendation to the Ministry of Finance and Economic Planning. Though the deliberations of APCC, so far, have been on major inter-ministerial developmental policy issues, it remains a possible parent organization that will certainly be concerned with agricultural research policies. Therefore, the body to formulate agricultural research policies could be set up as a sub-committee of APCC.

Discussion

None of the alternatives appeared ideal to the team; a more effective body would combine desirable features from each alternative, such as:

1. the position of TCAFF in CSIR which has the mandate for coordinating all research;
2. the terms of reference proposed for ARDAC;
3. operating as a subcommittee of the influential APCC, located as it is in the Ministry of Finance and Economic Planning.

To have a chance of being an effective authority, the body would need the support of a consensus of the Ministry of Agriculture, the Ministry of Finance and Economic Planning, and the Ministry of Industry, Science and Technology (or the arm of Government responsible for CSIR).

The functions of such a body should include among others (see Annex 9):

- to formulate a national agricultural research policy and strategy based on the agricultural science and technology policy and the agricultural development plan;
- to determine priorities for major research areas and advise on the allocation of research funds to appropriate institutions;
- to deliver clear statements on the "mission" of national agricultural research; and hence
- to provide guidelines for criteria for assessing performance of researchers;
- on a longer time scale, to supervise the development of a medium-term agricultural research plan and the elaboration of national research programs.

The need for such a body is urgent, not only for the planning guidelines for research programming, and as a powerful advocate for adequate funding, but also for other aspects of balance and well-being of the system that are dependent on high-level policy decisions based on national values.

6.3 MISSION OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

By "mission", is meant a statement of what the nation expects from its agricultural research system. This will determine in part the content of the research programs; the criteria for rewards and promotion of scientists; and the organizational structure of the system, in particular the kind of mechanisms that will be put in place for planning, monitoring and evaluation, and reporting.

There appeared to be some confusion among researchers as to the purpose of the national agricultural research system. This may be partially due to historical development. Until 1962, when agricultural research was under the Ministry of Agriculture, the mission of the system was to be a service to agricultural development. In 1962, agricultural research was placed under the newly established Ghana Academy of Science. This move was accompanied by a slight change in the orientation of agricultural research towards contribution to agricultural sciences, which was to remain after CSIR was created in 1968, and is still reflected in the current constitution, promotional criteria of CSIR, and membership of the management boards of the institutes.

There are many signs that the mission of agricultural research has been interpreted differently in recent years, inside as well as outside the research community. A number of researchers are de facto working with another mission in mind, i.e., that their work be a service to the development of the agricultural sector. This evolution is in line with the GOG's strong recognition of the need to improve the productivity of its agricultural sector, as the mainstay of Ghana's economy.

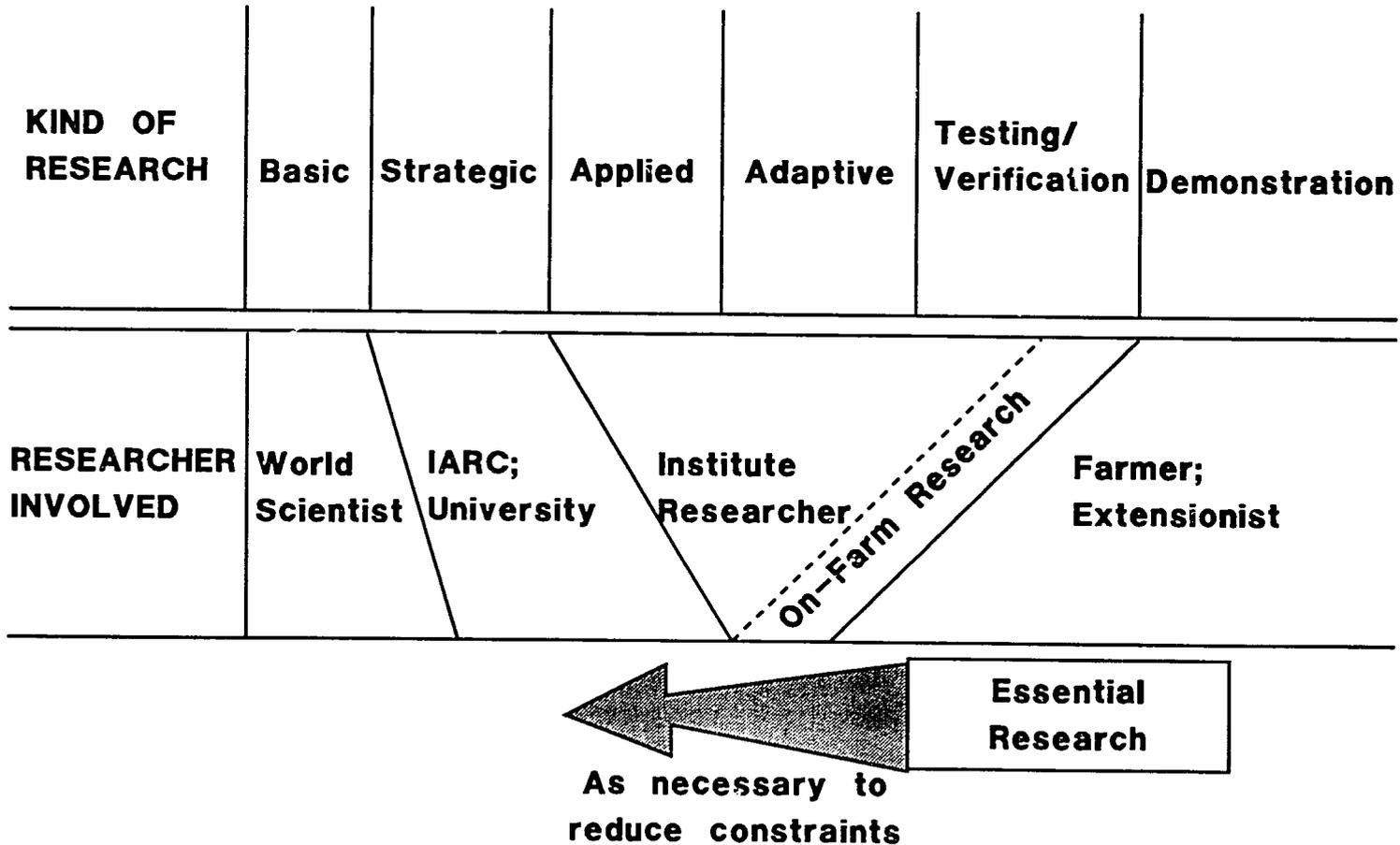
In chapter III it was stressed that different kinds of research were necessary in different circumstances. Fig. 1 is repeated here for reference. The national research institutes in Ghana occupy a central position involved in a wide range, from testing and verification research to applied research. Every nation needs to consider the full spectrum of research, reach decisions on what balance of research effort is most appropriate to its needs, and encourage its researchers to achieve this.

An early issue for a policy body to address is whether the present emphasis is appropriate to current circumstances and reflects the national view of the role of agricultural research. The policy body will need to issue clear statements of what is expected of the research system, emerging from a consensus of research practitioners and research users as to what the purpose of agricultural research should be.

6.4 CRITERIA FOR REWARD AND PROMOTION

As a corollary to the previous issue, encouragement to researchers to pursue the objectives and values of their employers is usually achieved through reward and promotion. It is important that the

Fig. 1: Spectrum of kinds of research in a national agricultural research system: indication of kinds of researcher involved in Ghana. The overlap of institute researcher and extensionist implies an overlap in time of sequential research operations confirming suitable technological components.



criteria used to assess performance are in accordance with the employer's objectives. For research this is a very sensitive and delicate area. For creative researchers, many non-monetary factors enter the scene, and a fair measure of intellectual freedom is one of them. High quality in design, implementation, and interpretation of experiments and studies is an essential characteristic of professional researchers, whether engaging in verification trials or in basic laboratory work. However, verification trials do not publish readily in scientific journals. Excessive reliance on publication in refereed journals as the prime criterion for promotion undoubtedly pushes the balance of research endeavor from testing towards strategic research. CSIR is now emphasizing other criteria for evaluating agricultural research. The universities may be encouraged to do the same.

A policy body, on establishment, should review the scene carefully and approve guidelines to be adopted for different kinds of research in accordance with research policy objectives. It cannot be over-emphasized how much "criteria for reward" influences researchers at the point of critical choice and design of experiments at the "ground level" origin of the national research program. They do not influence appreciably either program planning or review at institute or national levels.

However, it should be stressed that it is pointless to use criteria for high performance if funds or facilities with which to perform are inadequate; researchers prefer promotion by seniority in such circumstances.

6.5 FUNDING FOR AGRICULTURAL RESEARCH

Some national guideline decision is needed on the level of effort the country is prepared to put into agricultural research. It was argued in Chapter V and Annex 6 that operational funding per researcher should be at a level at least equivalent to what it was in 1974 to permit the efficient use of well-trained manpower. For the current number of researchers this implies an increase in overall funding from 0.57% AGDP to 0.68% AGDP (excluding cocoa) towards the 1% proposed by the World Bank. A decision to provide adequate operating funds per researcher for all researchers would have important planning implications, since it defines the number of researchers that is sustainable on the total funding available (see Table 15). Planning in research should really be done in terms of person-years of trained researchers, and support and operating funds incorporated in modular form to arrive at broad costings.

Another decision concerns the medium- to long-term future. Because of the long time span required for most research, continuity and sustainability of funding support is often more important than high short-term levels of funding from external sources that cannot be guaranteed over the long term. Deliberate decisions are called for on whether medium- to long-term planning should be based on sustainable national support, or how far it should be planned to rely on attracting donor funds for core long-term research work.

6.6 SCOPE OF THE SYSTEM: SETTING PRIORITIES FOR RESOURCE ALLOCATION

In the absence of priorities being set, research has been carried out in all possible areas, with very limited resources for each. Except for cocoa, oil palm, maize, and cowpea, research programs are widely dispersed and fragmented: excluding cocoa, 56 research topics were identified in 32 institutions, for a little over 136 person-years.

Concentrating resources into coherent national programs would increase the probability for successful research output. Resources should be concentrated according to research priorities, themselves determined in relation to the development objectives of the country, the needs of the system's clients, and the resources available or likely to be available for the execution of the research programs.

The need for concentrating the resources leads to the determination of the number of research programs or thrusts that can be realistically envisioned (not the desirable ones), which depends upon two critical factors:

- a) the GOC decisions concerning the overall level of resources, financial and human, to be devoted to agricultural research;
- b) the research critical mass, that is, the minimum level of resources (financial and human) needed per commodity, class of livestock or factor, for results with a probable impact on development to be achieved. The research critical mass will vary according to the constraints that will be addressed and, furthermore, according to the strategy that will be chosen to tackle those constraints: that is, how much technology can be borrowed (i.e., is it available elsewhere?), which determines to what extent applied or even basic research may be needed; or, to what extent one could rely solely on testing and adapting.

This, plus the overall availability of resources, which includes human resources capability, will determine how many of the desirable research thrusts can be realistically sustained, presently, as well as at various points in the future.

6.7 ROLE OF UNIVERSITIES IN NATIONAL AGRICULTURAL RESEARCH SYSTEMS

The universities are vital sources of high-quality recruits to the research system. It behooves the research system to help maintain the universities in an exemplary state of research competence to preserve the quality of recruits.

In addition, the university staff represent a considerable research capability that should be harnessed to the national research program, as well as providing valuable advice through boards and committees. The critical issue here is that currently, the state of physical facilities has fallen so low at the universities that it is threatening the very quality of the undergraduate studies and the postgraduate studies as well (Annex 10).

In times of financial stringency, it is difficult for research institutes and ministries to allocate scarce funds to support university research in addition to their own. However, in some cases support of university research can represent a better value for investment, and this deserves every encouragement.

A policy body should examine ways in which university researchers can be supplied at an adequate level of operational funding, while ensuring that the research effort fits within a nationally coordinated program.

6.8 RESEARCH/EXTENSION LINKAGES

If it is decided that the national agricultural research system is partially to serve the immediate needs of agricultural development, then research/extension interaction must be improved. The policy body should ensure that extension has a significant voice in the planning of the research program at all levels (as discussed in chapter VI).

In addition, the new policy body should emphasize throughout the system that time spent constructively in collaborative work between research and extension is not time wasted from pursuing separate research and extension activities, but activity fully in line with performance expectations, and meriting recognition and reward.

6.9 NATIONAL AGRICULTURAL RESEARCH POLICY AND ELABORATION OF A MEDIUM-TERM ACTION PLAN

An immediate objective, following the establishment of a policy body for national agricultural research, would be to develop a national agricultural research policy, including long-term programs, followed by an action plan that should be complementary to the agricultural development plan.

This will not be achieved rapidly and will probably need an intensive effort over at least one year of a core of research planning staff marshalling the part-time contributions from a large number of senior agricultural research and planning staff, starting from the review already carried out by the Technical Committee for Agriculture, Forestry and Fisheries.

The development of the plan will need careful planning itself. A speculative draft of the possible stages in the development is set out in Annex 9.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

A joint team was established with local consultants and visiting consultants from ISNAR to review the agricultural research system of Ghana, and recommend how the system might be strengthened.

In general, the basic structure and organization of the agricultural research system in Ghana is appropriate to its tasks:

- * a set of universities with faculties producing adequate numbers of graduates with basic qualifications for recruits into the research services, besides carrying out direct research and providing a well-informed pool of advisers;
- * a set of national research institutes, responsible for guiding research in commodities and production factors, with reasonable autonomy of operation under a central council or parastatal organization;
- * a set of development ministries, agencies, and quasi-governmental organizations that are primarily responsible for promoting production, but are concerned with the research stages closest to convincing the producers of new opportunities of reaping benefits from innovations.

The team recommends, therefore:

- (i) that as little change as possible be made in the underlying structure of the agricultural research system, consistent with
- (ii) taking steps to improve the efficiency and effectiveness of the research capability that has been built up, and
- (iii) that the nationally sustainable capacity for research be increased towards a level reflecting a national expenditure on agricultural research approaching 1% of AGDP.

The team recommends that steps to improve the research system be taken in the means of carrying out research, in the procedures for determining the research program, and in the methods of communicating conclusions to the clients of research.

7.1 MEANS OF CARRYING OUT RESEARCH

1. The physical facilities for research have deteriorated in a period of neglect, and outstandingly, it is strongly recommended that selected buildings, laboratories, and farms be rehabilitated, and that equipment and vehicles be repaired or replaced.
2. The operational funding per scientist has declined drastically in recent years to a level where the expensive training of researchers is not being effectively utilized. It is strongly recommended that operational funding per researcher be returned to

the 1974 level, about \$20,000 - \$25,000 per researcher (in 1987 dollars). Such levels of operating funds in 1987 would have required an increase in research investment from 0.57% to 0.68-0.74% of 1987 AGDP, still well below the 1% AGDP proposed by the World Bank.

3. Good research depends critically on information services. It is recommended that library, information, and documentation services be rehabilitated and updated with modern technology.
4. A large number of research staff have only first degrees. It is desirable that all research staff should have a second degree. It is recommended that every effort be made to ensure that all research staff have the opportunity for formal postgraduate training in research methodology in a field of specialty appropriate to the national program.
5. It is recommended that the criteria for promotion of research staff be closely linked with national agricultural research policy and the required contribution of individual researchers in the system.
6. It is recommended that the scheme of service for research scientists be improved to provide incentives (not necessarily only in salary, e.g., better housing) to retain their services over long periods of continuity.

7.2 DETERMINING THE RESEARCH PROGRAM

The efficiency of the research system depends critically on the choice of highly relevant and penetrating experiments and studies out of a wide array of possibilities. While procedures for reviewing research proposals from researchers to national Council are well in place, the process of planning the research program from the national level to the researcher requires improvement.

1. The team strongly recommends that a body be established with the authority to formulate national agricultural research policy, based on merging national science and technology policy with national agricultural development policy. It should also have the authority to advise the Ministry of Finance and Economic Planning on priorities for allocation of resources to areas of agricultural research and to appropriate research institutions. Such a body would require a permanent Technical Secretariat to service it and provide it with analyzed information to facilitate decision-making by the body.

After careful consideration of possible alternatives, the team recommends that the present Technical Committee of the CSIR responsible for Agriculture, Forestry and Fisheries be upgraded to the appropriate policy body for national agricultural research; that it be assigned new terms of reference to reflect its modified functions; that its membership be reexamined in light of the new tasks and emphases; and that it report to the Agricultural Policy Coordinating Committee of the Ministry of Finance and Economic

Planning, as well as to the CSIR. The Technical Secretariat to service the Committee could be provided by an expansion of the headquarters staff of CSIR, exercising a neutral role on behalf of all agricultural research institutions and organizations in the country.

2. The limiting resource for carrying out research is the time of professionally trained manpower. The team recommends, therefore, that the policy body give advice on allocations in terms of years of trained manpower, the primary parameter for research planning. For broad planning purposes, the Ministry of Finance and Economic Planning can convert researcher years into financial requirements by applying a realistic module that covers the expenses of a researcher, together with adequate support staff and operational funds.
3. The team strongly recommends that a national agricultural research policy be elaborated that will specify agricultural research objectives, recommend allocation of resources accordingly, and provide guidelines to the institutions receiving the resources allocated for the next stage in the planning process: the choice of the major constraints to productivity in the identified area of research.
4. At the national research institute level, the team strongly recommends that appropriate staff of development ministries and agencies and staff of universities be closely involved in the planning stages of research programs to give focussing guidelines to the team leaders and researchers at station level.
5. Several commodity or factor research programs extend beyond the bounds of one research institution. It is recommended that such programs be nationally coordinated and planned on an inter-institutional collaborative basis. For larger programs, program coordinators should be appointed (following the prototype Ghana Grains Development Project Management Committee).
6. At the research station level, the team recommends that the appropriate staff of the development ministries also be invited to be involved when proposals for research experiments and studies are put forward for the first level of review, preferably within a multi-disciplinary group.
7. The team commends the subsequent research program reviewing procedures in place in most institutes, but recommends that, in due course, the Technical Committee of the apex policy body should confirm to the body that the proposals are within the planning guidelines.
8. The team recommends that, following the initial policy and priority guidelines laid down by the policy body in the National Agricultural Research Policy, a Medium-Term Agricultural Research Plan be prepared under the supervision of the Technical Secretariat. This would include plans for staff recruitment, training, and development of physical facilities, as well as

long-term research program plans. The development of such a comprehensive plan should not preclude immediate improvements in research program planning, but a full plan should be the final target.

7.3 COMMUNICATING CONCLUSIONS TO CLIENTS OF RESEARCH

The effectiveness of the national research system finally depends critically on the communication of the conclusions from research to the clients of research. There are many clients of research, including national planners and scientific peers in-country and overseas, but the ultimate client is the producer. However, the most critical immediate client is the extension service that will take on the larger task of communicating with, and convincing, very large numbers of farmers.

Research/extension linkages are therefore a very important part of the national agricultural research system, and deserve a considerable amount of time and expenditure. The effectiveness of those linkages also deserves recognition as a criterion for assessing good performance in research. The linkages are two-way, bringing information into the research system to improve program formulation, and delivering information to extension for dissemination to farmers.

1. The team recognized the effectiveness of the procedures of the Ghana Grains Development Project, and those in the VORADEP project, and strongly recommends that similar procedures be used for other commodities and projects. Planning linkages are necessary at highest management levels to endorse expenditures in collaboration at lower levels. Quite different linkage mechanisms are needed at a series of lower levels, for planning collaborative trials, arranging for their implementation and reviewing, and publicising the conclusions of research. The team stresses that such activities need careful costing and clear inclusion in the budget (both of research time and finances).
2. The team noted the importance in the Ghana Grains Development Project (GGDP) of keeping to a minimum the time for a research proposal to become a recommendation of improved practice. To ensure transfer from research into smooth extension action, the team recommends that there be a considerable overlap of research by extension in the widespread testing and demonstration activity within the final stages of research institute verification trials.
3. Research/extension linkage is only one of many linkages that research must maintain with the environment external to the research system. The team recognized that since all linkages cost time and money, not all desirable linkages can be maintained, and therefore recommends that the Technical Secretariat review carefully with research leaders the priorities that should be assigned (and time and budget allocated) to different linkages: a linkage planning process.

7.4 OTHER RECOMMENDATIONS

1. In light of the importance of research to agricultural development, the team recommends that the Director General of CSIR be appointed in his own right to the Agriculture Policy Coordinating Committee.
2. Collaboration: The team noted that research on a commodity or factor of production was a continuum from basic to demonstration research, but that different groups of researchers in different organizations were involved in parts of the continuum. The team recommends strongly that the interfaces between kinds of research be kept blurred and that administrative and professional territorial claims be kept to a minimum to maintain the greatest degree of collaboration.
3. Research Stations and Substations: There is a very large number of substations of national institutes, universities, and ministry departments spread across the country, many in a poor state of maintenance, and few with permanent graduate research staff in them. It is strongly recommended that the use of some of these substations be rationalized, and that they be treated as national sites for research work by any research institution (that can pay for its own trial operations). The most convenient institution should maintain each substation for the benefit of all. The central policy body could draw up a collaboratively agreed list of stations and ensure budgetary support.
4. Universities: The faculties and school of agriculture at the universities are vital to the research system as the source of supply of graduate recruits, and would be extremely valuable for local postgraduate training. However, the facilities, equipment, and libraries in the university faculties have been neglected for so long that they are really inadequately equipped now for much postgraduate work. The team strongly recommends that the faculties of agriculture be rehabilitated to give the well-qualified staff a better chance to train high-quality graduates for the research service (and other services). A substantial improvement in library facilities would be essential for high-quality postgraduate work. Funding for research operational expenditures on a contract basis from national institutes or the Ministry of Agriculture would help ensure that the faculties of agriculture play their full role in the national agricultural research system.

Report to the
Government of Ghana

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REVIEW OF THE GHANA AGRICULTURAL RESEARCH SYSTEM

Volume II: Annexes

Joint Review by
National Team Selected by the Council
for Scientific and Industrial Research
and
International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, the Netherlands, on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting governments of developing countries to strengthen their agricultural research. It is a nonprofit autonomous agency, international in character, and nonpolitical in management, staffing, and operations.

Of the 13 centers in the CGIAR network, ISNAR is the only one that focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on research policy, organization, and management issues, thus complementing the activities of other assistance agencies.

ISNAR has active advisory service, research, and training programs.

ISNAR is supported by a number of the members of CGIAR, an informal group of donors that includes countries, development banks, international organizations, and foundations.

Report to the
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AGROVOC Descriptors

financing research; Ghana; information services; management; organization of research; planning; public research; research; research policies

CABI Descriptors

agricultural research; Ghana; government research; information services; management; organization of research; planning; research; research policy

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ANNEX 1

TERMS OF REFERENCE FOR THE REVIEW OF THE AGRICULTURAL RESEARCH SYSTEM OF GHANA

OVERALL OBJECTIVES FOR THE REVIEW AND PREPARATION OF NATIONAL AGRICULTURAL RESEARCH PLAN

1. Phase 1. To review the current structure, organization and management, programs, and resources of the agricultural research system.

Phase 2. To prepare a medium- to long-term national agricultural research plan based on priority needs within the context of the government's policies and resources.

Phase 3. The proposals could form the basis of a future agricultural research project with financial support from the World Bank and other donors.

General Terms of Reference for the Review

Organization and management of the research system

2. To review existing structures, organizational and management systems with the objective of suggesting ways of increasing their efficiency and effectiveness.

The studies would include review of the linkages of research with other organizations, both at policy and operational levels, especially with regard to extension. Ongoing and potential opportunities for promoting collaboration with other African countries, with international research organizations, and with bilateral research programs in priority areas would also be reviewed.
3. The systems reviewed would include mechanisms for:
 - (i) priority setting, planning, and coordination of research;
 - (ii) research program formulation and review;
 - (iii) human resource management, including recruitment, retention and reward;
 - (iv) funding and financial management;
 - (v) monitoring and evaluation of research programs; and
 - (vi) dissemination of research results.

4. The review would take account of the effectiveness of the existing system and above mechanisms, highlighting strengths and weaknesses, and suggest options for measures for their improvement, outlining implications for staff development and operational support resource needs.

Research Programs

5. The review would consider the past and possible future direction of current research programs of various institutions and parastatals involved in agricultural research, and assess the current priorities as indicated by the allocation of research manpower (and finances), as a basis for the development of a national agricultural research plan.

Research Stations

6. The study would review the roles and responsibilities of each unit in the system, and make recommendations about any rehabilitation, reorganization, or consolidation of units.

Human Resources Development

7. The study would review the current human resources available to the research system, and their allocation among existing research programs, as a basis for planning a future staff development program, with reference to both professional and research support staff.
8. The review would pay particular attention to the utilization of skills available in the university system and elsewhere in the country. It would suggest ways and means of strengthening staff collaboration between research institutes and the universities in both research and teaching, with a view to obtaining the most effective utilization of staff in this area.

Research Information and Documentation Service

9. From a review of research institutes and university library services, the study would recommend establishing an effective service for the research system, phased in accordance with available resources. This recommendation would include all aspects of modern information and documentation service, including the use of computers where judged feasible, and would take into account previous investigations in this area.

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ANNEX 2

MEMBERSHIP OF THE JOINT REVIEW TEAM

Ghanaian Members

Leader: Prof. K.A. Haizel, Director, School of Agriculture,
University of Cape Coast

Mr. F.W. Addo-Ashong, Consultant, ex-Director Forest
Products Research Institute

Dr. S.V. Adu, Managing Director, Land Resources
Evaluation and Development Consultants, Ltd.

Dr. E.J.A. Asomaning, Consultant, ex-Director Cocoa
Research Institute of Ghana

Mr. K. Poku, Principal Engineer (Partner), Dony
Engineering

Mr. T.O. Sunkwa-Mills, Agricultural Development Officer,
Barclays Bank of Ghana, Ltd.

International Members

Leader: Dr. M. Dagg, Senior Research Officer, ISNAR

Ms. M.A. Bellamy, Information Specialist, Commonwealth
Agricultural Bureau, International Development
Services

Dr. P. Bennell, Consultant, Human Resources Management

Dr. M.H. Collion, Senior Research Officer and Planning
Specialist, ISNAR

Dr. W.J.A. Payne, Consultant, Livestock Research

Prof. J.W. Tanner, Consultant, Crop Sciences Department,
University of Guelph, Canada.

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ANNEX 3

PROCEDURES FOR CSIR/ISNAR REVIEW OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF GHANA

Procedures for Information Gathering

It is important to gather as much information as possible on the policies, organization, and management of the national agricultural research system of Ghana prior to arrival of the ISNAR team, currently scheduled for early April 1989. The Council for Scientific and Industrial Research (CSIR) has appointed a five-member review team to conduct interviews and describe those organizations in Ghana that conduct research, and those that have linkages to research. In the preliminary ISNAR mission of November 28 to December 6, 1988, the following procedures were discussed and adopted by the CSIR review team.

Units of Analysis

Information will be collected from:

- 1) all agricultural researchers in Ghana in whatever organizations they may be found;
- 2) the directors of all CSIR and non-CSIR research institutes in Ghana concerned with agriculture, fisheries and forestry;
- 3) the CSIR Secretariat;
- 4) the deans of the three faculties of agriculture in Ghana (University of Ghana, Legon, University of Science and Technology, Kumasi, and the University of Cape Coast) and the department heads of their relevant departments; and
- 5) the directors of relevant departments and divisions of the Ministry of Agriculture, the Ministry of Lands and Natural Resources, and other government agencies that conduct or have important linkages to agricultural research.

- 1) Agricultural research is conducted to some degree by many organizations in Ghana, including CSIR and non-CSIR institutes, universities, production and extension departments of the Ministry of Agriculture and others, and by development organizations. To obtain a complete inventory of who is conducting research and on what problem areas, a questionnaire has been developed for all agricultural researchers in Ghana. They will be distributed and collected by their respective directorates.

- 2) CSIR institutes and some other research organizations have been asked to return a questionnaire developed by CSIR on recurrent and capital costs over the past three years. Some follow-up is needed to collect this information; also, the questionnaire will be sent to the organizations added by the recent ISNAR/CSIR working session. This action will be taken by the CSIR Secretariat.

In addition, a questionnaire, including:

- a) a list of current programs with a brief description;
- b) time allocation in person-weeks of researchers and technicians to programs; and
- c) the amount of funds unused in 1988 in each program, if possible.

This questionnaire will be distributed by the CSIR Secretariat prior to the interviews and on-site visits by CSIR review team members, scheduled to begin mid-January.

In these interviews, to be conducted on-site with institute directors, review team members will:

- A. assess the general state of facilities at the institute and its stations; this will include a general description of buildings, laboratories, numbers and types of transport, and equipment, and their overall condition;
- B. discuss and describe the process of program formulation being used (priority setting, programming and review, monitoring and evaluation) at institute and program levels;
- C. discuss and describe the institute's linkages with other organizations, including:
 - a) the current linkage mechanisms, both formal and informal, such as representation on management boards, field days, etc.;
 - b) the mandates and membership by office of such bodies; and
 - c) their current effectiveness, as indicated by such things as full participation, timeliness of decision-making, and sufficient authority to execute decisions. Some of this analysis will, of course, be subjective.

The linkage analysis should cover information coming into the research institute from:

- a) sources of information and support external to Ghana, such as international research centers, regional networks, data retrieval services, universities, and foundations; and
- b) sources within Ghana, such as universities, extension services, farmers, and development organizations; and information coming

from research institutes to clients and partners of research, including:

- policy-making bodies;
- extension services, farmers, and development organizations;
- world science.

D. Any further description the team members think are relevant about the history and development of the institute should be written up for review by the entire team.

3. The CSIR Secretariat will be analyzed by review team members through interviews and documentation available at CSIR. The primary objectives will be to:

A. Describe the formal structural relationships between CSIR and:

- MFEP, including the Agricultural Policy Coordinating Committee
- MIST
- MLNR, including relevant departments and the Forestry Commission
- MOA, including the National Agricultural Advisory Council, with its advisory committees on crop production, animal production, and fisheries, the Agricultural Research and Development Advisory Committee, the Departments of Extension Crop Production, Fisheries, and Animal Production, the Grains and Legumes Development Board, the Cocoa Board, development organizations such as Voradep and Uradep, PPMED, and Global 2000
- MOHEC, including the U. of G., Legon, the U. of S.&T., Kumasi, with its Institute of Renewable Resources, the U. of C.C., and the Ghana Academy of Arts and Sciences
- MTC's meteorology division
- the Ghana Atomic Energy Commission
- the National Center for Development Studies, and
- other organizations involved in agricultural research.

This structural analysis will discuss formal linkages, roles and responsibilities, and effectiveness, if possible.

B. Discuss and describe the current formal linkage mechanisms for national agricultural research priority setting and resource allocation for the following bodies. This analysis should include a statement of their mandates, objectives, reporting relationships, and membership by office; their effectiveness should be assessed by looking at such indicators as:

- a) when they actually meet;
- b) the date of the last meeting;
- c) the attendance of their members;
- d) their most recent output (e.g., report: date, title, contents, and to whom);
- e) timeliness of decision-making; and
- f) authority to take actions within the mandate.

This will be done for:

- the National Sectoral Technical Committee on Agriculture, Fisheries, and Forestry.
 - the National Center for Development Strategies
 - the National Agricultural Advisory Council and its Committees (MOA).
 - the Agricultural Research and Development Advisory Committee (MOA).
 - the Agricultural Policy Coordination Committee.
 - the Institute Boards and other bodies.
- C. Data on CSIR finances will be provided by the Secretariat for the past three years, including funds requested and received. The review team should also describe the funding relationships and mechanisms among CSIR, MIST, and MFEP.
- D. The CSIR Secretariat will provide human resources information as follows:
- a) staff profiles by categories for the Secretariat and the Institutes;
 - b) a description of conditions of service; and
 - c) a description of the reward structure, criteria of promotion, and the mechanisms employed.
4. The Faculties of Agriculture and relevant departments of the University of Ghana, Legon, the University of Science and Technology, Kumasi, and the University of Cape Coast will be analyzed. Information will be requested by questionnaire on staff and programs. The review team members will also interview the deans and department heads to ascertain:
- a) Actual potential university staff capacity and level of effort available to research if operating funds were available.
 - b) University staff roles (current and suggested) in priority setting and program formulation at both national and program levels.
 - c) Facilities available for agricultural research, including farms, laboratories, and specialized equipment.
 - d) Current graduate training capacity in the agricultural sciences, with a brief discussion of perceived departmental strengths and weaknesses.
5. The Ministry of Agriculture and other relevant ministries will be analyzed through both a questionnaire and an interview. The team members will:
- a) Describe MOA policy and planning mechanisms as they affect agricultural research, including roles and responsibilities, membership, and effectiveness of the Councils and Committees described above in 3.b);

- b) MOA participation in CSIR and Institute committees, intended and actual;
- c) Special funding mechanisms for research, e.g., grants, development projects;
- d) MOA position on the research/extension interface, and the respective responsibilities for adaptive research, testing (verification), and demonstration;
- e) The role of GLDB in adaptive research and seed multiplication, and the implications of restructuring on the future of GLDB;
- f) Seed sector issues relevant to research, including:
 - actual research being conducted at GSC and others in both varietal testing and seed technology; and
 - current status of the National Seed Committee for varietal release, and the Seed Inspection Unit, and their linkages to research.

Methods of Information Gathering

Information will be collected from:

- a) questionnaires sent directly to researchers and directors of the above organizations;
 - b) interviews with directors conducted by CSIR review team members;
 - c) site visits of research institutes and primary stations by CSIR review team members; and
 - d) documentation collected during site visits or on file at CSIR.
1. There are three questionnaires:
- i) one sent in August 1988 to institute directors by the CSIR Secretariat on recurrent and capital costs for the past three-year period;
 - ii) a biographical questionnaire to be filled out by every agricultural researcher in Ghana; and
 - iii) an institute questionnaire to be filled out by directors and department heads on resources and programs.

The latter two questionnaires were prepared in accordance with suggestions made during the preliminary visit. They, along with the attached interview format, will be discussed by the CSIR review team in Accra on December 19, 1988. The team may wish to modify the institute-level questionnaire, which was not drafted in final form before the departure of the ISNAR team.

These questionnaires will be hand delivered by the CSIR Secretariat, if possible, to the designated organizations. Directors will be asked to distribute the biographical questionnaire to all researchers within their organizations and to collect them again before the interviews with CSIR review team members take place. Some CSIR Secretariat follow-up may be necessary to secure all three questionnaires. The purpose of the questionnaires is to get full account of what research is being conducted in Ghana, by whom, and to what extent (as indicated by funds and person-year allocations to research programs).

2. The CSIR review team will divide itself into teams of two to conduct the interviews and site visits. The team members will assure that all of the points covered in the attached format are described as fully as possible. In addition, the team may wish to indicate in somewhat greater detail facts which may be important for the review, such as the historical evolution of the particular institute or department, why a shift in program activities occurred, or the reasons behind the relocation of an institute to a different parent ministry. The interviewers will request at that time relevant documentation on the institute or department, such as organizational charts, latest annual report, technical committee reports, and evaluations, and will file them with the completed questionnaires in the CSIR Secretariat.

It will be necessary that interviewers give a full account of the purpose of this review and the approach being taken. The CSIR Secretariat should request that parent organizations encourage their full staff cooperation in filling out questionnaires and for interviews. Interviews should be as relaxed and candid as possible.

3. The site visits held in conjunction with the interviews will indicate in a general way what facilities are currently available in each organization and their condition. This will include a description of buildings, the numbers and types of transport, laboratories, specialized equipment, and farm land. The team is not expected to try to visit outlying or more minor research stations. A description of these facilities can be obtained by interview.
4. Much information on CSIR institutes is currently available in the Secretariat. This relevant information, as described in the attached format, will be organized and on file for the review team. During site visits other relevant documentation, particularly for non-CSIR organizations, will be collected and delivered to the Secretariat. It is important for all documentation to be organized and accessible to the review team, ideally in a separate office.

ISNAR/CSIR Review
of the
National Agricultural Research System of Ghana

Questionnaire for Agricultural Researchers

As you are probably aware, the International Service for National Agricultural Research (ISNAR) and the Council for Scientific and Industrial Research (CSIR) are embarking on a review of the entire national agricultural research system of Ghana. This includes the research sectors of agriculture, forestry and fisheries, related policy-making bodies, and extension services. The comprehensive review of agricultural research in Ghana will be the basis for developing a national long-term research plan within the coming year. To do this, it is important to know who is currently conducting agricultural research in Ghana and on what problems, the resources, both human and financial, being applied to research, the state of research facilities, and the linkages between policymakers and clients/partners of research, such as universities, extension services, farmers, and development organizations.

Agricultural research is currently being carried out to some degree in various institutes, universities, and ministry departments. The ISNAR/CSIR review needs your cooperation in filling out the attached questionnaire in order to get a complete picture of the actual national agricultural research system. You are being asked to supply some basic biographical information, and also to attempt to allocate the time you spend on different research and non-research activities. While realizing that many institutes and departments are not currently following a program budgeting system, where time and funds are allocated to specific research programs and projects, please estimate the time you spent in calendar year 1988 on areas of research specializations and on programs/projects as closely as possible. This information will be used to determine the current government commitment to various lines of research and will serve as a starting point for assuring that adequate resources will be applied in the future to priority areas of research.

One more note of explanation may assist you in filling out this questionnaire. The terms "program" and "project" adopted in the questionnaire are not standard for all of the institutes and departments conducting research in Ghana. They refer here to the collection or aggregation of the individual experiments, studies, and activities that researchers carry out in order to obtain information on a researchable problem. Attempt in this questionnaire, Section 5.C to be as specific as possible, considering the unit in which we are interested (whether called program, project, activity, etc.) to be that which involves from approximately .3 to 2 person-years of researcher time. For example, if one researcher supervises several activities carried out by technical and support staff, or extension staff, consider the activities under one "program" umbrella.

ISNAR and CSIR appreciate very much your participation in this review. Please fill out this questionnaire and return it to your institute or department directly by January 14, 1989.

ISNAR/CSIR Review
of the
National Agricultural Research System of Ghana

Organization: _____

Biographical Data Form for Agricultural Researchers

1. Last Name: _____ Initials: _____
Date of Birth: _____ Sex: M/F
Nationality: _____

2. Qualifications

Highest Qualification: _____ Year Obtained: _____

Subject (Discipline): _____ Yrs Res. Experience _____

Institute/University: _____

Short-term Training (1 to 9 months) - 2 most recent ones

Subject: _____ Duration: _____

Institute/University: _____ Year: _____

Subject: _____ Duration: _____

Institute/University: _____ Year: _____

Specify any management training (subject, location, duration and year):

3. Specialization(s) (as many as relevant)

Commodity Specialization(s) which includes research carried out on specific crops, animals, fish or tree species, or systems of production based primarily upon a commodity. Examples: maize, pastures, beef cattle, fresh-water fish, eucalyptus, maize-based cropping systems: _____

Factor of Production Specialization(s) which includes research on the environment applicable to the nation as a whole, or to broad input factors not related to a particular commodity. They are not commodity-focussed. Examples: soil survey, water resources inventory, pest surveys, agro-meteorology, type of fertilizer, herbicides: _____

Discipline Specialization(s) which is the general area of your academic training. Examples: plant pathology, entomology, biochemistry, biometrics. As an entomologist you could work, for example, in two commodity areas and on one factor of production: _____

4. Employment

Current Institution: _____

Date of Appointment to Current Institution: _____

Date of First Appointment to Research Service: _____

5. Time Spent on Agricultural Research in Calendar Year 1988

A. Time by Type of Activity:

Listed below are eight major types of activities in which you may be involved. Please estimate the percentage of your time for 1988 spent in these activities. Your total must equal 100%.

	<u>% of Time 1988</u>	<u>Person-Weeks of Time 1988*</u>
Agricultural Research	_____	_____
Other Research	_____	_____
Administration	_____	_____
Teaching	_____	_____
Extension/Demonstration/Advisory	_____	_____
Production Activities	_____	_____
Study Leave/Training	_____	_____
Other Leave (Vacation, Personal)	_____	_____
Total	100%	52

B. Time by Research Topic:

Please estimate the percentage of your total annual time in 1988 spent on commodities, or factors of production. The sum of these percentage allocations must equal the total time indicated above for agricultural research activities. Allocate time to commodity if possible. If not, allocate to factor research. AVOID assigning time to a discipline (e.g. entomology, chemistry) if at all possible.

	<u>% of Annual Time</u>	<u>Person-Weeks of Annual Time</u>
<u>Commodities:</u>		
_____	_____	_____
_____	_____	_____
_____	_____	_____
<u>Factors of Production:</u>		
_____	_____	_____
_____	_____	_____
_____	_____	_____
<u>Total (equals ag. research time % in 5A)</u>	_____	_____

For Example:

	<u>% of Annual Time</u>	<u>Person-Weeks of Annual Time</u>
From 5A: you spent 80% of your total yearly time on agricultural research	80	41.6
From 5B: of which you spent half of your total <u>research</u> time on maize and half on cowpea commodity research.		
Commodities: maize	40	20.8
cowpea	<u>40</u>	<u>20.8</u>
	80	41.6

* Refer to definitions and conversion chart on last page

Person-Weeks: is an average allocation of your time, totaling 52 weeks per year, based on on a typical work week. For purposes of this questionnaire a 5, 6, or 7 day work week are all equivalent to 1 person-week.

Conversion chart

	Annual time to person-weeks
	<u>% annual time = Person-weeks of time</u>
1%	0.52
2%	1.04
3%	1.56
4%	2.08
10%	5.20
50%	26.00
80%	41.60
100%	52.00

ISNAR/CSIR Review
of the
National Agricultural Research System

Research Organization Survey

This questionnaire is being submitted to all agricultural research Institute Directors, university Deans of Faculties of Agriculture, and relevant Department Heads of the Ministry of Agriculture and the Ministry of Land and Natural Resources. The purpose of this questionnaire is to determine which organizations in Ghana are currently conducting agricultural research (including fisheries and forestry) and to estimate 1988 researcher time spent on programs and projects as accurately as possible. Your assistance is required in collecting this information. It will be an important part of ISNAR/CSIR's review of the national agricultural research system in Ghana.

Through a personal interview with a member of the ISNAR/CSIR review team, you will also be requested to discuss aspects of research priority setting and program formulation as they currently function in your organization. This questionnaire and your views are important to the review of national agricultural research being undertaken. Thank you for your participation.

1. Respondent: _____ Title: _____
Organization: _____

2. Personnel Data:

Please indicate the total number of staff by category directly involved in agricultural research on a full-time and part-time basis, including researchers, technicians, and field and lab. assistants in 1988. Do not include administrative and secretarial staff. If staff works less than 20% time on research, do not include.

Research Institutes:

Ministries:

Universities:

<u>FT</u>	<u>PT*</u>	<u>FT</u>	<u>PT</u>	<u>FT</u>	<u>PT</u>
CRD Director		Director		Professor	
P.R.O.		C.A.O.		A.P.	
S.R.O.		P.A.O		S.L.	
R.O.		S.A.O.		L.	
A.R.O.		A.O.		A.L.	
C.T.O.		Field Asst.		Field Asst.	
P.T.O.		Lab. Asst.		Lab. Asst.	
S.T.O.		Etc.		Etc.	
T.O.		_____		_____	
Field Asst.		_____		_____	
Lab Asst.		_____		_____	
Etc.		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	

* FT = Full Time / PT = Part Time

3. Program Data

A. From Research Project Outlines or other documentation, list current agricultural programs or projects in your organization with the following information:

Title of Project: _____

Objectives: _____

Date Work Started: _____ Estimated Duration: _____

Total Funding (in Cedis): _____

By whom (e.g. GOG, grants): _____

Development Funds Requested 1988: _____ (Cedis)

Development Funds Received 1988: _____ (Cedis)

Estimate of Researcher Time Spent in 1988 (Person-weeks): _____

Estimate of Technical Support Time Spent in 1988 (Person-weeks): _____

Current Status of Project: _____

Title of Project: _____

Objectives: _____

Date Work Started: _____ Estimated Duration: _____

Total Funding (in Cedis): _____

By whom (e.g. GOG, grants): _____

Development Funds Requested 1988: _____ (Cedis)

Development Funds Received 1988: _____ (Cedis)

Estimate of Researcher Time Spent in 1988 (Person-weeks): _____

Estimate of Technical Support Time Spent in 1988 (Person-weeks): _____

Current Status of Project: _____

Additional sheets are provided. If more are needed, please make copies.

ANNEX 4

Components of the National Agricultural Research System of Ghana

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)

1. Origin

The CSIR, as it exists today within the Ministry of Industry, Science and Technology, emerged from the Ghana Academy of Sciences (which continues as a separate body today as the Ghana Academy of Arts and Science). Agricultural research in Ghana had its origins in the Ministry of Agriculture, where it developed and crystallized as the Scientific Services Division. In 1962 the Scientific Services Division was merged with the National Research Council (NRC). This body was merged with the Ghana Academy of Sciences, from which it was separated again in 1968, as the Council for Scientific and Industrial Research.

2. Mandate

The CSIR has an advisory, executive, and promotional function. It is the main body to advise Government on the use of science and technology for development. It is empowered to promote research in any area that will advance development, and to ensure that the facility exists for its implementation. Thus CSIR has 12 institutes through which it engages directly in research, but has the responsibility to coordinate research in the country as a whole.

3. Structure

The CSIR is headed by a Director General with executive powers. He is assisted by a 26-member Council. There are five technical committees at the Secretariat. These are subcommittees of Council to oversee and deliberate respectively in the specific areas of (a) Agriculture, Forestry and Fisheries, (b) Industry and Technology, (c) Health and Medicine, (d) Natural Sciences, and (e) Social Sciences. Currently these groups are engaged in discussions and have, indeed, produced an interim report that should assist in the formulation of national policies in the different areas.

Of the 12 institutes directly within the management of the CSIR, seven are agricultural or agriculturally related (Animal, Crops, Food, Oil Palm, Soil, Aquatic Biology and Water Resources). Each research institute is semi-autonomous. It is headed by a director and assisted by its own management board. Directors of the different

institutes meet monthly at the Directors Management Committee chaired by the Director General. Members of the management boards of each of the institutes are appointed by the CSIR Council.

Perhaps the most complex of the institutes is the Crops Research Institute (CRI), which is spread widely on the ground, with a number of research stations and substations. It has two major projects, which by virtue of the fact that they are donor-assisted are managed semi-autonomously. These are the Nyankpala Agricultural Experimental Station, located in the northern savanna ecological zone and assisted by GTZ; and the Ghana/CIDA Grains Development Project located at Kwadaso, Kumasi in the semi-deciduous forest zone.

4. Facilities

The physical infrastructures vary considerably among the various institutes. The CRI, and to a limited extent the Soil Research Institute (SRI), by the nature of their work operate agricultural research stations distributed widely throughout the country. The object of this is to catch a representative range of soils, ecology, and socioeconomic circumstances in their studies.

Most of the stations date from colonial times. The buildings are old, poorly maintained and, in many cases, in a serious state of disrepair. With assistance from GTZ, Nyankpala Agricultural Experimental Station has relatively new and modern laboratory, administrative, and residential buildings. The Ghana/CIDA program at Kumasi - like the rest of the CRI at Kwadaso - operates in old and crowded buildings. The CRI, however, has the prospect of moving into a new and massive laboratory building at Fumesua. This building has been in construction for the past two decades and needs little further investment to get it completed.

The SRI seems to be adequately housed at Kwadaso in its original buildings, with the addition in recent times of a very large library complex. The pressure of extra work will be catered for by two new laboratories built in Tamale and Accra which are yet to be completed. OPRI has just moved into relatively new office and laboratory buildings, but as with all institutes, residential accommodation is inadequate. The Institute of Aquatic Biology and the FRI are in temporary buildings and are still looking forward to permanent buildings designed for their specific needs. The Animal Research Institute is still housed in its original temporary premises at former Achimota College. A large new building for ARI at Katamanso is still far from completion.

The equipment situation is critical for most of the institutes. Equipment is either non-functional or obsolete. The situation is better where donor assistance is provided, such as GTZ for NAES Nyankpala, CIDA for the GGDP Kwadaso, and the World Bank for OPRI, Kusi. This state of affairs is true for the laboratories as well as for the field equipment. Vehicles are noticeably in short supply or absent at most institutes and stations, and are a major reason for poor work output.

5. Program Formulation and Priority Setting

Institutes are guided to the choice of topics for research by the mandate for the institute. This mandate is spelled out in the instrument bringing them into existence. This is rather general and not specific. Within this context most projects are researcher initiated. The entire institute is under a variety of influences through discussions at the Management Board, contact with users and clients, discussions with colleagues within and outside the institute, at conferences, seminars, workshops and by world science through the literature. All these contribute to what the individual scientist chooses to work on.

The director of the institute has to approve a project even when it is researcher initiated. The director may also assign specific topics for investigation. This often applies in order to fulfill a contract obligation or a request from outside the institute, or if the director considers it a vital issue.

At most institutes the research subcommittee of the management board scrutinizes the projects and reports to the board. This body also often prioritizes projects and monitors their progress.

In the Nyankpala program, there is an evaluation every three years by a team of experts, who also define priorities and the general direction in a Goal Oriented Project Planning (GOPP). There is an in-house review group with two or three external experts which meets annually to evaluate the progress of work and to harmonize operations.

In the Ghana Grains Development Project a public forum is provided at an annual workshop, where farmers, researchers, extension officers, and policymakers all gather to exchange views. Here comments are received and discussed and the future direction of research is identified. A standing committee evaluates progress twice a year. Both the Nyankpala program and the GGDP project have strong on-farm research/demonstration/and verification teams. These periodically conduct a socioeconomic study of the impact of research results and also constantly bring back feedback from the field.

In the final analyses, however, most institutes declared that the direction of research is determined by where money is available. The machinery works better in the externally funded project, where financing is easier.

Monitoring at most institutes is by periodic reporting to the director or the research sub-committee. The director is obliged to report annually to the Council of the CSIR. In many places this is reinforced with periodic seminars, and farm visits which offer opportunity for peer evaluation and criticism. Publications emerging from research done are highly valued for purposes of promotion and professional advancement.

6. Linkages

The directors of the institutes have direct and unrestricted access to the Director General for consultation. All directors meet formally with the Director General monthly at the Committee of Directors meeting. In addition to these there are numerous informal linkages between the staff of various institutes at various levels. They have a joint use of the facilities at the CSIR Secretariat in Accra.

Membership of the Management Board offers formal linkage with the universities, ministries, and departments, various user agencies, or farmers. Relationships with the universities are otherwise informal and often take the form of using institute staff for part-time lecturing or external examining or using institute facilities for student projects or for collaborative work.

Many members of the institutes serve on various committees of the Ministry of Agriculture. It is interesting to note that the MOA is not represented on the Management Board of the FRI, but like all directors of the research institutes the FRI has been represented on the Agricultural Research Advisory Committee, ARAC. Relationships between the MOA and the institutes are otherwise informal but vigorous.

The MOA and the Grains and Legumes Development Board (GLDB) are in partnership with the CRI in the execution of the Ghana Grains Development Project. This necessitates a closer relationship in programming funding and field-level operations. The MOA indeed has a technical staff permanently posted to the GGDP for on-farm work and extension activities. The Nyankpala project similarly has a technical officer of MOA posted to it.

Apart from the possible representation at the Management Board, the relationships between the institutes and the farmers are rather casual. Many institutes organize from time to time, both at the local and national level, field or open days and workshops to which farmers are invited. Some bulletins and printed guides to farmers are issued from the institutes, but this has been dormant lately for lack of funds. The annual workshop of the GGDP and the meetings of some professional associations, such as the Animal Sciences Symposium, encourage the active participation of farmers and policymakers.

Internationally, most institutes have an elaborate array of international connections. The range and the specifics vary for different institutes. These connections are cherished for the following: they offer opportunities for funding, for limited supply of equipment, for staff training, for short-term exchange of scientists, for supply of literature, for collaborative work, and for invitations to workshops.

MINISTRY OF AGRICULTURE (MOA)

1. Origin

The Ministry of Agriculture had its beginning in the Government Botanical Gardens established at Aburi in 1890. In its early years it did more training of local staff and research than advisory service. The Department of Agriculture which finally emerged from this was throughout the colonial era a monolithic organization, in which research, training, and advisory service existed together under one head.

2. Mandate

The mandate of the MOA has always been to promote agricultural production in the country in the effort to improve the nutrition of the people, their living conditions, and to promote exports. In doing this the MOA seeks to create an atmosphere that will facilitate farming as a way of life and as a business. In the Ghanaian context this means ready and secure access to land and other means of production, and also access to sound advice and up-to-date information on production techniques, good pricing and marketing arrangements.

Agricultural research remained part of the MOA's mandate until 1962, when it was transferred to a body that eventually became the CSIR. In 1972/73 the COCOBOD took over responsibility for cocoa services from the MOA, and in 1975 a new Ministry of Cocoa Affairs was created. In 1961, about the time agricultural research was removed from the mandate of the MOA, United Ghana Farmers Cooperation (UGFC) was formed to mobilize the farmers; and State Farms were created to use the facilities of the agricultural stations and elsewhere for large-scale production.

3. Structures

The MOA has been restructured many times since the country gained its independence in 1957. There has been the need to restructure it once again in the Agricultural Services Rehabilitation Project now going on.

In its latest restructuring the thrust is towards:

- (a) strengthening of the central policy, planning, monitoring, and evaluation capacity;
- (b) a phased program of decentralization of field operations;
- (c) merging of a number of separate extension services;
- (d) the disengagement of MOA from fertilizer operations and tractor hire services; and

- (e) provision for better coordination between the various sector agencies.

The Ministry is headed by a Secretary of State assisted by two deputies: one for crops and the other for animal-related matters. There is a range of nine departments, each headed by a director. Within the Ministry, the World Bank recognizes three categories of state-owned enterprises (SOEs):

- (a) for direct production and marketing, such as Food Production, State Farms and State Fishing;
- (b) for delivery of inputs and services, such as the Ghana Seed Company and the FASCOMs in the Upper East, Upper West, and Volta Regions;
- (c) for implementation of Government policies, e.g., the Irrigation Development Authority (IDA) on irrigation; and Ghana Food Distribution Corporation for food security. To these may be added the Central Veterinary Laboratories at Pong Tamale for the production of vaccines.

The MOA has access to a number of agricultural stations scattered all over the country, most of which are shared between organizations, including research institutes of the CSIR. A prolonged period of neglect has led to the deterioration of a lot of the facilities at these stations. They enjoy the advantage of having been distributed over a range of ecological situations and are highly valuable in that respect for research. The Irrigation Development Authority has fairly autonomous self-sustaining irrigation projects at Dawhenya, Afife, Aveyme, and ICOUR, Navrongo.

4. Program Formulation and Priority Setting

The MOA is not a research organization but thrives on the results of research. For research to answer its needs MOA should be involved in determining the priorities in research, its formulation and evaluation.

The following machinery exists to make it possible for the MOA to influence the choice and conduct of agricultural research:

- i. The MOA is represented on the Council of the CSIR.
- ii. Departments of MOA are represented on the management boards of the CSIR as is relevant to their field of operation. The FRI is an exception to this. Also the representation is not in all cases ex-officio.
- iii. Wherever they exist, the Ministry is given representation on the Research Committees of the Management Board.
- iv. Various Heads of Departments of the Ministry are represented on the Technical Committee for Agriculture, Forestry and Fisheries of the CSIR.
- v. All Directors of the Agricultural Research Institutes of CSIR are represented on ARDAC.

Both ARDAC and the CSIR Sector Technical Committee are top policy and monitoring bodies in each institution.

- vi. The review reveals that there are numerous ways in which the MOA uses personnel of the Research Institutes informally for technical advice and execution of programs.

5. Linkages

Internal:

- i. On CSIR Council (formal).
- ii. Informally or formally with CSIR institutes and the universities.
- iii. Ministry of Finance and Economic Planning.
- iv. Ministry of Lands and Natural Resources.
- v. Environmental Protection Council.
- vi. With the farmer through the Extension Department, Farmers Week, radio, television, and the press.

External:

IITA, FAO, EEC, CIDA, IFAD, Jap. Tech. Aid, etc.

MINISTRY OF EDUCATION AND CULTURE

The universities are a responsibility of the Ministry of Education and Culture. They constitute a special schedule under the Deputy Secretary in charge of higher education. The faculties of agriculture, by virtue of their being part of the universities, relate to the Ministry of Education and Culture and not to the MOA.

1. Origin

The Faculty of Agriculture of the University of Ghana was established in 1952; that of UST, Kumasi in 1961, and the School of Agriculture at Cape Coast University in 1975. The Institute of Renewable Resources was established in 1982.

2. Mandate

The faculty at Legon was established in the normal process of growth of the university to offer education to its highest level possible in agriculture. It had a particularly strong commitment for research at the beginning, to explore the agricultural potentialities of the Accra Plains and the Forest Belt.

The UST faculty developed from the Department of Agriculture of the Kumasi College of Technology, established in 1953. This department had the mandate of providing a number of ad hoc courses lasting a few terms to three years for the Ministry of Agriculture. When it was

raised to faculty status in 1961 it was to follow the steps of Legon in providing high-level manpower in agriculture and to research problems of agricultural production, particularly in the Forest and the transitional belt of Ghana.

The School of Agriculture was specifically established to provide high-level manpower in agriculture for the teaching profession. As a university institution it also carries out research in agriculture and agricultural education. So far its agricultural research activities have been directed to the high rainforest and the coastal scrub and thicket belts of Ghana.

3. Structures

The faculties at Legon and at Kumasi are housed in permanent buildings. They comprise offices, laboratories, and lecture theaters. The School of Agriculture at Cape Coast is temporarily housed in the buildings of the Faculty of Sciences, whose teaching and laboratory facilities it shares.

Kumasi has relatively more modern buildings, which offer adequate office, laboratory, and teaching space. Legon is much older and finds its office, laboratory, and teaching facilities very much stretched. The School of Agriculture is about to take over a new building. This would relieve present congestion in office accommodation and offer more modern laboratory facilities for teaching. Laboratory equipment at all the institutions is old, obsolete, and inadequate, but most of them are in good working condition. Cape Coast has equipment which is yet to be installed. Lack of adequate numbers of roadworthy vehicles is a constraint at all institutions.

There is access to farm land for teaching at all three institutions. The least developed of these is at Cape Coast. Three big research stations attached to the faculty at Legon and located at Kade (forest), Nungua (Coastal Savanna - livestock) and Kpong (Coastal Savanna - irrigation) have become more or less national assets and are funded separately from the faculty.

At Legon and Kumasi a student can specialize in a particular field in agriculture at the first degree level. At Cape Coast the program does not allow this by virtue of its mandate. In Cape Coast, however, it is an obligation to pursue a course for a diploma in education concurrently with the degree program. Diploma courses offered by the Legon and Kumasi faculties are subdegree and separate.

The Institute of Renewable Resources developed out of the program at the Kumasi faculty. It offers courses leading to a B.Sc. or a Diploma in Natural Resources Management, and an M.Sc. in Wood Technology.

4. Program Formulation and Priority Setting

Research projects are commonly researcher initiated. In doing so researchers take into account the needs of the country. There is also some collaborative work often induced by donor or contract funding. This is often in response to a proposal made. Within the broad context of national need, priority for research topics is set by the availability of funds. Money made available for departmental research annually is very little, but one can apply to the research and conferences funds of the university by putting forward an acceptable proposal.

Much of the research carried out in the faculties is through students' projects. This is because project work is a requirement for a student's degree and is always funded, however meager the resources of the department. Monitoring is the responsibility of the head of department. He may be assisted by a research committee.

Monitoring and evaluation arise by consultation and by periodic reporting. An annual report to the Vice-Chancellor is an obligation. The Vice-Chancellor reports on departmental research work in the Vice-Chancellor's Annual Report. More critical evaluation takes place at workshops, conferences, and seminars. Professional publications form part of the basis for promotion.

5. Linkages

The faculties of agriculture are very much a part of the university system. They are therefore conditioned by the ideals of the parent body for truth and excellence. This should not be a handicap for the faculties to relate in realistic terms with the apparent disharmony of the real world of rural agriculture.

Within the university the faculty represents a unit of administration in which most disciplines related to agriculture are placed. These include, crop science, animal science, soil science, engineering and mechanization, home science, agricultural economics, and agricultural extension. As a basic unit of administration the agricultural faculty has representations on various committees of the university, including the Appointments and Promotion Board and the Finance Subcommittee of the University Council.

The faculty is headed by the dean/director, coordinating the activities of departments, each of which has its own head. The departments are fairly autonomous and are represented in many situations in their own right.

The universities are represented on the Council of CSIR but not necessarily by the dean of the faculty of agriculture. The dean, however, specifically represents the faculty on the Sector Committee of the CSIR and on the Agricultural Research and Development Advisory Committee of MOA.

Many members of the faculties serve on various boards and committees of the research institutes of CSIR and the MOA, but in their own right. There are several other informal linkages by which the faculty or its members relate to institutes of the CSIR and the departments of MOA, either in advisory capacity or in a collaborative manner.

Within the country there is nothing that formally links the three faculties of agriculture together. Internationally, however, they are linked by their individual membership of the Association of Faculties of Agriculture in Africa (AFAA). International relationships in the more technical fields are developed on departmental lines and along disciplines. Most common of these linkages is with institutes of the international agricultural research centers, such as IITA, CYMMIT, ILCA, ICRISAT, etc. This provides for exchange in research information and material. There are also linkages with potential donor organizations, such as FAO, EEC, UNDP, IDRC, IBSRAM, etc.

PRIVATE & QUASI-GOVERNMENT ORGANIZATIONS

This group consists of private organizations with or without government participation, which operate at such a level of technology that they would need research assistance to sustain or promote them.

The organizations are:

1. Akropong Farms Limited, founded in 1965 as a purely commercial enterprise for the production of eggs. In 1978, a breeding program was established. With the technical assistance of the Animal Research Institute and the Department of Animal Science of the UST Faculty of Agriculture, the farm has developed its own grandparent stock from crosses between local birds and imported breeds. The new breed, which is labelled AFBOSBEK, has been in production for the past seven years. The enterprise does not carry out any research but takes advice from local research institutes. Funding is essentially private, with assistance from the banks.
2. Benso Oil Palm Plantation (BOPP). This was established as a joint venture between UAC International and the Government of Ghana. The total size of the plantation is 3,925 ha., all of which is planted. It has a factory with a capacity of 16 metric tons per hour. As part of the Unilever Plantations Group, the plantation depends for technical advice on the research center for the Group, which is based at Colworth House in the United Kingdom. Any experiments carried out locally are at their direction or specification. There are plans to employ an agronomist locally, but experts from the Group visit from time to time.
3. Darko Farms. This is a limited-liability company established in 1967 to produce poultry, poultry products, and pork on a commercial scale. The farm does not carry out any research on its own, but

depends on the Animal Science Department of the University of Science and Technology (UST) for its research needs. It has, however, a well-equipped set-up for testing the food values of basic ingredients that go into the manufacture of feed, and does this as a service to other feed manufacturers. The farm has a capacity of over 100,000 birds and a hatchery producing 5.0 million day-old chicks per annum. Once a year the farm imports new grandparent stock, but currently maintains three lines of grandparents at a time. Darko Farm has linkages with PROVIMI of Holland for the supply of feed ingredients, PREMMER PHARMA of the UK for drugs, CURRB of the UK for grandparent broilers, and ISA BROWN of the UK for grandparent layers.

4. Cotton Company in Tamale. This company was established to take over the management of the Cotton Development Board, which was dissolved in 1986. The company is owned by some eight textile companies and the banks. The company does not undertake any research but depends on results from work done by the Crops Research Institute, by an agronomist and an entomologist based at Nyankpala Agricultural Experimental Station. An Egyptian plant breeder with the company is currently doing some cross-breeding using material obtained from Côte d'Ivoire, with the goal of evolving a superior variety of cotton for the company. This expert is also a source of introduction of cotton germplasm for testing in Ghana. The company maintains a laboratory for routine measurements and tests for quality control.
5. Nasia Rice Company in Tamale is a private company established in 1973 in partnership with the Ghana Government to develop rice farming in the Northern Region of Ghana. It is currently owned by a consortium of banks (National Investment Bank, Barclays Bank, the Agricultural Development Bank, and the National Savings and Credit Bank). The company does not conduct any research but has a laboratory well equipped for quality control purposes.
6. Pioneer Tobacco Company. This is essentially a manufacturing company. It has a small field unit which promotes tobacco leaf production by farmers to ensure a local supply of leaf to the company. The company has been involved in tobacco production in Ghana since 1953. The company does not normally undertake research but on occasion is obliged to carry out adaptive trials with regard to certain products. They have had occasion to test fertilizer rates and combinations in the past and to evaluate the effectiveness of certain herbicides. The company is under the management of the British American Tobacco Company (BAT). BAT provides technical advice when needed.
7. Aveyime Cattle Ranch Ltd. This is a project established to supply improved local bulls to upgrade local farmers' stock. It is also to improve the quality of grazing land on the plains and to make the community more productive in meat and hides. Facilities at the ranch include dams, cattle kraals and sheep pens, dips and spray races. In their endeavor they are in constant touch with the ARI and the Department of Zoology of the University of Ghana, who also assist in project formulation. The project is currently financed by the EEC, and the Volta Region Agricultural Development Corporation are the sole shareholders.

8. Food Distribution Corporation Rice Mill. This mill was taken over in Tamale by the Food Distribution Corporation from the Ministry of Agriculture to save the mill from total collapse. The corporation does not carry out research. The corporation does not grow any rice but buys the paddy from farmers. The mill has been inactive for the past two years and is undergoing reorganization.
9. Ghana Atomic Energy Commission (GAEC). GAEC was established in 1963 by an Act of Parliament to take responsibility in Ghana for all matters relating to the peaceful uses of atomic energy. The commission carries out research that will promote peaceful application of atomic energy and has set up a National Nuclear Research Institute for the purpose.

The institute is well housed. It has laboratories for various aspects of study, including studies in physics, biology, agriculture, and engineering. There is also a nuclear reactor and a workshop. The Central Administration Block has a big laboratory and a big lecture theatre. The laboratories, libraries, and lecture theaters are well equipped and very modern. Transportation is somewhat inadequate and limits the scope of field work.

Program Formulation. Programs are formulated by the sectional head after consultation with his/her staff. At a research committee meeting the heads of the different departments discuss the projects for their sections. Projects are approved on the basis of what is needed and on the availability of funds for it.

Linkages. The institute has wide linkages for collaborative research with the universities in the area of soil studies and plant breeding; and with Oil Palm Research Institute and Animal Research Institute of the CSIR. The institute trains Ministry of Agriculture extension staff in various aspects of the use of radiation in agriculture. The institute is administratively under the Chairman of the Committee of Secretaries at the Castle.

10. Ghana Oil Palm Development Company (Kwae Estate), was established in 1978 with World Bank funding. The estate maintains a laboratory for quality control purposes. Otherwise it carries out no research; the estate gets information and support from the following linkages:
 - It depends on the FAO for local plant quarantine.
 - It is directly under the Ministry of Agriculture and Ministry of Finance and Economic Planning.
 - OPRI has no formal relationship with it.
 - IRHO is the parent organization managing the estate. They advise on aspects of plantation management, including seed supply, disease control, soil and leaf analysis. Library facilities are meagre, but the top staff have access to key journals by personal subscription. These include Oleagineux and Planta.
11. Ghana Rubber Estates Ltd. The plantations which form the basis of the estate were established between 1968 and 1981 as part of Firestone (Ghana). Sodece took over from Firestone in 1988 and is

now rehabilitating the estate. Sodece, the managing partner, is a French company, which has its laboratories and research facilities in Cote d'Ivoire. There is no facility for local research.

12. Ghana Seed Company. This company has a research officer who is supposed to be carrying out research of an adaptive nature to promote the cultivars which the company intends to sell to farmers. The research officer does not do any research because his time is engaged in other things that will bring the company immediate money. The company is completely run down in funds since USAID stopped funding it, and has become ineffective.
13. Komenda Sugar Factory. The project was started in the 1960s to grow sugarcane and process it into sugar and various byproducts. Work stopped at the estate in 1982. There is uncertainty about the future of this project. In anticipation of its possible rehabilitation, some seven promising varieties of sugarcane at the station have been selected and are being regularly nurtured on an acre of land at the nursery. Otherwise no research is carried out.
14. National Oil Palm (NOP) Ltd. - Pretsea. Originally established by the UAC in 1939. It was taken over by the State Farms Corporation in 1962. After a prolonged period of neglect it was taken over by NOP. It was reviewed for rehabilitation by EEC consultants in 1984/86. Yields are poor from past neglect, so a replanting program has started, replanting 200 ha each year. A laboratory is kept at the factory for quality control. Herbicides are employed in the fields for weed control selected from on-the-spot field testing. Any such trial is initiated by field staff and eventually approved by the general manager. Research takes up very little time, less than 20% of the station's effort. The station has no formal contact with any research unit, but the Soil Research Institute has been requested to conduct soil tests and foliar analysis in order to form the basis for fertilizer recommendations. The station has a good working relationship with OPRI for the supply of seeds and for general advice. The station needs close research support to make it survive.
15. Twifo Oil Palm Plantations (TOPP). This plantation was established as a commercial concern in 1978 with assistance from the EEC and CDC. The estate has an agronomy laboratory, with ovens, microscope, and soil augurs. There is also a laboratory for quality control. The estate has no linkage with CSIR or the Ministry of Agriculture. The estate has often asked for research assistance from the School of Agriculture, University of Cape Coast. Partnership with Harrison, Fleming and Partners as managers of the project entitles them to seek research assistance from Harrison Fleming Advisory Service overseas and also from Lever Bros. U.K.
16. Ejura Farms Limited. The project was started in 1969 by an American group led by Chanex International Ltd. In 1977/78 GOG became the major shareholder, with 91% of the shares, Chanex International retaining 9%. In early days, while management was with Chanex, experts were sent from abroad to monitor the project, but they do not come now that management is under MOA. There is no management board at present. The farm is highly mechanized, using planters and

harvesters. It has a 10,000-ton grain drying and seed cold storage facility. The farm specializes in the production of hybrid seed for sale to farmers. This is done under license from Pioneer Hybrid International of Iowa, USA. The farm receives foundation seed from the GGD Project at Kwadaso for multiplication. Cattle production was adopted as an enterprise by the farm in 1980, using material from Ghana.

The cattle graze the natural vegetation and receive supplementary grain byproducts. Some cattle breeding is going on at the station under the supervision of a veterinary officer.

17. Cocoa Processing Company. This is a subsidiary of the Ghana Cocoa Board. It is not engaged in research. The UN Alimentation Codex Committee reviews its standards from time to time.
18. Northern Regional Rural Integration Program (NORRIP). NORRIP was started in 1975/76. It is not entirely an agricultural organization. It was set up with Canadian assistance to assist various departments to perform better. It operates in the field of agriculture, animal production, roads, forestry, education, community development, water, and infrastructure. It does not carry out any research, but liaises between researchers and executors.
19. Subri Industrial Projects Ltd. This was established to produce species of pulp for a paper industry in Ghana. The project is exploratory, since it is seeking for suitable local species for the purpose. In this respect Gmelina SPP has been selected. Other pulp species like Wawa, tropical pine are also being investigated. Before the forest is cleared for the establishment of the chosen species an attempt will be made to identify and preserve indigenous medicinal plant species. The project has a well-equipped laboratory. The priorities of the project have been set. Monitoring and evaluation is carried out during regular meetings, quarterly reports, and management board meetings. The project has formal linkages with the Agricultural Management Training Program funded by IFAD, STRC, ADB, and the World Bank. Technical management is carried out by Silviconsult Company. No systematic research is carried out.
20. Takoradi Veneer and Lumber Company (TVLC). The company produces veneer and various wood products. TVLC sometimes pioneers the use of non-traditional species such as Avodire spp., which is now used in the furniture and door industry. The company has regular interaction with the Forestry Department but has nothing to do with FPRI. The company was assisted by the International Development Agency for a while in the past.

ANNEX 5

HUMAN RESOURCES

Vacancies and Attrition

Vacancies in approved establishments are relatively very high for both scientists and technical officers at most CSIR agricultural institutes (see Table A.1). Corresponding data for other institutions undertaking agricultural research are not available. A reassessment of the cadres of research staff required should be one of the outcomes of the forthcoming medium-term plan.

Table A.1: Scientist and Technical Officer Vacancies at CSIR Agricultural Institutes, 1989

Institute	Scientists			Technical Officers		
	In Post ¹	Vacancies	% TAE ²	In Post	Vacancies	% TAE
ARI	16	24	60	12	6	33
CRI, GGDP	17	9	22	40 ³	3	7
Other CRI, Kumasi	23			na	na	na
CRI, Nyankpala	9	17	34	8	22	73
FRI	31	9	22	17	16	48
IAB	20	27	57	4	10	71
OPRI	9	1	11	2	0	0
SRI	12	45	79	28	45	62
WRRRI	24	4	17	9	7	43
TOTAL/Av.	161	136	46	-	-	-

Source: 1989 Estimates of Expenditure, CSIR/ISNAR Institutional questionnaire returns and Staff Lists.

Notes: 1. "In Post" 30/6/88 or 31/12/88, excluding in-service trainees.
 2. Total approved establishment 1989.
 3. Excludes development officers.

To gain further insight into the process of attrition a trace survey was conducted on five institutes in CSIR. Approximately 40% of the CSIR agricultural scientists who were employed in 1975 continue to work at CSIR. There are, however, significant variations among the five institutes (see Table A.2). Again, ARI and SRI have had the highest rate of attrition.

Some 20% of these scientists work outside of Ghana, although it is widely reported that some are returning home, especially from Nigeria.

Table A.2: Current Whereabouts (April 1979) of Scientists Employed at CSIR Agricultural Research Institutes in 1979

Institute	Still at CSIR	Retired/ Died	University	MoA	Para-statal	Private/ Business	Overseas	Other unknown	Total
ARI	3	2	0	0	1	1	7	0	14
CRI ¹	11	3	0	0	1	0	3	4	22
FRI	9	3	1	0	1	2	2	0	18
IAB	6	1	2	0	0	1	1	1	12
SRI	4	3	2	1	0	0	3	1	14
TOTAL	33	12	5	1	3	4	16	6	80
Percentage	41	15	6	1	4	5	20	7	100

Source: Tracer survey of CSIR agricultural scientists, 1975 - 1979, conducted as part of CSIR/ISNAR Review, April 1989.

Notes : 1. Excludes oil palm scientists.

Strategic Human Resource Planning

Strategic human resource planning involves assessing the requirements for and the availability of personnel with specific skills, attitudes, and commitments who are needed for the attainment of specific objectives over a particular time period in the most cost-effective manner. For the NARS as a whole in Ghana, strategic human resource planning, as defined above, has never been undertaken. Even within CSIR no systematic planning of this kind has been attempted during the last 15 years. However, the number of CSIR agricultural scientists has more than doubled since 1970, with the largest absolute increases at CRI, FRI, and WRI (see Table A.3).

Vacancies in approved establishments have always been so large that institute directors have rarely needed to seek permission for increases in their establishments. Thus the size and pattern of employment growth that has occurred has largely been due to the success of individual directors in filling vacant posts.

The development of a human resource plan for the NARS in Ghana will be one of the most important components of the medium- to long-term agricultural research plan. Human resource requirements will need to be derived for each research program area with at least a ten-year planning horizon. The success of this human resource planning process will depend critically on

the realistic assessment of the major utilization constraints that are likely to prevail during this period. The future availability of operating and fixed capital resources are important parameters. Estimates will be needed of likely total resource requirements per scientist in each of the main research program areas. Detailed human resource planning activities can only be undertaken once a clear set of research priorities and related resource allocations has been established. However, it is unlikely that there will initially be any major expansion in the total number of scientists employed for research, since at first sight it appears the first priority must be to ensure that whatever additional resources are made available are used to more effectively utilize the existing cadre of scientists.

Table A.3: Number of National Scientists in Post¹ at CSIR Agricultural Research Institutes, 1970 - 1989

Institute	1970	1975	1980	1985	1989
ARI	12	12	19	13	16
CRI, Total	23 (1)	22 (0)	41 (all)	27 (7)	49 (10)
GGDP	-	-	na	9	na (2)
Nyankpala	?	?	na	9	9 (7)
Other			na	9	na (1)
FRI	15	19	na	24	31
IAB	11	12	na	18	20
OPRC/I	-	-	6	7	9
SRI	8	13	19	9	12
WWRU/I	3	na	na	17	24
TOTALS	72			116	161 (10)

Source: Annual reports of CSIR and CSIR/ISNAR institution questionnaire returns, 1989. Nominal Roll contained in 1989 Estimates.

Notes : () = Non-Ghanaian (expatriate) scientists.

1. Excludes scientists who are on long-term study leave.

More generally, there is a need for comprehensive up-to-date information of the employment of skilled agricultural personnel in both the public and private sectors in Ghana. Little is currently known about the distribution of these personnel or what future requirements are likely to be. Such a comprehensive survey would be invaluable in preparing or revising a human resource plan for the NARS, since it would allow more accurate judgements to be made about the future availability of skilled agricultural personnel and the ability of the research institutions to attract the numbers and quality of recruits that will be needed to satisfy its human resource requirements.

Human Resource Development: Skills and Training

Postgraduate degree training

The importance of postgraduate training is fully recognized by CSIR management, and this is reflected in the promotion requirements to the research officer grade and beyond. Individual demand for this training is also high. Young CSIR scientists are, quite understandably, eager to study overseas. Many feel that they need this challenge and exposure in order to build up their confidence and that for many specializations local training is not available. Perhaps as important is the fact that studying overseas provides a once-in-a-lifetime opportunity to acquire a vehicle or other highly valued consumer durables. These factors, in conjunction with the crisis conditions that have prevailed in Ghanaian universities during the last decade, have meant that fewer than 20% of CSIR scientists with postgraduate degrees have obtained this training locally (Table A.9).

Master's degree programs in the main agricultural specializations were started at the Universities of Ghana and Science and Technology at Kumasi in the mid 1970s. Outputs have been very limited, and there were no M.Sc. graduates in any field between 1980 and 1985. There are strong grounds for strengthening national postgraduate training capacity in agricultural sciences. A CSIR subcommittee is currently considering how this might be done.

A high degree of collaboration will be required between the universities and CSIR institutes in providing core training programs. Serious consideration should also be given to the establishment of twinning arrangements with foreign universities which would allow Ghanaian students to complete some of their coursework overseas, while undertaking relevant research work for theses and dissertations in Ghana.

Over 80% of CSIR scientists have arranged to complete their first postgraduate degree training before reaching 35 years old. While this is relatively good by developing-country standards, many young scientists still have to wait up to five years for a suitable training opportunity. This is much too long a period for efficient use of recruits for research, especially when adequate on-the-job supervision and training in research methodology is unavailable, which has been a common occurrence in recent years.

Approximately 30 CSIR scientists are currently undertaking postgraduate training (10 CRI Kumasi, 7 CRI Nyankpala, 3 IAB, 3 OPRI, 2 ARI, 1 FRI, 2 SRI, and 2 WRI). This leaves some 42 scientists who will require master's degree training in the next 2-3 years (see Table A.4). It is important that this training be provided in a timely fashion. CSIR should therefore develop a comprehensive training plan for these individuals and take vigorous steps to ensure its successful implementation. In the past it has largely been left to individual scientists to seek out available scholarships, often with little or no assistance from their own institute directors or the CSIR Secretariat.

Table A.4: Outstanding Master's Training Requirements
of Agricultural Scientists in CSIR Institutes, 1989¹

Institute	Current Age		Total
	Under 35	Over 35	
CSIR			
ARI	2	1	3
CRI, Kumasi	10	1	11
CRI, Nyankpala	1	0	1
FRI	7	3	10
IAB	2	0	2
OPRI	4	0	4
SRI	4	1	5
WRI	5	1	6
Subtotals	35	7	42

Short-term technical training

While the importance of appropriate in-career training opportunities for research scientists is recognized by senior managers in the Ghana NARS, the availability of such training has been generally limited and sporadic. This has heightened the sense of intellectual isolation felt by many agricultural scientists in Ghana and has undoubtedly had a serious effect on both productivity and morale. There have been few short-term training courses in Ghana for scientists in recent years (19 from 170 respondents, see Table A.5). This is a particularly serious situation for younger scientists who, early in their careers should receive general training in areas such as biometrics, computing, oral and written communication, and staff supervision, along with more specialist courses in their own areas of specialization. About one-third of CSIR and university agricultural scientists have been able to attend an overseas training event or professional meeting during the last three years. This is more nearly satisfactory, but should be improved further. The provision of short-term training opportunities for technical support staff has been much more limited. Many technical officers have never benefited from such in-career training.

Table A.5: Short-term¹ Training Courses Attended by
Agricultural Research Scientists, 1986 - 1989

Institution	Number Respondents ²	GHANA				OVERSEAS			
		Number of Attendances				Number of Attendances			
		0	1	2	3+	0	1	2	3+
CSIR									
ARI	13	9	4 (4)	0	0	7	6 [4]	0	0
CRI, Nyankpala	8	9	2 (2)	0	0	2	4 [2]	2 (1)	0
CRI, Kumasi	24	20	4 (3)	0	0	21	3 [3]	0	0
FRI	22	19	3 (2)	0	0	10	10 (1)[1]	1	0
IAB	na								
OPRI	5	3	2 (2)	0	0	1	5 (1)	0	1
SRI	11	10	1 (1)	0	0	10	0	0	0
WRII	19	19	0	0	0	14	3	1	1
Subtotal	102	86	16(14)	0	0	65	31 [9](2)	4 (1)	2

Other									
FoA/UG	22	22	0	0	0	15	7 1	0	0
FoA/UST	27	25	0	1	0	17	9 [2]	0	0
FoA/UCC	14	12	2 (2)	0	0	8	5 [2]	1 [1]	0
VORADEP	5	0	0	0	0	1	4 2	1 (1)	0
Subtotal	68	59	2 (2)	1	0	41	25 [7](3)	2 (1)	0
TOTAL	170	145	18(16)	1	0	106	56[16](5)	6 (2)	2 [1]

Source: CSIR/ISNAR Survey of Agricultural Research Scientists in Ghana, 1989.

Notes : () = management training courses

[] = courses at the international agricultural research centers (IARCs)

1 0.5 - 6 months in duration

2 Only includes Research Grade Staff employed before 1987.

It is recommended, therefore, that the needs of both research scientists and technical support personnel for timely in-career technical training, both in Ghana and overseas, be fully incorporated into the medium- to long-term research plan, with sufficient resources being made available to fund these activities. Immediate steps should be taken to identify individual training needs.

Management Training

Agricultural research is a management-intensive activity with many specific and unique characteristics. The need for appropriately trained, highly professional research management is greater still in difficult economic circumstances.

Therefore there is an urgent need for regular, well-conceived management training for agricultural research managers in Ghana that will help to impart the skills and attitudes needed for effective and efficient management of the NARS. Some useful training has been provided in recent years, but it has not been sufficiently geared to addressing specific research management training needs nor has it been conducted on a regular basis.

Research management training needs, therefore, to be given priority attention. There are two main management training centers in the country, the Management and Productivity Development Institute and the Ghana Institute of Management and Public Administration, both located in the Accra area. Further analysis will be needed to ascertain which will be in a better position to develop and deliver the specialized research training programs and, in the longer run, ensure the effective institutionalization of such training. Specialist outside assistance will also be required initially.

A detailed assessment should be undertaken of the management training needs of institution heads (i.e., CSIR and other institute directors, deans of agriculture-related faculties, and heads of other research units) and also second-level research managers (e.g., project and divisional managers, commodity team leaders). Annual two-week training workshops should be held for each group.

Strengthening the Training Function

The NARS in Ghana needs to develop a coherent training strategy with sufficient resources to ensure that training requirements are met in a systematic fashion.

It is recommended that a training officer with well-defined duties and responsibilities be appointed as soon as possible. In addition, the recently revamped CSIR Scholarship Committee could be renamed the Training Committee, with a broad mandate to consider all aspects of training and to make recommendations to senior management.

Motivation

The desire of agricultural research personnel to work in an effective and efficient manner will ultimately determine whether the agricultural research system in Ghana, as elsewhere, will produce the agricultural technologies that are so urgently required. Given the extremely difficult conditions and meager rewards that scientists and their support staff have had to endure for many years, it is remarkable that the overall level of morale is what it is. Nevertheless, the motivation of staff in all

agricultural research institutions is still well below the levels in many comparable developing countries. Unless this basic issue of motivation is squarely addressed, other efforts to strengthen the NARS in Ghana are likely eventually to founder due to low morale and continued high rates of attrition.

Grades and Pay

The present grading structures for research-grade staff and senior non-research-grade staff in CSIR institutes are logical and provide a clear sense of career progression for individual staff members. While recognizing that motivation involves a number of diverse and complex human needs, it is obvious that the totally inadequate (material) standard of living of research personnel is the overriding problem.

From the early 1970s to the mid 1980s the real incomes of all public servants fell dramatically. While there has been a slight improvement for research-grade staff since 1985, the present levels of pay are still considered inadequate to maintain an individual and his/her family at even subsistence level.

Many scientists and support staff spend a significant proportion of their working day undertaking secondary income-earning activities. The salary of a scientist probably amounts to no more than 30% of the total income deemed necessary for survival in the urban areas. Clearly the situation is even more critical for lower grades of staff. Thus, in reality many CSIR and university personnel are part-time employees. (However, researchers pointed out that with the chronic shortage of resources to do research work, it would be impossible to work productively on a full-time basis, even if they could afford to). This is a real and significant current constraint on research productivity that cannot be ignored, even though conditions are expected to improve.

The pay structures within and between research and senior non-research-grade staff are also seriously flawed. Within each group the top-bottom pay differentials are only 60-70% (see Tables A.6 and A.7). Consequently, the median salary-experience income profiles are very flat, with limited dispersion of salaries around the median values. Equally serious is the lack of any overlap in salaries between scientists and technical officers. The 50% inducement allowance received by research-grade staff since 1984 means that a chief technical officer with many years of experience and considerable responsibilities earns less than a new graduate recruit from university. This is clearly anomalous, and steps should be taken to remedy this situation.

Despite the very low absolute incomes received by agricultural research personnel, given the realities of public-sector pay policy in Ghana, the scope for significant improvements in pay, particularly for professional staff, is probably very limited in the first place. CSIR and university staff already receive higher salaries¹ than equivalent staff in the

¹If better promotion prospects and non-salary benefits (most notably vehicles and housing) for civil servants (particularly those at the most senior level) are taken into consideration, then the relatively privileged salary position of CSIR staff is somewhat reduced. As part of the current Civil Service Reform Programme (CSRPF), it would appear that GOG's intention is to reduce significantly income differentials between civil servants and employees of invented organizations such as CSIR and the universities.

Ministry of Agriculture and even other high-status professional groups. Government can reasonably argue, therefore, that they are already being accorded special treatment status. And second, the top-bottom income differential in CSIR is currently 8:1.² This is only slightly less than the CSRP target top-bottom income differential of 9-10:1 for the civil service as a whole, and therefore the scope to stretch the CSIR/university pay structure even further would appear to be limited.

Non-salary Benefits

Possibly the greatest scope for improving research staff motivation lies in the area of non-salary benefits. The housing situation for senior CSIR staff at many research institutes, particularly those in or near Accra and Kumasi, is very difficult. CSIR-owned accommodation is in short supply, and much of it is in a poor state of repair. Most officers are obliged, therefore, to seek rented accommodation, the cost of which is now far in excess of their rent allowance (which is only 20% of basic salary).

Quite understandably, CSIR staff want to own their own houses. However, given rapidly escalating house prices and high interest rates, the current cost of doing so is prohibitive for most of them. The CSIR Staff Housing Loan Scheme is of little assistance, mainly because the maximum loan of C 2.0 million (US\$ 5,700) is insufficient to cover the cost of even a basic two-bedroom house (estimated to cost C 3.5 million or US\$ 10,000 in Accra in early 1989) and with high interest rates, monthly requirements are higher than the total salary of many officers.

Therefore serious consideration should be given to improving the accommodation of CSIR staff members at least in the senior grades. A CSIR building program could be another cost-effective way of motivating and retaining staff. The provision of loans on favorable terms for houses and vehicles should also be explored further.

Performance Appraisal

Appraising the performance of scientific research personnel is never an easy task. However, it is an essential component of human resource management, as well as the overall research planning process. Two types of appraisal are undertaken in CSIR: grade promotions and annual confidential reports.

Grade Promotions. CSIR institutes follow identical procedures and criteria in assessing research and non-research-grade staff for promotions from one grade to another. For research scientists, the procedures and criteria have been essentially the same as those in the university system. Consequently, considerable reliance is placed on two External Assessors, one of whom is usually a university academic and the other a high-ranking member of a relevant user agency. The External Assessors rely exclusively on the written outputs of the candidate since his/her last promotion. Their assessments are reviewed by the appropriate CSIR

²This includes the 50% inducement allowance for scientists.

Table A.6: Annual Gross Salaries of CRIS Scientists¹ and Technical Support Personnel at CSIR Research Institutes, 1989

Dir/CRO	289	292					
PRO	277	281	235				
SRO	254	258	262	265	269	273	
RO	235	239	243	247	250	254	258
RO	209	212	216	220	224	228	231
ARO	180	184	187	191	194		
CTO	231	235	238	241	245	248	251
PTO	208	212	215	218	222	225	228
STO	163	167	171	175	179	184	188
TO	134	138	142	146	150	155	159
STA	125	127	128	129	130	131	132
TA ^I	104	107	110	113	116	119	122
TA ^{II} /Artisan	84	86	89	92	95	98	101
Laborer (skilled)	62	64	65	67	69	72	
Laborer (ordinary)	55	57	59	60	62	64	

Source: CSIR Secretariat

Notes : 1 Excludes 50% inducement allowance for research grade staff

Table A.7: Salary¹ Index with each Occupational Group, CSIR, 1989

DIR/CRO	160	162					
PRO	154	156	158				
SRO	141	143	146	147	149	152	
RO	130	133	135	137	139	141	143
RO	116	118	120	122	124	127	128
ARO	100	102	104	106	107		
CTO	172	175	178	180	182	185	187
PTO	155	158	160	162	166	168	170
STO	122	125	127	130	133	137	140
TO	100	103	106	109	112	116	119
STA	148	151	152	154	155	156	157
TA ^I	124	127	131	135	138	142	145
TA ^{II} /Artisan	100	102	106	109	113	117	120
Laborer (skilled)	113	116	118	122	125	131	
Laborer (ordinary)	100	104	107	109	113	116	

Source: CSIR Secretariat

Promotion Panel. While the one/two Permanent Assessors from CSIR are in a better position to make a more comprehensive and balanced assessment of the candidates' performance, an examination of the minutes of the Promotion Panels indicates that primary emphasis has been given to refereed publications until relatively recently. This is also clearly reflected in the application form for promotion which each candidate is required to complete. Where a scientist is deemed to be performing "service" activities and thus is not in a position to produce publishable research, the panels have recommended that the candidate should be transferred to the scientific officer grade.

No precise performance criteria are specified for individual scientists. The existing conditions of service only refer very generally to the individual's "contribution to the institute's work" and other very broad criteria.

Most CSIR scientists have serious reservations about the prevailing promotion criteria. For a minority of them, their main concern is the lack of opportunities to publish in Ghanaian and/or overseas journals. However, the majority of scientists object in principle to the reliance on refereed publications, because they believe that this is an inadequate indicator of the value of their research outputs to the farming communities they serve.

Promotion from one grade to another for research-grade staff in CSIR is a slow process. The ages of officers in each of the main grades is a clear indication of this (see Table A.8). This problem has been recognized by the CSIR Sub-Committee on Conditions of Service, but only minor changes have been proposed to speed up promotion.

Annual Confidential Reports. The recent proposal of the CSIR Sub-Committee on Conditions of Service to replace the present system of annual confidential reports (where the individual appraisee is only informed of an adverse appraisal) with a more open appraisal process, is to be welcomed. Ideally the annual performance appraisal should be based on clear work standards and targets agreed upon by the individual with his supervisor twelve months earlier. With open, well-structured interviews, a forward-looking goal-oriented appraisal system stimulates individual motivation and can be integrated into the annual research planning process. It is recommended, therefore, that serious consideration be given to the introduction of such a scheme for agricultural scientists in Ghana.

Table A.8: Average Age by Grade of Scientist at CSIR
Agricultural Research Institutes, 1989

Institute	CRO/D	PRO	SRO	RO	ARO
ARI	-	-	49	40	31
CRI	-	53	55	38	34
FRI	55	51	43	37	30
IAB	na	na	na	34	31
OPRI	48	-	51	35	30
SRI	58	-	45	41	32
WRI	53	52	42	35	33

Source: CSIR/ISNAR Individual scientist questionnaire survey and
1989 Estimates of Expenditure.

Table A.9: Countries where Currently Employed (1989) CSIR Agricultural Researchers Received Their Postgraduate Training

Institute	Ghana		United Kingdom		United States		Canada		Western Europe		Soviet Bloc		India		Other Africa		Other/ not known		Total	
	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.
ARI	2	0	2	2	0	1	1	1	0	0	0	1	0	1	0	0	0	0	5	6
CRI, Kumasi	2	3	1	2	2	5	1	3	0	0	0	2	0	0	0	0	1	0	6	15
CRI, Nyankpala	0	0	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	2	4
FRI	0	2*	0	5	1	1	0	0	0	0	0	1	1	0	0	1	0	2	1	12
IAB	0	2*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3
OPRC/I	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	3
SRI	0	2	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	0	0	6
WRRU/I	0	3*	1	2	1	0	0	1	0	2	1	1	0	0	0	1	0	1	3	11
Totals	4	13	7	12	5	9	2	6	0	4	1	9	1	1	0	3	1	4	19	60
%	19		24		18		10		5		13		3		1		6		100	

Source: CSIR/ISMAR Survey of agricultural researchers in Ghana.

Notes: * Non-agriculture faculties, e.g., science, engineering.

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ANNEX 6

FUNDING OF AGRICULTURAL RESEARCH

1. OVERALL FUNDING LEVEL

The overall funding of agricultural research is usually expressed as a share of agricultural GDP (Ag.GDP) or per hectare of arable land. The averages of 1986/1987, calculated in constant 1987 prices, show funding levels of 0.57% and 0.80 % of Ag.GDP, respectively, excluding and including cocoa. Expressed per hectare of arable land, the funding level is US\$ 0.72 and 1.30, also excluding and including cocoa (see Table 7).

Can this overall level of funding be considered adequate? One way to answer the question would be to compare these figures with those of developing countries with comparable circumstances. The ISNAR data base shows levels of funding of 0.29% of Ag.GDP, and US\$ 0.96 per ha of arable land in the period 1980-85 for developing countries of 10 to 15 million inhabitants.

Comparing the percentages of Ag.GDP, the level of funding in Ghana is better than average. However, the comparison is somewhat biased, as the figures that ISNAR has been able to collect from developing countries tend to underestimate the level of funding: often, only the funding of research institutions is spelled out in government budgets, but not research at universities, parastatals, and ministries. Thus, an accurate comparison would be with the level of funding of CSIR. Even taking only CSIR funding, Ghana appears to fare well compared to other developing countries: CSIR funding represents 0.36% of Ag.GDP (excluding cocoa) (see Table 7).

However, there is some danger in basing comparison only on percentages of Ag.GDP, as these will obviously be dependent on the agricultural sector revenues.

Agricultural output in Ghana has been steadily declining from the beginning of the 1970s on, a trend which began to reverse itself in 1984. In such a situation, as expressed in percentage of Ag.GDP, the same level of research funding appears higher than it would have been with a better-performing agricultural sector. That agricultural research, excluding cocoa, may not be as adequately funded as it may appear at first is evidenced by the level of funding expressed per hectare of arable land: it is below the average for other similar developing countries (US\$ 0.72 vs. US\$ 0.96). True, there has been a substantial increase in levels of funding between 1985 and 1986 (See Table 2). However, it is mostly due to increase in civil servants' salaries.

Looking at the human resources, Ghana's situation is fair compared with other developing countries of a similar size: 25 researchers per million ha of arable land, compared with 29.6; and 120 per billion of Ag.GDP compared with 89.2, (Table 7).

To help put these figures in perspective, Table 7 also presents similar data for medium-size developed countries. Developed countries invest a substantially higher share of their Ag.GDP in agricultural research, over 2%. This has often led to recommendations for funding levels of at least 1% of Ag.GDP for developing countries, increasing towards 2%. However, it is fair to say that there is no evidence why agricultural research should be funded at the same level in developing and developed countries.

2. FUNDING PER COMMODITY GROUPING

The analysis of the overall funding of agricultural research is somewhat biased by cocoa research, which gets a large share of resources. In 1986/87, it represented 45% of all research funding, while it contributed only 17% to Ag.GDP (See Table 6). By contrast, all the rest of agriculture and livestock were getting 51%, but contributed 71% to Ag.GDP. Similarly, forestry and fishery research represented 3.6% and 1.0% of research funding, but contributed 8.5% and 3.2% to Ag.GDP.

When looking at the research funding of the same commodity grouping as a share of their respective contribution to Ag.GDP over two years (1986 and 1987), cocoa research is 2.1% of cocoa GDP; agriculture and livestock, 0.57%; forestry, 0.34%; and fisheries 0.25%.

The analysis of these figures may lead to the conclusion that cocoa research is getting a disproportionate share of the resources in relation to the other commodities, and that its contribution to Ag.GDP does not justify such a high level of funding. Two comments are in order here:

1. Cocoa has lost its place in Ghana's economy, both as a result of a substantial fall in production and as a result of unfavorable world prices. The value of cocoa production is temporarily lower, but research funding should not follow the rapid up and down trends. It should be relatively stable. It is helpful to compare the 1987 level of cocoa research funding with the value of the 1972 cocoa production at constant 1987 prices. Production was 407,000 t that year, with a value of 303.9 million cedis, that is 117,705 million cedis at 1987 prices. The 1987 funding of cocoa research represents 0.97% of 1972 cocoa GDP. Thus, if cocoa revenues had remained the same, the present level of funding for research would be normal, for a crop as strategically important as cocoa is for Ghana's economy.
2. Levels of funding expressed as a share of Ag.GDP should be only indicative. If taken rigidly they amount to using the congruence method for resource allocation, which is not always appropriate. A commodity may contribute highly to the Ag.GDP, but it may not be necessary to invest correspondingly in research, either because technologies are already well known, and there is not much more that research can contribute; or else the government may decide to diversify its economy and exploit market opportunities for a relatively undeveloped commodity. This would lead to a research emphasis on that commodity which would appear disproportionately high when expressed as a percent of the present contribution of that commodity to the overall Ag.GDP.

In conclusion, the present distribution of funding should be looked into carefully. Cocoa does receive a high level of funding relative to other commodities. Whether this is justified or not, and whether the GOG should consider revising the balance should be addressed, and this would require an in-depth analysis beyond the above data. In particular, it would be necessary to analyze to what extent more research is needed for cocoa, relative to research for other commodities that are deemed strategic for the Ghanaian economy.

The data also highlight the low level of funding of forestry and fishery research as compared to their importance in the economy (see Table 6). Here again one cannot assess this level of research funding on the basis of the comparison with the GDP alone. A wider analysis similar to that proposed for cocoa is required.

3. DISTRIBUTION OF FUNDING BETWEEN INSTITUTIONS

Table 1 and Table 2 present research funding in various organizations from 1985 to 1988, in current and constant 1987 prices respectively. CRIG gets 45%, CSIR and FPRI 31.8%, the ministries 8.5%, the parastatals 4.4%, and the universities 10.2%. Within CSIR, CRI obtains a large part of the funding: 55%. CSIR Secretariat absorbs only 5% of all CSIR funding (for agricultural research).

4. FUNDING LEVEL PER SCIENTIST

The funding level calculated as a percent of Ag.GDP or per hectare of arable land enables one to assess whether the overall level of funding is adequate. Another measure is the funding level per scientist. It reveals whether scientists have adequate resources to work with. Scientists need a minimum level of operating funds to be expected to produce any results. Table 3 presents the funding levels per scientist in the CSIR institutes and CRIG in 1987; Table 4 the funding levels of CSIR institutes in 1974 calculated in 1987 constant prices. The year 1974 was earmarked as a basis for comparison, since research funding was estimated to have been adequate during this period.¹

Table 3 shows average operating funds of 1.64 million cedis (US\$ 10,000) in CSIR and FPRI, and 17.8 million cedis (US\$ 110,000) in CRIG; total recurrent expenditures are respectively 5.4 and 30.71 million cedis. By comparison operating funds per CSIR scientist in 1974 were 3.3 million cedis (US\$ 20,500) and total recurrent costs 9.2 millions cedis (US\$ 56,700). Table 3 also shows the discrepancy of funding levels between research institutes: from US\$ 2,000 in FRI and US\$ 2,900 in ARI; to US\$ 16,200 in OPRI and GGDP, and US\$ 32,300 in Nyankpala.

¹This analysis had to be restricted to institutes of CSIR and FPRI because data from other organizations were either estimates or not accurate enough to support this analysis.

Most of the CSIR institutes, with the exception of the Ghana Grain Development Project, the Nyankpala station and OPRI, do not receive adequate operating funds per scientist to be effective. The comparison with 1974 funding level is interesting, as it shows how CSIR was funded when it was running reasonably well. On the average, CSIR scientists were getting twice as much operating funding to work with. The 1974 average operating funds compare with ISNAR's experience of a modestly adequate funding level, i.e., in the range of US\$ 20,000 to 25,000.

The discrepancy of funding levels per scientist between research institutes also needs to be addressed. While it is recognized that different types of research need different levels of operating funds, it is obvious that some institutes cannot be expected to operate efficiently, given their present level of operating funds, while others may be adequately provided for. Some difficult choices have to be made: either to increase the level of operating funds to reach the appropriate minimum level (by reallocating funds between institutes or by increasing the overall national research effort); or else, keep the operating funds constant but reduce the size of the facilities, programs, and staff so that the remaining scientists have adequate resources with which to work.

5. DISTRIBUTION OF FUNDING BETWEEN OPERATING EXPENDITURES AND SALARIES

Table 5 presents the distribution of funding between four major categories: operating funds, salaries, capital expenditures, and training. Quite a high share of all recurrent expenditures is absorbed by salaries, leaving very little for operating funds: 71% for CSIR and FPRI as a whole, and over 80% for FPRI, SRI, and ARI. Adequate ratios of salaries to recurrent expenditures should be in the range of 50 to 60%. Of all the research institutes, only the Nyankpala station and the GGDP show adequate funding distribution (42 and 55% respectively), since the availability of external funding complements the national contribution.

Given the low levels of salaries in Ghana, one could wonder how such a large proportion of recurrent expenditures goes to personnel. It cannot be explained by the low funding of operations alone. Table 9 sheds some light on the issue. The figures refer to established positions for staff at senior, junior and other permanent staff. They show on average, more than seven supporting staff per senior staff. This is already rather high for many research operations. Moreover, not all established posts are filled. The research posts are on average only about 55% filled. Precise details of actual numbers of supporting staff were not available, but the impression was given that a higher proportion of posts was filled than for the researchers. This would increase further the number of support staff per researcher. Part of the reason for the large share of funds going to salaries could be due to a larger number of support staff than is desirable. There may be a case for a closer examination of this aspect.

An examination of the 1974 funding not only shows a higher level of operating funds per scientist, but also a somewhat better distribution between salaries and operating funds than today: in 1974, 64% of CSIR recurrent costs, on average, were applied towards salaries, as opposed to 71% in 1987 (Tables 4 and 5).

Out of the total funding in CSIR, operating funds represent 21.2%, salaries 51.2%, capital expenditures 23.8%, and training 3.8%. Training might have been underestimated, because overseas training, mostly funded from external assistance, does not appear in budgets unless it is part of a larger project.²

6. EVOLUTION OF FUNDING LEVELS

The previous discussion has already highlighted the fact that operating funds per scientist are less than what they were in 1974 and that the distribution between operating funds and salaries was better balanced then. Table 8 compares the 1974 funding of CSIR research institutes with the 1985 to 1987 ones, all expressed in constant 1987 cedis. ARI, SRI FRI, and FPRI receive less funding than they did in 1974. The situation for CSIR Secretariat is extreme, since its funding is only 33% of what it used to be. IAB, CRI, and WRRRI are all receiving more.

Finally, Table 4 also looks at the evolution of operating funds: on the average the 1987 operating funds are half of what they used to be, the worst case being ARI, with 1987 operating funds representing 12% of the 1974 level of funding.

7. IMPLICATIONS

On the criteria of agricultural research expenditures as a share of the Ag.GDP, the present level of funding (0.8%) is similar to, or even better than, that of other developing countries. However, this is partly due to the high level of funding of cocoa research. Research funding for the rest of the sector is much lower: 0.57% for agriculture and livestock, 0.34% for forestry, and 0.25% for fisheries. Furthermore, when calculated per hectare of arable land, funding levels (excluding cocoa) are lower than in other developing countries under similar circumstances.

On the basis of the funding levels of agricultural research in developed countries, it has been recommended that governments increase the national effort to reach 1% of Ag.GDP. If it was the case, agricultural research (excluding cocoa) would receive approximately 3,000 million cedis (in 1987 prices) as compared to an actual 1,600 million cedis; that is an 85% increase. Such an increase in the overall national effort would be unlikely to be achieved immediately and should be considered as a goal to be achieved over a period of time, say five years.

2. Figures for Nyankpala, GGDp and OPRI were obtained from documents, respectively GTZ, CIDA, and the World Bank; see quotations from Table 1.

The criteria of funding level measured as a share of Ag.GDP, and the subsequent recommendations of an adequate funding of 1% of Ag.GDP could appear as somewhat arbitrary and, moreover, subject to the vagaries of the agricultural revenues. A more tangible criterion is the one of minimum operating fund per scientist. As shown above, the present operating funds are inadequate for most of the research institutes, with salaries absorbing a disproportionate share of recurrent funds.

As noted above, it has been suggested that an adequate level of operating funds per scientist is in the range of (1987) US\$ 20,000 to 25,000 per year. The current average level of operating funds per scientist in CSIR is about US\$ 10,000 per year. If this was raised to an average of US\$ 20,000 per year for all 300 scientists in the system (excluding cocoa), it would mean an extra US\$ 3 million per year overall. However, not all scientists involved in research are in full-time research, or command a full set of support staff. A more realistic figure might be the equivalent of 200 rather than 300 scientists. This would imply a desirable increase in operational funds of US\$ 2 million per year or 320 million cedis (in 1987).

If staffing and salary levels remained constant, such an increase in research operating funds would mean an increase in funding for agricultural research (excluding cocoa), from 0.57% AGDP to 0.68% AGDP, or an increase of 19%.

An increase in operating funds to US\$ 25,000 per scientist would mean an overall increase of 490 million cedis per year, an increase from 0.57% AGDP to 0.74% AGDP, or 30%.

On the same basis of research/support staff remaining constant, and on 1987 salary levels, the total expenditure per scientist would be US\$ 43,000 per year (for an operational funding at US\$ 20,000 per scientist) or US\$ 48,000 per year (for operational funding at US\$ 25,000 per scientist). The implications of using these as planning figures for estimating possible numbers of researchers at different levels of overall expenditure on agricultural research are shown in Table 10.

Table 10: Number of Full-time Scientists Sustainable at Different Levels of Overall Support for Agricultural Research (Illustrated for 1987 AGDP)

Funding per Scientist	Total Funding (excluding Cocoa)		
	0.5% AGDP C 1557 mill.	1.0% AGDP C 3115 mill.	1.5% AGDP C 4672 mill.
1987 <u>Average level of</u> US\$ 33,000	290	580	870
US\$ 43,000	223	445	668
US\$ 48,000	200	400	600
1974 <u>Average level of</u> US\$ 57,000	168	336	504

However, if salaries were to be increased, the total number of researchers sustainable on the support of a given fraction of AGDP would fall. In 1974, when real salaries were appreciably higher than in 1987, the total funding per scientist in CSIR institutes was the equivalent of US\$ 57,000 in 1987 dollars (Table 4). This funding figure has been included in Table 10 to indicate roughly the "scope" of research in terms of staff salaries in 1974. (However, detailed comparison of the effects of different salary levels between 1974 and 1987 would need information on the numbers and distribution of support staff per scientist in each year.)

8. CONCLUSIONS AND RECOMMENDATIONS

The size and scope of the national agricultural research system depends on agricultural development, educational and science and technology policy decisions at a very high level, and on how much the country wishes to invest in ensuring continuing improvement in, or maintenance of, the potential for productivity in agriculture. Clearly, agricultural research has its distinctive contribution to make to economic development, and it is worth maintaining a capability to carry out research. In broadest planning terms, the level of recurrent funding for research can be related to the agricultural performance by expressing it as a percentage of agricultural GDP.

The criteria of funding level measured as a share of Ag.GDP, and the subsequent recommendations of an adequate funding of 1% of Ag.GDP could appear as somewhat arbitrary and, moreover, subject to the vagaries of the agricultural revenues. A more tangible criterion is minimum operating fund per scientist. Each research scientist should have adequate support and financial resources to carry out an efficient research program, and reasonable levels of support per scientist have been discussed earlier. The overall level of support (as above), combined with a rate of funding per scientist, will indicate the likely sustainable size of an effective research cadre, and future planning for research should be in terms of a constrained limit of trained manpower. It is true that national support can be supplemented with external funding, but such assistance should be regarded with some caution, and as temporary supplement to a core research capability sustained by planned national long-term allocation of resources.

The current average level of operational funding per scientist is low, much lower than in 1974 for most of the research institutes, with salaries absorbing a disproportionate share of recurrent funds. Any extra funding for recurrent expenditures should go first to improving levels of operational funding for high-priority programs, rather than to any increase in staff. It is recommended that the operating funds per scientist be immediately increased to the 1974 level (that is, US\$ 20,000) and progressively to US\$ 25,000. Table 10 shows that with reasonable levels of operational funding per scientist, there is unlikely to be scope for expansion of research staff in the near future.

It should be noted that the above recommendations are fairly conservative: they do not call for major increase of funding. Given the situation in the Ghanaian economy, it is probably unrealistic to call for massive increases of funding to research. Therefore, all efforts must be made to

rationalize the use of existing funds and of whatever increased funding that can be obtained. Two recommendations are warranted:

1) Streamlining the Support Staff:

Such an action would be in line with the present GOG redeployment efforts. Job inspections and other analyses are presently being carried out by the Management Services Division of the Office of the Head of Civil Service, supported by technical assistance provided by ODA. CSIR should seriously consider asking for assistance from this project to elaborate a plan for personnel redeployment.

2) Concentration of Research Activities in a Few Priority Research Areas:

Optimizing the use of resources is one of the purposes of concentration. It enables reaching a critical mass of resources on a few priority topics, a necessary requirement for research activities to have the potential of reaching a higher level of productivity.

Table 1: Agricultural Research Funding¹
(including capital expenditures² in current 000's cedis)

	1985	1986	1987	1988 ³
CSIR:				
ARI	14,780	37,660	55,210	118,990
SRI	31,770	59,050	99,910	183,880
OPRI ⁴	46,200	82,240	206,210	391,300
FRI	8,040	32,110	37,550	94,970
IAB	11,560	16,660	34,630	78,840
WRI	8,100	13,030	20,740	36,630
CRI:				
• Nyankpala				
- GOG	52,020	59,640	90,490	116,290
- GTZ	<u>62,750</u>	<u>86,100</u>	<u>120,950</u>	<u>147,500</u>
Subtotal	114,770	145,740	211,440	263,790
• GGOP				
- GOG	34,830	72,940	81,800	178,180
- CIDA ⁵	<u>29,420</u>	<u>55,940</u>	<u>57,970</u>	<u>n/a</u>
Subtotal	64,250	128,880	139,770	178,180
• Others	49,110	81,570	113,900	1,576,570
Subtotal CRI	228,130	356,190	465,110	2,018,540
CSIR Secretariat ⁶	16,060	35,970	47,820	309,820
SUBTOTAL CSIR	<u>364,640</u>	<u>632,910</u>	<u>967,180</u>	<u>3,232,970</u>
FPRI	35,960	74,710	100,900	258,400
CRIG ⁷	n/a	1,037,130	1,140,850	1,254,930
TOTAL RESEARCH INSTITUTES	n/a	1,744,750	2,208,930	4,746,300
MINISTRIES				
VORADEP (WB)	20,600	30,030	88,500	0
VORADEP and Others (GOG)	n/a	146,870	169,710	n/a
TOTAL MINISTRIES	n/a	176,900	258,210	0
PARASTATALS				
Grain Leg Dev Board ⁸	7,060	12,510	17,690	24,510
All Others	n/a	91,830	104,220	n/a
TOTAL PARASTATALS	n/a	104,340	121,910	24,510
UNIVERSITIES				
Ghana				
• Nungua	10,619	19,430	25,610	26,318
• Kade	20,881	29,350	39,880	60,397
• Kpong	9,400	15,970	20,400	30,388
• Faculty	n/a	25,450	36,640	n/a
SUBTOTAL GHANA	n/a	90,200	122,530	n/a
Cape Coast	n/a	12,140	17,470	n/a
Science & Technology				
• IRR	n/a	2,530	3,640	n/a
• Faculty	n/a	24,970	35,950	n/a
SUBTOTAL SCIENCE & TECHNOLOGY	n/a	27,500	39,590	n/a
TOTAL UNIVERSITIES	n/a	129,840	179,590	n/a
GRAND TOTAL AG. RESEARCH	n/a	2,155,830	2,768,640	n/a

Notes to Table 1:

- 1 Financial data on research carried out by ministries, parastatals, and universities cannot be obtained directly as none of these organizations separate agricultural research from the rest of their activities in their budget. The research stations of the university and the Grain Legume Development Board are exceptions in this regard. Thus, the data presented for these entities are proxy or estimates based on the time allocated to research and on a funding module per person year of research calculated on the basis of CSIR institutes funding. This was possible as good time allocation data were obtained from researchers in these various institutions: the turnout on individual questionnaires was excellent; the questionnaires were filled out with care. This proxy thus assumes that the level of funding per person year of research is equivalent in CSIR as in the ministries and parastatals. For the faculties of agriculture the proxy taken was the funding level of the Animal Research Institute. The team's observations and discussions enable concluding that research funding levels at the faculties were low, about as low as the funding for ARI. Financial data for the CSIR institutes also take into account the fact that some activities are not research, (but for example production, such as in the case of OPRI). Here again the percentage of time allocated to research was applied to the budget of the institutes to obtain the data presented in the Table.
- 2 Capital expenditures are included only for CSIR and CRIG. Figures were not available for the other institutions.
- 3 Figures for 1988 are only estimates; i.e., the budget asked for and approved. For the other years, the figures correspond to actual expenditures.
- 4 OFPRI is benefitting from a large World Bank rehabilitation project.
- 5 CIDA funding is managed by CRI, but GLDB staff and CRI staff are working together in the framework of the project. It is impossible to separate the parts of CIDA funds used by GLDB staff and the part used by CRI staff. Thus CRI funding is somewhat overestimated. The figures in the Table represent 80% of the total CIDA funding of the project, as it has been estimated that about 80% of the project activities are research, the rest being purely extension.
- 6 These figures represent 68% of the total CSIR secretariat funding. Based on the staff size of each CSIR institute, agricultural research has been evaluated at 68% of total CSIR research.
- 7 CRIG data for 1987 and 1988 are estimates.
- 8 This is the contribution of GLDB to the GGD project. No other research is being done by the GLDB outside the GGD project. The figures represent 80% of the GGD funding to the project through the GLDB, since about 80% of the project activities can be considered as research, the rest being extension.

Sources:

Data were collected by the review mission from each entity carrying out research, except for:

- GRIG: World Bank. Africa Region. 1987. Ghana cocoa rehabilitation project: project files, working papers 1-6. Washington D.C.: World Bank, p.75.
- GLDP: Wiebe, J. and G.W. Channer. 1988. Ghana grains development project phase 3: Proposal review. Ottawa, Canada: Canadian International Development Agency. Ghana Grains Development Project. 1987. Ninth annual report 1987. Kumasi, Ghana: Crops Research Institute.
- VORADEP. World Bank.

Table 2: Agricultural Research Funding
(including capital expenditures in constant 1987 000's cedis)

	1985	1986	1987	Average ¹	% Change 85/86	% Change ² 86/87	As a % of CSIR/Total ³
CSIR:							
ARI	25,720	52,720	55,210	44,550	105	5	5.4/...
SRI	55,280	82,670	99,910	79,290	50	21	9.6/...
OPRI	80,390	115,140	206,210	133,190	43	79	16.2/...
FRI	13,990	44,950	37,550	32,160	221	-16	3.9/...
IAB	20,120	23,320	34,630	26,020	17	48	3.2/...
WRI	14,090	18,240	20,740	17,690	29	14	2.1/...
CRI:							
• Nyankpala							
- GOG	90,520	83,500	90,490	88,170	-8	8	
- GTZ	109,190	120,540	120,950	116,890	10	0.3	
Subtotal	199,710	204,040	211,440	205,060	2	4	
• GGDP							
- GOG	60,600	102,120	81,800	81,510	69	-20	
- CIDA	51,190	78,320	57,970	58,630	55	-41	
Subtotal	111,790	180,440	139,770	140,140	61	-26	
• Others	85,450	114,200	113,900	104,520	34	-0.2	
Subtotal CRI	396,950	498,680	465,110	453,580	25	-8	54.5/...
CSIR Secretariat	27,940	50,360	47,820	42,040	80	-5	5.1/...
SUBTOTAL CSIR	634,480	886,080	967,180	824,660	40	9	100/28.7
FPRI	62,570	104,590	100,900	89,350	67	-3	.../3.1
CRIG	n/a	1,451,980	1,140,850	1,296,415		-21	.../45.1
TOTAL RESEARCH INSTITUTES	N/A	2,442,650	2,208,930	2,210,425			
MINISTRIES							
VORADEP (WB)	35,840	42,040	88,500	55,460	17	111	
VORADEP & Others (GOG)	n/a	205,620	169,710	187,670			
TOTAL MINISTRIES	n/a	247,660	258,210	243,130			.../8.5
PARASTATALS							
Grain Leg Dev Board	12,280	17,510	17,690	15,830	43	1	
All Others	n/a	128,560	92,270	110,415			
TOTAL PARASTATALS	n/a	146,070	109,960	126,245			.../4.4
UNIVERSITIES							
Ghana							
• Nungua	18,480	27,200	25,610	23,760	47	-6	
• Kade	36,330	41,090	39,880	39,100	13	-3	
• Kpong	16,360	22,360	20,400	19,710	37	-9	
• Faculty	n/a	35,360	36,640	36,140			
SUBTOTAL GHANA	n/a	126,010	122,530	118,710			
Cape Coast		17,000	17,470	17,240			
Science & Technology							
• IRR		3,540	3,640	3,590			
• Faculty		34,960	35,950	35,460			
SUBTOTAL SCIENCE & TECHNOLOGY		38,500	39,590	39,050			
TOTAL UNIVERSITIES		181,510	179,590	180,550			.../10.2
GRAND TOTAL AG. RESEARCH	3,017,890	2,756,690	2,873,510				

Notes to Table 2:

1. Average over the three years or the two when 1985 is not available.
2. Percentage change has not been calculated for the institutions for which a proxy was used to calculate funding.
3. The figures represent funding of CSIR institutes as a percent of CSIR funding, on the left of the slash. On the right of the slash, is the funding of research in various organizations out of total agricultural research funding.

Source:

Figures in Table 1 were used; the Consumer Price Index to convert current figures into constant ones was obtained from the Statistical Service, Accra.

**Table 3: 1987 Funding of Agricultural Research:
Operating Funds and Total Recurrent Costs Per Scientist**

(in cedis and US\$)

	Number of Scientists	Operating Funds per scientist		Total Recurrent Costs ¹ per scientist	
		cedis	US \$ ²	cedis	US \$
CSIR					
ARI	15	470,000	2,900	3,200,000	19,600
SRI	10	1,190,000	7,300	7,900,000	48,600
OPRI	8	2,630,000	16,200	12,100,000	74,700
FRI	26	330,000	2,000	1,300,000	8,100
IAB	11	690,000	4,200	1,900,000	11,700
CRI					
Nyankpala ³	13	5,230,000	32,300	9,100,000	56,000
GGDP	22 ⁴	2,630,000	16,200	5,860,000	36,000
Others	14	1,770,000	10,900	8,500,000	52,400
FPRI	18	1,010,000	6,200	5,200,000	32,100
Average per Scientist⁵					
	137	1,640,000	10,100	5,400,000	33,140
CRIG					
	23	17,800,000	109,600	30,710,000	188,900
UNIVERSITIES					
Nungua	4	2,300,000	14,300	6,402,000	39,400
Kade	5	2,860,000	17,600	7,980,000	49,000
Kpong	3	2,390,000	14,700	6,800,000	41,800
Average per University Scientist⁵					
	12	2,560,000	15,700	7,160,000	44,000

Notes to Table 3:

1 Operating costs plus salaries.

2 1 US\$ = 162.62 Cedis (1987 official exchange rate).

3 Total funding (GOG and GTZ) but excluding expatriates.

4 20 CRI researchers, including five national service personnel, were working within the GGD Project in 1987. Of these, seven were on training, or withdrew for training during that year. CRI had approx. 14 researchers at any given point in time. Eight researchers from GGLB were also working on the project. The figures include CIDA funding, as well as GOG funding through CRI and through the GLDB.

5 Weighted average.

Sources:

Data collected from each entity carrying out research by the review mission, except for CRIG, GGD Project and VORADEP (WB). Sources for those are given in Table 1.

**Table 4: 1974 Funding of Agricultural Research:
Operating Funds and Total Recurrent Costs per Scientist in CSIR**

(converted in 1987 cedis and US Dollars)

	Number of Scientists	Salaries as a share of recurrent costs	Operating Funds per scientist		Total Recurrent Costs per scientist		Ratio of 1987 funding level over 1974 (Operating Fund)
			cedis	US Dollars ³	cedis	US Dollars	
CSIR							
ARI	12	.58	4,000,000	24,800	9,500,000	58,900	.12
SRI	16	.75	2,200,000	13,400	2,700,000	53,500	.54
IAB	11	.25	2,200,000	13,800	3,000,000	18,500	.31
CRI ¹	29	.67	4,200,000	25,800	12,500,000	77,400	.42 ²
FPRI	16	.59	3,200,000	19,900	7,900,000	48,600	.31
Average per Scientist ⁴	84	.64	3,300,000	20,500	9,200,000	56,700	.49

Notes to Table 4:

- 1 In 1974, FRI did not exist, and oil palm research was part of CRI.
- 2 Ratio calculated for CRI excluding Nyankpala and GGD project.
- 3 One US \$ = 162.62 cedis (1987).
- 4 Weighted average

Sources:

Data collected by the review mission.

**Table 5: 1987 Funding of Agricultural Research:
Operating Funds, Salaries, Capital Expenditures and Training in
Research Institutes**
(in '000s of 1987 cedis)

	Operating Funds (1)	Salaries (2)	Capital Expenditures	Training	Total Funding	Salaries as a share of recurrent Costs 2:(1+2)
CSIR						
ARI	7,010	40,720	7,480		55,210	.85
SRI	11,890	66,870	21,150		99,910	.85
OPRI ⁶	21,010	75,790	107,960	1,450	206,210	.78
FRI ¹	8,470	25,710	3,360		37,540	.75
IAB ²	7,530	13,210	13,900		34,640	.64
WRI ⁴	4,640	8,920	7,180		20,740	.66
CRI						
• NY -GOG	23,870	50,090	16,530		90,490	
GTZ ³	44,080		61,500	15,380	120,960	
Subtotal NY	67,950	50,090	78,030	15,380	211,450	.42
• GGDP -GOG	18,670	59,130	4,000		81,800	
-CIDA ⁷	33,450			24,520	57,970	
-GLDB	5,650	12,040	-		17,690	
Subtotal GGDP	57,770	71,170	4,000	24,520	157,460	.55
• CRI Others	14,790	94,050	5,060		113,900	.86
CSIR Secretariat ⁹	10,940	32,970	3,910		47,820	
FPRI ⁵	18,100	75,900	6,900		100,900	.81
TOTAL CSIR & FPRI⁸	230,100	555,400	258,930	41,350	1,085,790	.71
	(21.2%)	(51.2%)	(23.8%)	(3.8%)	(100%)	
CRIG	409,840	296,580	434,430	n/a	1,140,850	.68

Notes to Table 5:

- 1 Includes funds from ARCT for capital expenditures (2550 thousand cedis).
- 2 IAB received funding from ICLARM, WHO, and WACAF for capital expenditures: 3409 thousand cedis.
- 3 Includes all equipment, maintenance, and travel, but not expatriate costs.
- 4 Includes external funding from Unesco, FRG, IAFA, and the Commonwealth Science Council. Total current US \$ 160,000.
- 5 Includes some funding from IDRC and DANIDA, (90,000 and 50,000 cedis over 5 years).
- 6 OPRI benefitted from a rehabilitation project from the World Bank which brought in US \$ 2 million to the institute over 5 years, since 1984.
- 7 Includes equipment and maintenance. No expatriate costs.
- 8 The total is different from the one on Table 1, as it includes FPRI and the GLOB funding to GGD Project.
- 9 Again, this is only the part of CSIR attributable to agricultural research. See footnote 6 in Table 1.

Sources:

Data collected by the review mission.

Table 6: Summary Statistics on Agricultural Part of Gross Domestic Product

A. In millions 1986 & 1987 current cedis

	Ag. GDP		Ag. Research		Ag. Res. Exp. as a share of Ag. GDP ¹	
	1986 (a)	1987 (b)	1986 (c)	1987 (d)	1986 (e)	1987 (f)
Total						
Agriculture	244,317	377,481	2,155.8	2,768.6	0.88	0.73
Agriculture & Livestock	175,621	266,077	1,027.4	1,492.2	0.58	0.56
Cocoa	41,017	66,030	1,037.1	1,140.9	2.53	1.72
Forestry	18,870	34,607	74.7	100.9	0.40	0.29
Fishing	8,809	10,768	16.7	34.6	0.19	0.32

**B. In millions 1986 & 1987 constant cedis
(at 1987 prices)**

	Ag. GDP		Ag. Research		ζ ² Change (k)	As a % of Ag. GDP ³ 1986-87 (l)	Res. Exp. as a % of total 1986+87 ⁴ (m)	Contribution to Ag. GDP (%) ⁵ (n)
	1986 (g)	1987 (h)	1986 (i)	1987 (j)				
Total								
Agriculture	342,044	377,481	3,018.1	2,768.6	-8.3	0.80	100.0	100.0
Agriculture & Livestock	245,869	266,077	1,438.4	1,492.2	+3.7	0.57	50.6	71.2
Cocoa	57,424	66,030	1,451.9	1,140.9	-21.4	2.10	44.8	17.2
Forestry	26,418	34,607	104.6	100.9	-3.5	0.34	3.6	8.5
Fishing	12,333	10,768	23.3	34.6	+48.5	0.25	1.0	3.2

Notes:

- 1 (e) = (c):(a); (f) = (d):(b)
- 2 (k) = [(j)-(i)]:(i)
- 3 (l) = (i+j):(g+h)
- 4 Calculated in columns i + j
- 5 Calculated in columns g + h

Sources:

- Agricultural research expenditures are from Tables 1 and 2 (Annex 6).
- Agricultural GDP figures are from Quarterly Digest of Statistics, June 1988, as quoted in: World Bank, Ghana: Structural Adjustment for Growth, January 23, 1989, p. 120-121.

**Table 7: Ghana's Agricultural Research Expenditures
Compared with a Sample of Developing and Developed Countries**

(Ghana 1986-87⁴; others 1980-85)

	Ghana	Developing Countries ²	Developed Countries
AG. RESEARCH EXPENDITURES			
As a % of Ag. GDP ¹			
• excluding cocoa	0.57%		
• including cocoa	0.80%		2.04%
• CSIR only	0.36%	0.29%	
Per hectare of arable land ³			
• excluding cocoa	0.72 US\$	0.96 US\$	1.74 US\$
• including cocoa	1.30 US\$		
Number of scientists per million ha of ag. land	25	29.6	15.4
Number of researchers per US\$ billion of ag. GDP	120	89.2	226.6

Notes:

- 1 Average of 1986/87 calculated using 1987 constant prices.
- 2 The comparison is made with "medium-large" developing countries (10 to 15 million inhabitants) of which Ghana belongs. As pointed out in the text, the comparison is biased, as figures for developing countries may underestimate research funding. Thus, the comparison is valid only with CSIR funding. Figures for developed countries are likely to be more accurate.
- 3 Agricultural land area is estimated at 13,700,000 hectares: Policy Planning, Monitoring and Evaluation Division, "Agricultural Land Base of Ghana", Ministry of Agriculture, 1988.
- 4 Calculated at constant 1987 prices.

Table 8: Agricultural Research Funding Levels
1974 and 1985, 1986, 1987 at 1987 constant 000's Cedis
 (CSIR only)

	1974	1985	1986	1987	Ratio of 1987/1974
ARI	114,600	27,200	54,000	55,200	0.48
SRI	138,600	58,400	84,700	99,900	0.72
FRI	72,300	14,800	46,000	37,500	0.51
IAB	32,900	21,200	23,900	34,600	1.05
WRI ¹	13,200	14,900	23,900	20,740	1.57
CRI ²	363,800	396,950	498,680	465,120	1.28
FPRI	126,000	66,100	107,100	113,900	0.90
CSIR	146,500	29,500	51,600	47,800	0.33
TOTAL	1,007,900	629,050	889,880	874,760	0.87

Notes:

¹ The data for the WRI are difficult to compare: in 1974, it was only a small unit, part of CRI.

² Including external funding.

Table 9: Distribution of Total Establishment
of Staff at CSIR Institutes

Institute	Senior Staff	Junior Staff	Other Staff (monthly rated)	Total
API	39	108	165	312
CRI (Kumasi)	56	223	587	866
CRI (Nyankpala)	32	73	366	471
FRI	59	66	27	152
IAB	58	70	38	166
OPRI	14	179	325	518
SRI	66	136	317	519
WKRI	48	65	24	137

Source: 1989 Estimates by Institutes

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ANNEX 7

INFORMATION SERVICES FOR AGRICULTURE IN GHANA

General Overview

Library services at all levels in Ghana were generally able to meet the needs of their respective clienteles until the late 1970s. Indeed, there had been some notable successes. The first special library in Ghana was established in 1890 for the Ministry of Agriculture. The setting up of the Library Board and a nationwide mobile library service in the late 1940s/early 1950s led to Ghana's public library service being described by UNESCO as the best in Africa. While the services available may not have reached all potential users (notably in the rural areas), they were justifiably a source of some pride. In the sphere of scientific and technical information provision, Ghana was poised to rationalize, modernize, and computerize by the mid 1970s.

However, the situation has changed dramatically since 1978, affecting access to literature at all levels. The situation in the late 1980s is one of under-funded, under-resourced, under-equipped libraries. In particular, the long-established specialist libraries in Ghana (which includes those servicing agricultural research) are very low on holdings of current materials, particularly journals, and are unable to provide efficient information services. There are virtually no complete runs of serials for any year later than 1976. The last Union Catalogue of Serials was published in that year.

Few libraries have adequate photocopying facilities; many have no photocopier, or none that is operational. Some have inadequate or unsuitable shelving and seating; many have little or no means of protection from deterioration of materials through heat, fungi, termites, etc.

State of Agricultural Information Services

Nowhere is access to information more crucial and the lack of it more critical than in agriculture, on which Ghana depends for more than 50% of its export earnings (mainly from cocoa), and for staple food supply to its 17 million population. The extent of the current problem is highlighted by the World Bank, which advocates 'urgent action' by the Ghana government to 'budget adequate foreign exchange funds to allow the institutes to maintain their subscriptions and acquisitions of scientific journals and books'. While this identifies a major current constraint, the problem is one of assessing all factors contributing to the current poor state of agricultural information provision: those that depend on foreign exchange, and those that require policymakers and management to budget adequate local funds. The prime requirement is to develop and sustain an appropriate agricultural information system.

Visits to universities, selected CSIR institutes, the Ministry of Agriculture, and the Cocoa Research Institute and interviews generally confirmed the depressing picture, gained from preliminary research and discussions, of libraries receiving inadequate funds for basic facilities, equipment and maintenance, with insufficient, and sometimes inadequately trained, staff, and above all, chronic shortage of basic tools: current journals, books, and even local reports and other materials. This situation prevailed, in spite of the stated commitment of the government to large investment in the sector.

This state of affairs affects the ability to effectively perform any of the tasks of agricultural research and its dissemination of information at all levels: drawing up policies, planning research, training research scientists for higher degrees in the universities, designing and executing appropriate (and non-replicatory) research programs in the research institutes; and communicating research results to extension workers and farmers. Researchers and lecturers lack information on current developments, both in their own subjects and, in a broader perspective, on trends in agriculture and development worldwide, on which to draw for their own work and in teaching and training the next generation.

This also affects their ability to write and publish scientific papers containing any reference to current work in Ghana or elsewhere.

Only those researchers recently returned from abroad, or with recent opportunities to attend conferences, were in any way conversant with the work of their peers. Except in those cases where additional funding has been available (World Bank education project, Ghana Grains Development Project), it is also worth noting the differential level of library/information services between institutions with apparently similar basic resources. This seemed attributable largely to the attitudes of those in charge (i.e., those budgeting and controlling the allocation of funds) to the library resource of their institution, when making choices, and to the level of self-motivation and experience of the library personnel.

For example, the Cocoa Research Institute seems likely to acquire 90 journals (value £13,000) with the help of a multinational firm. The CSIR librarian is actively pursuing local sources of funds (VALCO trust) for acquisition of key journals as identified by science and technology institutions throughout Ghana. Requests are being rationalized in a master list. It is clearly in the interests of all agricultural research libraries and institutions to support this activity and respond swiftly to his requests for lists of journals, so that a realistic 'shopping list' of core journals can be compiled.

Introduction of Information Technology

The proposed four-year GHASTINET project (Ghana National Scientific and Technological Information Network) aims to develop a computerized technology information network with CSIR as its focal point.

The \$3 million project (as estimated in 1987), is currently seeking \$1.4 million donor funding (to be matched by C1.4 million from the Government of Ghana).

The long-term objective is to establish a sustainable national network to provide scientific and technological information. There will be a gradual build-up of facilities, equipment, personnel, and systems to develop a computerized information system and bibliographic database.

The project will facilitate the collection, processing, storage, retrieval, repackaging, and dissemination of scientific information and data relevant to national needs, through the application of modern information science and technology. The exact conformation and composition of the system will obviously need to be decided only when the facilities and infrastructure are ready, so that the system is truly 'state of the art' when the order is placed.

This clearly has major implications for the development of information services for agriculture. The project proposal identifies agriculture as a key sector requiring a 'nodal point' (one of the research institutes or Ministry of Agriculture) and the universities as special resource centers.

While the introduction of information technology may seem premature in view of the constraints already identified in the agricultural library and information situation, the careful, phased approach to be adopted by GHASTINET is a realistic one.

Critical factors to be tackled before agriculture can develop information technology are:

- a central focus for agricultural information;
- a senior librarian to coordinate services;
- library personnel need training in information technology;
- agricultural libraries need to collaborate in: identification of key serials for possible funding; user surveys; building up collections of indigenous materials; completing buildings; upgrading facilities and equipment, including power supply; budgeting for recurrent expenditure items.

Appropriate tools of information technology

Individual libraries could introduce IBM (or IBM-compatible) personal computers, using software packages such as MIN-MICRO CDS-ISIS Version 2, for cataloging, preparing current awareness materials. Desktop publishing can also be integrated into such a system. This would overcome problems identified both in publishing prestige journals, and disseminating research results in appropriate forms.

CDROM (Compact Disk Read Only Memory) is a means of storing very large amounts of bibliographic and other data (e.g., statistics, maps) in machine-readable form. (For example, 200,000 printed pages, or up to three years' worth of the entire CAB ABSTRACTS database can be stored on each disk). This technology is widely regarded as the viable and economic alternative to use of on-line information systems currently only available to developing countries through expensive and often unreliable international telecommunications networks.

A CDROM player is a relatively cheap piece of equipment (\$1000), which links up with an IBM-PC (or compatible).

This development is of particular interest in agriculture, because several major agricultural databases are available in this form (AGRIS - pilot version, AGRICOLA, TROPAG). CAB International produced a prototype CDROM in 1985, which was tested at several sites worldwide during 1985-88. In Africa the test sites were the International Livestock Center for Africa (ILCA) in Ethiopia, the Southern African Center for Coordination of Agricultural Research (SACCAR) in Botswana, and Chidedze Agricultural Research Station in Malawi. These examples illustrate the different levels of information base at which CDROM technology can be introduced.

Conclusions

Ghana's library services, a source of considerable pride until the mid-1970s, were found to be unable to function effectively under present constraints. The situation in special libraries, specifically those serving the agricultural research community (the universities, research institutes within the Council for Scientific and Industrial Research (CSIR), the Ministry of Agriculture, and selected other institutions), is considered critical.

The existing facilities, manpower, and literature resources cannot really support the existing research system, and would be unable to offer adequate services to complement any proposals for reorganization and strengthening of the national agricultural research system.

In the universities, too, library resources are sorely depleted. Both academic staff and students lack current literature, to the extent that the viability of offering postgraduate courses in agriculture is seriously in doubt. Without current literature, agricultural research is being carried out in a vacuum, possibly replicating work elsewhere, using outdated methodology and analytical techniques, unaware of many of the new developments of the last 10 years and wasting scarce resources, both funds and manpower. Only one library in the agricultural research system, that of the Cocoa Research Institute, will shortly have facilities that can support its research workers' needs.

Against this gloomy scenario must be set the very positive efforts being made by some dedicated and visionary librarians to reverse this situation. The plans for a scientific and technological information network (GHASTINET), phased gradually to the point where computer technology can be introduced and sustained, should be given every support from agriculture, as this project will meet some agricultural information needs.

Also very encouraging are efforts under way to obtain support from the private sector in Ghana to fund journal subscriptions.

There is abundant evidence of government support for the rehabilitation program (completion of CSIR library, completion in sight for Animal Research and Crop Research Institutes, rehabilitation of the Ministry of Agriculture Library). This commitment needs to be sustained by adequate

recurrent expenditure provision, especially on journal subscriptions, equipment, furniture, and general maintenance.

Recommendations refer to measures for the short, medium and long term, which could correspond to the time scale and three phases of the GHASTINET project, but do not depend critically on its implementation, except to achieve the long-term goal of a fully integrated computerized system for the agricultural sector.

Short-term (12-18 months) goals include: ensuring that adequate basic furniture and equipment are available; investigating manpower needs and conditions of service, especially rationalization of salary scales for library personnel across agriculture; appointing a coordinator; renotivating librarians by encouraging them to provide lists of essential core journals, and to conduct user surveys, and by sending them on appropriate short courses; facilitating the use of the AGRIS/CARIS input center and, most importantly, providing researchers with instant access to current literature through the many free schemes available (provision of searches, selective dissemination of information (SDIs) and documents - ILCA, CABI, FAO, CTA, Infoterra).

In the medium term (2-3 years), long-term funding of subscriptions should be secured, collections should be consolidated and rationalized; identified librarians should be given further training, especially in information technology. They should be encouraged to join relevant professional associations, such as the International Association of Agricultural Librarians and Documentalists. In-service training, for example, at the new CSIR library, should be provided.

In the long term (4-5 years), recurrent expenditure budgets of all institutions should be able to cater for all library requirements, except new capital equipment. Resource sharing should be sufficiently advanced to allow pooling and dissemination of information throughout the agricultural library system. All the main agricultural libraries should be using information technology. There should be a professional librarian, with support staff, in post in any institution conducting significant agricultural research (at the rate of about one librarian for 30 researchers).

These plans will need to be drawn up in detail, using local expertise as far as possible. It is recommended that John Villars, CSIR Librarian, be asked to look at how agriculture can best participate in GHASTINET, because this will also serve the goal of providing information for research. If any extra assistance is needed in the overall project, expertise available within Africa should be drawn on, notably Michael Hailu at ILCA, Addis Ababa, and Stephen Lawani at IITA, Ibadan.

Available expertise should also be consulted to ensure that proposed computer systems are state-of-the-art at the time they are installed.

The question of appropriate publishing facilities needs to be reviewed in greater depth.

Value of Information

It is absolutely essential for a viable, relevant agricultural research system that adequate facilities and resources are provided to enable researchers, policymakers and all others concerned with identifying research needs, to carry out research, and disseminate its results. Without information, time, money, and manpower are wasted and research is duplicated. It can be argued that access to and provision of information is the single most important prerequisite for an efficient, productive and relevant research system.

However, in virtually all developing-country research situations, lack of information is identified by researchers as one of their major constraints, and a major cause of lack of motivation, of inability to keep up with developments in the subject and emerging trends, and worst of all, waste of funds and time through duplication and replication of work already done elsewhere.

Lack of information affects the ability to effectively perform any of the tasks of agricultural research and its dissemination at all levels: drawing up policies; deciding priorities; planning research; training research scientists for higher degrees in universities; designing and executing appropriate (and non-replicatory) research programs in the research institutes; and diffusing research results to extension workers and farmers.

In addition, researchers and lecturers need information on current developments, both in their own subjects and in a broader perspective, on trends in agriculture and development worldwide, on which to draw for their own work and in teaching and training the next generation.

Policy

Information is an integral part, if not a prerequisite, of any research program. Policymakers and managers need to be aware of this and be prepared to allocate sufficient resources (funds) to sustain appropriate library and information services. Physical facilities at the University of Legon should be upgraded to improve postgraduate training in modern librarianship.

Policy decisions for information provision should include the following components:

a) Physical facilities

Funds need to be allocated to complete, furnish, and equip new buildings, and maintenance and repair requirements should be catered for in recurrent budgets.

Physical facilities at the University of Ghana, Legon, should be upgraded to improve postgraduate training in modern librarianship.

b) Manpower

Salary structures and working conditions for librarians throughout agriculture need to be standardized. A senior post is needed to coordinate agricultural information services. Minimum qualifications need to be specified for post in specific agricultural libraries. In-service training of library personnel should be given the same priority as that accorded to researchers.

c) Literature acquisition

Adequate funds should be regularly committed for renewals of journal subscriptions and purchase of other necessary literature. Library committees should be set up to make decisions on appropriate collections.

d) Cooperation

Support of efforts to rationalize literature acquisition and modernize information systems (information technology) is required.

ANNEX 8

ORGANIZATIONAL MECHANISMS FOR POLICY AND PLANNING
OF AGRICULTURAL RESEARCH IN GHANA

Agricultural research program planning is the process by which a country's development objectives are translated into research objectives, priorities, and strategies with various time horizons, and by which resources are allocated to major program thrusts reflecting these priorities and strategies.

A country requires suitable mechanisms and organizational devices to determine policy, develop the strategy, elaborate the planning, and allocate the resources accordingly.

1. PRESENT SITUATION

1.1 Existing planning and policy documents

The GOG appears to be well aware of the need for sound policy-making with a medium- to long-term perspective. The MOA, under the Policy Planning Monitoring and Evaluation Division, has embarked on a major planning exercise with the support of the World Bank and UNDP/FAO. The first output has been a "Government Statement of Agricultural Policy and Strategies (1989-1993)", presently being followed by the elaboration of a medium-term plan of action (5 to 7 years). A special task force has been formed to that effect within the MOA.

Similarly, CSIR has been asked to prepare a Science and Technology Policy Statement. A draft S&T policy was submitted to the Government in August 1986. The three-page statement describes in very broad and general terms the objectives and principles of a S&T policy. In response, the GOG requested CSIR to prepare "a draft action plan which would set forth the practical measures required for the implementation of the policy statement".

To this end, five technical subcommittees set up during 1985 by CSIR were inaugurated in September 1986 by the Chairman of the National Development Commission and Member of the PNDC. One of which is for the fields of "Agriculture, Forestry and Fisheries". These were created as permanent standing committees, whose initial assignment was to prepare "Sectoral Science and Technology Policies and Plans, to be part of the Government overall National Development Plans".

Following the terms of reference given to the technical subcommittee, the document that has been drafted (February 1989), but not yet approved, is a review of the agricultural sector, broadly describing the constraints,

recommending policy measures and development actions, and pointing towards potential research areas for most of the commodities.

These two documents should provide some of the information necessary for the elaboration of a National Agricultural Research Policy and Strategy. However, the agricultural development objectives presented in the above document are not at the level of detail that is necessary for the determination of the agricultural research objectives. The agricultural sector objectives are expected to be further quantified and specified in the Medium-Term Action Plan.

1.2 Existing organizational devices in CSIR

A national agricultural research policy is not the only possible mechanism for transmitting guidelines for the elaboration of research programs at the institute level. Guidelines could also be transmitted through the various forums where researchers and policymakers interact. Such formal linkages exist in Ghana; they are: 1) the Council for Scientific and Industrial Research; 2) the Planning and Analysis Group, with its agricultural research coordinator; 3) the management boards and the research committees of the research institutes; 4) the proposed Agricultural Research and Development Advisory Committee of the MOA; 5) the Agricultural Policy Coordinating Committee of the MFEP; and 6) the Technical Subcommittee for Agriculture, Forestry and Fisheries of CSIR.

1.2.1 The Council for Scientific and Industrial Research

The CSIR was established in 1968 and amended as to its membership in 1969. The functions of the Council, as set out in the constitution are:

- a. to advise the Government on scientific and technological advances likely to be of importance to national development and in particular to advise the Government or other agencies of Government on scientific and technological matters affecting the utilization and conservation of the natural resources of Ghana and on how best scientific research may be coordinated and employed in the interests of such utilization and conservation;
- b. to encourage scientific and industrial research of importance to the development in the national interest of industry, technology, agriculture, and medicine;
- c. to establish, where it thinks it necessary, research institutes, units, and projects;
- d. to exercise control over all or any of the research institutes, units, and projects of the Council and to have power to dissolve or reconstitute, as the Council considers necessary, any such institute, unit, or project;
- e. to coordinate research in all its aspects in the country; and in particular to provide machinery that will ensure that the Council, the research institutes of the Council, the universities of Ghana

and other institutions engaged in research in Ghana coordinate their research efforts and cooperate in research;

- f. to encourage and assist in their research efforts individuals and organizations engaged in research in Ghana;
- g. to cooperate and liaise with national and international organizations in any part of the world on matters of research;
- h. to undertake or collaborate in the collation, publication, and dissemination of the results of research and of other useful technical information;
- i. to encourage the training of scientific personnel and research workers through the provision of grants, fellowships, studentships, and bursaries;
- j. to arrange and organize such central and common services as may be required by organizations engaged in national research;
- k. to ensure uniformity of standards in the selection, grading, and promotion of all persons working for national research organizations;
- l. to perform such other functions as the Government may assign to the Council or as are incidental or conducive to the exercise by the Council of all or any of the foregoing functions.

The CSIR has recognized the need for planning and for bringing agricultural policy in line with the requirements for agricultural development, even though this is not required by the constitution. The Planning and Analysis Group (PAG) represents the CSIR's current effort in strengthening the mechanism for doing this.

1.2.2 The Planning and Analysis Group (PAG)

The Planning and Analysis Group (PAG) is directly attached to the office of the Director General of CSIR. PAG has been set up to have six staff members, senior scientists in the fields of agriculture Sciences, industrial engineering, statistics and economics, biology and medicine, natural science, and system analysis.

Four of these positions are filled at present with an agronomist, a sociologist, an agricultural economist, and a chemical scientist.

PAG acts as a technical service to the director general in the support of CSIR coordinating and advisory functions to the institutes and to the GOG. The functions of PAG are:

- a. to provide analytical studies needed by the CSIR to carry out its broad advisory functions;

- b. to collaborate with the Economic Planning Division of the Ministry of Finance and Economic Planning with a view to identifying priority areas of the national development where scientific and technological advice is needed;
- c. to analyze and recommend assignment of identified projects to research organizations (institutes, agencies, universities, and private organizations) that can best deal with the problems;
- d. to maintain contact with the various research organizations and to retrieve from them any findings (published and unpublished) that are likely to be of importance to national development; and to correlate and access data from different sources for ultimate transmission to the CSIR;
- e. to project requirements for manpower and other resources needed for investigating problems;
- f. to recommend and organize ad hoc task forces for analytical studies when authorized by CSIR;
- g. to carryout other functions assigned by CSIR;
- h. to serve as Member/Secretaries of the Sectoral Technical Committees.

In particular, two of the PAG's original functions (b and c) are aimed at providing the research institutes of CSIR with the necessary information on the priority areas for research.

PAG needs to be strengthened to carry out its coordinating functions effectively. The PAG operates in assisting Council to formulate policies. This is clearly in its mandate. The Secretary to each Sectoral Committee represents the Director General at all the relevant Management Boards and, from that position, is able to influence discussions on policy and programming. With regard to research carried out in institutions outside CSIR, PAG only maintains communication with these institutions on an informal basis.

1.2.3 The Technical Committee for Agriculture, Forestry and Fisheries

This is one of the five committees that have been set up during 1985 by CSIR to formulate the sectoral S&T plans, as mentioned above. These were inaugurated in September 1986 by the Chairman of the National Development Commission and member of the PNDC, as permanent Standing Committees. Since their establishment, they have produced draft reports towards preparing "Sectoral Science and Technology Policies and Plans, to be part of the Government overall National Development Plans". The terms of reference are the following:

- a) to provide machinery whereby Council can have a comprehensive overview of the sector to enable the formulation of a national science and technology policy for the sector, based on a sound

assessment of sectoral requirements and priorities with a view to promoting national scientific and technological capability and maximum productivity within the sector;

- b) to advise Council of scientific and technological advances within the sector likely to be of importance to national development;
- c) to coordinate research in all its aspects within the sector and, in particular, to provide machinery that will ensure that the research institutes of the Council, the universities of Ghana, and other institutions engaged in research in Ghana within the sector coordinate their efforts and cooperate in research;
- d) to identify problem areas within the sector not properly catered for in existing national programs to which the Council needs to address itself in the interest of the national economy, and to institute appropriate measures for dealing with them;
- e) to deal with such other problems within the sector as may be referred to the Committee from time to time.

The terms of reference for its work in its sector reflect those of the parent Council for the country in general.

1.2.4 Management Boards and Research Committees of the Institutes

The Management Boards of Institutes under the Council are charged in particular to arrange for:

- a. the consideration and approval of research programs drawn up by the Director of the Institute, for submission to the Council, after taking into account the needs of user agencies and national development programs;
- b. periodic review of the progress of research programs being carried out at the Institute, and the results achieved;
- c. consideration of the budgetary implications of these programs and projects, including the requirements for staff, equipment, supplies, and capital development;
- d. supervision of the finances of the Institutes in accordance with the financial regulations of the Council by periodically reviewing the accounts;
- e. the management of the estate and properties of the Institute before they are submitted to the Council;
- f. review of the reports and draft budget estimates prepared by the Directors of the Institute before they are submitted to the Council;

- g. appointment of specific grades of junior staff of the Institutes in accordance with the regulations laid down by the Council;
- h. ensuring the proper execution of capital development projects in accordance with the regulations laid down by the Council;
- i. discharge of such other duties as may be assigned to it by the Council from time to time.

The functions of the Management Boards are mainly concerned with the management of the means of carrying out research. They appear to do this well within the restricted resources made available to them. From a review of recent minutes, the Board have been putting emphasis on administrative managerial functions. Meetings concentrate on issues related to staff management, physical facilities, and equipment and the budget. The membership of the Boards reflects their administrative managerial role, particularly with the presence of a member of the local Trade Union Congress, a member of Committee for the Defense of the Revolution, two representatives of the institute's researchers, and a large representation of research practitioners, including university professors (approximately 60%). The frequency of the meeting of the Board in some cases (up to 8 times a year) also appears to confirm their managerial role.

The Board should also give considerable attention to the long-term strategic research programs, which should involve the broad allocation of researcher time to major research thrusts of high priority. This is an ex-ante plan for the main elements of research programs. This would provide the ultimate basis for the review by the Board of the proposed annual research program, and enable a check to be made that the balance of the research effort is indeed along the lines indicated in the long-term guidelines and that satisfactory progress is being made.

Recognizing that the Board must be concerned with planning functions as well as managerial, due time and consideration should be given to the planning function. Most of the institutes have set up Research Committees that report to the Board for the purpose of program formulation. Their work and membership should be reviewed to make them more effective. Some documents giving specific guidelines to the membership on the basis for priority setting would make it more efficient.

Finally, with the exception of one representative from the ministry, research subcommittees are mainly made up of scientists, whether from the institutes or from the universities. When reviewing the program activities the scientists are well suited to discuss the relative quality of different experiments and studies and will guarantee the scientific value of the research activities. However, assessing the relevance of these for agricultural development requires matching the potential new technology to existing farming systems and circumstances, something for which representatives from extension services and proxies for producers are better placed. Therefore, the composition of the Research Committee, in order to better serve its expected function in program formulation would merit some rethinking.

1.3 Potential Agricultural Research Policy Formulating Bodies

It is highly desirable that there should be a body for determining the national agricultural research policy.

Currently three bodies can be identified, whose activities bear on high-level policy formulation in agriculture. These are:

- CSIR CSIR, through its mandate for coordinating all scientific and technological research in the country, and its position of the largest research capability in agricultural research;
- Min of Agr. Ministry of Agriculture, as the largest user of agricultural research conclusions, and is therefore very concerned about the research program;
- APCC Agricultural Policy Coordinating Committee, which has a mandate to coordinate nationally all operations involving agriculture, and therefore could include agricultural research.

1.3.1. The CSIR has established the Technical Committee for Agriculture, Food and Fisheries to be the central reference part for science and technology policy in the agricultural sector. It has so far worked to produce a science and technology plan for the agricultural sector. It is, however, well-placed to combine the national science and technology policy with national agricultural development policy to develop a national agricultural research policy. This is firmly in line with CSIR's mandate to coordinate research efforts in the country. The current terms of reference for TCAFF are given on page 65. These terms of reference would have to be strengthened to charge the committee with formulating agricultural research policy and advising on the allocation of resources to research institutions on the basis of national priorities.

1.3.2. The Agricultural Research, Development and Advisory Committee of the Ministry of Agriculture does not exist at the present but is being discussed as part of the reorganization of the Ministry of Agriculture, which is being undertaken with the support of a World Bank project. Indeed, the idea of an ARDAC is not totally new, since the committee existed before under the name of ARAC (Agricultural Research Advisory Committee). From the information the mission was able to gather, ARAC had not been very effective and had fallen into disuse.

Notwithstanding the problems that the previous committee had encountered, the idea to reinstate such a committee is a response to the need expressed at the level of the MOA and the MFEP to tie agricultural research to agricultural development objectives and priorities.

The general functions of ARDAC, that are being discussed, would be:

- a. development of agricultural research policies, broad research objectives, and research areas;

- b. resource allocation to research areas; this will depend on and be consistent with Ministry of Agriculture's agricultural development objectives;
- c. review of medium-term research plans from all research institutions in the country for consistency with national agricultural research policy, and collate into a national agricultural research plan;
- d. review annual reports of results from all research institutions, with a view to deriving recommendations for extension that will be discussed in annual seminars;
- e. review annual programs of work and budgets from research institutions and advise the Ministry of Finance and Economic Planning for funding accordingly.

The ARDAC would report to the Secretary of MoA. The Chairman would be from outside the MoA and the membership would consist of research practitioners and research users, with appropriate authority to advise the Secretary as indicated in the functions. The proposals for action plans and budgets for research institutions would be presented to the APCC by the Secretary (MoA) after approval by ARDAC.

Though it is difficult to comment on a committee that is not in existence yet, the team could foresee some difficulties. First, the composition that is being thought about for ARDAC is not substantially different from the one for the Technical Committee for Agriculture, Forestry and Fisheries.

Second, in order to fulfill the terms of reference that are presently being discussed, ARDAC would need to be established through a national decree that would give it the necessary jurisdiction for agricultural research policy planning, monitoring and evaluation, and recommending financial action. However, if ARDAC was to be created, the actual management of the institutes by CSIR should be maintained as it is, since researchers operate in a commendable research environment under CSIR (given reasonable operating funds for research).

1.3.3. The Agricultural Policy Coordinating Committee of the Ministry of Finance and Economic Planning is not at the moment directly involved with issues concerning agricultural research; however, its mandate implies that agricultural research will become one of its concerns because agricultural research policy is intimately linked with agricultural development policy.

The APCC is a committee of very senior ministry staff (Under-secretaries), the ministries of which are connected directly or indirectly to the agricultural sector. The chairmanship and the secretariat belong to the MFEP. It was created at the beginning of 1988, as a result of the growing importance that the GOC is giving to the agricultural sector. Because of the multiplicity of the organizations intervening in the agricultural sector (organizations, the decisions of which affect the

agricultural sector or, in turn, the functioning of which are affected by its output), some degree of coordination of all these actors was necessary. Thus one of the functions of APCC is a coordinating one for the purpose of concerted and coherent decision-making.

The membership of the APCC is as follows:

- | | |
|-------------------|--|
| Deputy Secretary | - Ministry of Finance and Economic Planning (Chairman) |
| Deputy Secretary | - Ministry of Agriculture |
| Deputy Secretary | - Ministry of Roads and Highways |
| 2 representatives | - Ministry of Finance and Economic Planning |
| 2 representatives | - Ministry of Agriculture |
| 1 representative | - Cocoa Marketing Board (COCOBOD) |
| 1 representative | - Bank of Ghana |
| 1 representative | - Ministry of Industry, Science and Technology |
| 1 representative | - Ministry of Local Government |
| 1 representative | - Ministry of Trade and Tourism |
| 1 representative | - Ministry of Lands and Natural Resources |
| 1 representative | - Ministry of Transport and Communications |
| 1 representative | - Ministry of Roads and Highways |

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ANNEX 9

NATIONAL AGRICULTURAL RESEARCH POLICY AND MEDIUM-TERM
AGRICULTURAL RESEARCH PLAN: PURPOSE AND ORGANIZATIONAL STRUCTURE

1. POLICY-MAKING AND PLANNING

1.1 Definition and Purpose

The discussion in the research review points to the need for defining a National Agricultural Research Policy (NARP) and elaborating a Medium-Term Agricultural Research Plan. The policy-making and planning process for agricultural research must consider two sets of issues in parallel:

1. What are the country's economic and agricultural development objectives and what can and should be the contribution of research towards the achievement of those objectives? This leads to determining the objectives of agricultural research.
2. What are the capacities and resources that can be applied towards this end? The expected research output is determined through an iterative matching process between the two.

This Annex offers an outline of a possible strategy for achieving this end result. The Plan should finally be specified in operational terms (activities and timing; human, physical, and financial resources to be used; organizational structure required).

2. DEVELOPMENT OF A NATIONAL AGRICULTURAL RESEARCH POLICY (NARP)

Among other things, the issues that policy-making and planning address are:

1. choices regarding the size, scope, and mission of the research system, the overall level of resource allocation, and the criteria for major technological and societal choices;
2. agricultural research objectives in function of 1) the overall agricultural development objectives; 2) the agricultural science and technology policy; 3) the available resources;
3. from there, a) the broad research programs, and the criteria on which to base priorities between them; and b) for each research program, the strategies that appear best suited to achieve the research objectives;

4. choice of planning methods and tools to prioritize between research areas and to allocate scarce resources accordingly; this will serve as the framework for program formulation;
5. whatever adjustments are necessary in the organizational structure of the research system in order to ensure adequacy between the mandate assigned to research and its structural support system;
6. what mechanisms and organizational devices for planning, communication and coordination, reporting, monitoring and evaluation, such that the basic policy objectives are served. (For example: that farmers' needs be at the core of the program; or alternatively, that consumers' needs be central to the program; or again, that the program shall have scientific vigor and international impact. These alternatives require quite different organizational devices).

2.1. The Mission of the Research System

The National Agricultural Research Policy is thus expected to specify the mission of the agricultural research system. By "mission" is meant a statement of what the nation expects from its agricultural research system.

This will determine much of its functioning: obviously, the mission determines in part the content of the research programs; beyond that, it will determine the criteria for rewards and promotion of scientists; and the organizational structure of the system, in particular the kind of mechanisms that will be put in place for planning, monitoring and evaluation, and reporting.

2.2. 'Scope' of the System'

The NARP will also define the scope of the research system. By scope is meant the number of research areas or thrusts that can be realistically envisioned (not all the desirable ones), and the type of research (basic, applied, or testing and adaptive), given the objectives that the system purports to achieve. This in turn depends upon two critical factors:

- a) the GOG decisions concerning the overall level of resources, financial and human, to be devoted to agricultural research;
- b) the research critical mass; that is, the minimum level of resources (financial and human) needed per commodity, class of livestock or factor, for effective results to be achieved. The research critical mass will vary according to the constraints that will be addressed and, furthermore, according to the strategy that will be chosen to tackle those constraints: that is, how much technology can be borrowed (i.e., is it available elsewhere), which determines to what extent applied or even basic research may be needed; or, to what extent one could rely solely on testing and adaptive research.

This, plus the overall availability of resources, which includes human resources capability, will determine how many of the desirable research thrusts can be realistically sustained, at present, as well as at various points in the future.

2.3. The Need for Sustained and Guaranteed Adequate Funding

Such a policy document (the NARP) would give the MFEP a reference against which to evaluate the relevance of the request for funding presented in the institutions' yearly budgets. It would justify additional resource allocation, that is, above and beyond a mere projection of past trends, when necessary. An adequate funding level for the whole system could be argued for and obtained at the time of the elaboration of the policy, and this could then be referred to by the institutions when defending their annual budgets.

The issue of sustainability will also be a critical one when developing the NARP. A sustainable agricultural research system could be defined as one in which domestic funding provides most of core salaries, operating funds, and capital investments; and where the contribution from external sources is within the limits of the domestic effort that the GOG could take on progressively, with a definite schedule.

2.4. Setting Priorities for Resource Allocation

The NARP should provide the research institutions with the guidelines and research objectives that will help them focus their activities on high-priority research areas. This should help ensure that research activities are in line with the needs of the development of the agricultural sector. It is also the basis for concentrating resources in a few areas, a concentration necessary to increase the probability that research activities will have an impact on and respond to the needs of the agricultural sector for appropriate improved technologies.

2.5. Major Societal Choices

Some major societal choices should have been made by national policymakers, either within the framework of the Medium Term Agricultural Development Plan, or of the S&T policy. Those which will be necessary for the purpose of agricultural research are, in particular:

- 1) the target groups for agricultural research (marginal or resource-poor farmers, the intermediate ones, or the large-scale producers/agro-industrial firms, or world science);
- 2) priorities among differing agro-ecological zones (Should emphasis be placed on the poorer savanna zone, in most need for development or upon the richer forest zone, with more potentials for the growth of the economy?);
- 3) the path for technological change (that is, critical choices on the way to release production constraints, such as increasing labor or increasing land productivity); and

- 4) environmental considerations: should the stabilization of agro-ecological systems, at the expense of immediate production increases, take preference?

3. THE DEVELOPMENT OF NATIONAL RESEARCH PROGRAMS

On the basis of the research thrusts defined in the National Agricultural Research Policy, combined with criteria for technological choices, a few broad long-term national programs¹ (often defined in terms of commodities, production factors, or systems) can be elaborated.

The elaboration of the research program could include: 1) a justification for it, based on an analysis of the socioeconomic conditions of the clients and on the technical constraints they face; 2) the definition of its objectives and expected outputs; 3) the technical constraints that should be addressed in order of priority; 4) the strategies to be followed (testing and adaptive, applied research; systemic or monodisciplinary approach, etc...); 5) the various sets of activities to be envisioned and their location; 6) the distribution of activities between different institutions (universities, institutes, ministries, parastatals); 7) the levels of resources required, especially of manpower; 8) broad time table for activities; 9) intermediate targets and expected outputs for monitoring and evaluation purposes.

4. THE MEDIUM-TERM AGRICULTURAL RESEARCH PLAN (MTARP)

On the basis of the long-term programs, each institution (i.e., not only the CSIR institutes, but also the universities, ministries, and parastatals) will draw an action plan for the resources (human, financial, and physical) needed to carry out the part of the research activities of each program assigned to them. The aggregation of all the medium-term action plans will form the basis for the National Medium-Term Agricultural Research Plan.

The action plan concerns not only the detailed content of the programs, but also the resources (human, financial, and physical) needed to carry out these activities. It is often in two parts: the first concerns the content of the research programs, with their detailed expected outputs and identification of beneficiaries, activities involved, resources used; the second part is a resource development plan (human, physical, and financial) which deals with the planning of the resources necessary to carry out the research programs. Following from the

¹A program is a coherent aggregation of experimentations, studies and research activities, the results of which, when brought together, may lead to technological improvements or innovations for productivity.

organizational adjustments specified in the long-term strategic plan, the action plan includes the details for their implementation.

5. PRINCIPLES FOR ORGANIZATIONAL DEVICES FOR THE PURPOSE OF PLANNING AND POLICY-MAKING

Given the configuration of the agricultural research system, dispersed as it is among CSIR, the universities, the ministries, and parastatal agencies, the process of formulating a national agricultural research policy should best be given to a body (council or committee) assisted by a technical secretariat or planning unit. The tasks of the body are limited, and most of the detailed planning and programming is left to national program committees and to the implementing research institutions.

5.1. Functions

5.1.1. The Body.

The functions of the body should be, at the minimum:

1. Upon propositions prepared by the technical secretariat, to formulate a national agricultural research policy and strategy, based on the agricultural S&T policy and on the agricultural development plan. This will include a clear statement of the "mission" and purpose of the national agricultural research system.
2. Following the formulation of the policy, to decide on the main research programs that will be implemented; to nominate heads of these programs and to decide on the composition of the national program committees; all of this in consultation with the directors or heads of the research institutions;
3. To review and approve for consistency with the NARP, the long-term research programs elaborated by the program committees within the guidelines provided by the NARP;
4. To review and approve for consistency with the NARP and with the long-term research programs, the medium-term action plan spelling out the implementation of the NARP;
5. To advise and recommend to the government on the financial and other resources requirements for the implementation of the NARP, as defined by the Medium Term Agricultural Research Plan and in particular with regard to the allocation of resources to the various organizations involved in the implementation of the NARP.
6. To arrange for a review of the research activities at the mid term of the action plan and an evaluation at the end.
7. To delegate to the technical secretariat the task of reviewing annual reports of research institutions, reviewing their annual

program of work and budget, and presenting to the body a summary and analysis of these, upon which the body will recommend release of funds accordingly. It is stressed that these are minimum functions. There could be more, but such a high-level body should not be distracted by too much detail. It should confine itself to decisions on policy and broad planning.

5.1.2. The Technical Secretariat or Planning Unit

1. To prepare proposals for the NARP with different scenarios that will be reviewed by the body; to prepare all the necessary background information that the body may require to be able to reach decisions. After a decision has been reached, the technical secretariat then incorporates the final amendments, produces and publishes the NARP, and organizes its widespread diffusion;
2. To provide technical back-up, planning, and budgeting capability to the Program Committees for the elaboration of the long-term programs; to collate those into a National Long Term Research Program and present it to the NARP body for its review and approval;
3. To provide technical back-up, planning, and budgeting capability to the heads of the institute in the formulation of their medium-term action plan; to collate those into a National Agricultural Research Plan that is reviewed by the body;
4. To review the annual reports of each program, and the annual program of work and budget of each research organization against the Medium Term Action Plan, and prepare a summary and analysis of these for the body;
5. To organize the monitoring of research progress and evaluation of research results at the mid-term of the Plan and at completion.

5.1.3. The Program Committees.

For each major national research program:

1. To elaborate the long-term program on a major topic designated by the body, among the various national institutions involved in the research effort;
2. To liaise between the various organizations which will be carrying out parts of the program;
3. To annually review research results and prepare the plan of work for the following year;
4. To organize national workshops at varying intervals on the research results obtained so far.

5. To provide one of the mechanisms for linking extension and research, in particular to provide feedback on farmers' conditions that will serve for the elaboration of the long-term program, the review and evaluation of research results.

5.2. Membership Principles

The process of formulating a national agricultural research policy should bring together:

1. The policymakers, who can bring the objectives for agricultural development to the level of detail needed for their translation into research objectives; in addition, the policies they are contributing to may affect research through the technology transfer system;
2. The research practitioners, who can specify for each agricultural development objectives, the constraints that can be alleviated through research, the time span required to produce any results, the likelihood of research success, the critical resource mass needed, and the possibility of borrowing technology;
3. The research users, who can specify their needs and constraints, and the type of research results in which they are interested. Some research users, in particular the farmers, will be represented through the extension services of the user ministries.
4. The research stakeholders.²

5.2.1. The NARP Body

The membership is obviously interministerial, given the various actors in the system. It should have authority to reach decisions or give authoritative advice to ministries. Thus, the body to formulate such policy should be placed at a high enough level in the government structure so that its decisions will have political weight and attract political commitment. It should also be in a position to effectively coordinate the research undertaken by various organizations, and thus be neutral vis a vis various research practitioners³.

²By research stakeholders it is meant the organizations or social groups that will be affected by the adoption of research results, or the decisions of which will affect the adoption of research results. They are not necessarily the direct users of research results.

³In this respect, the position of CSIR is a dual one: as exercising control over the research institutes, it is not neutral; however it is given in its constitution the task of coordinating all research in the country, and in this it is neutral.

Membership should be mainly from the organizations that are users of research outputs and research stakeholders, with a limited representation of research practitioners. The chairmanship should be based firmly on merit, but preferably from a user-of-research-results agency.

5.2.2. The Technical Secretariat/Planning Unit

Contrary to the body, which needs political weight, the staff of the technical secretariat are selected for: 1) their analytical capabilities in the area of planning, budgeting, and finance; 2) their technical knowledge and their research experience; 3) their knowledge of world research; 4) their understanding of producers and processors' prevailing socioeconomic conditions. The technical secretariat is permanent, but will have other duties in a larger technical service, as the work is not full time.

The technical secretariat prepares proposals for a National Agricultural Research Policy, reflecting different scenarios and following the guidelines given by the body, which then studies them, chooses a strategy and requests modifications where necessary.

For the elaboration of the long-term program, the technical secretariat will be working with the coordinators of the various program committees; for the elaboration of the medium term plan, with the directors of research institutes, deans of faculties, heads of research activities in extension, etc...

5.2.3. The National Program Committees

These are again technical groups, but with the emphasis placed on the content of research programs, and inter-institutional linkages. Members are experienced scientists in the areas relevant to the programs, the extension services and, if necessary some research stakeholders. The experienced scientists should be the ones involved directly in the research activities concerning the program; and similarly for the extension agents. The coordinator will usually be a senior researcher of the research institution concerned with the implementation of the major part of the program⁴.

5.2.4. The Management Boards of the Institutes

With the establishment of the body, the load of national policy-making is lifted from the management boards. However, they will

⁴The composition of the Management Committee of the Ghana Development Project, its mandate and mode of functioning provides a good model for the composition, mandate and mode of operation of a national program committee.

have a considerable role to play in research planning within the institutes. Some of the responsibility for planning and programming for major, inter-institutional national programs will be passed to the national research program committees, but a substantial amount of research will in general remain within one institute, and be planned by the board and institute staff. A board will also continue to be responsible for reviewing all emergent research proposals from the institute, and once the action plan is approved at the national level, the board will ensure its implementation through periodic reviews of the institute activities and use of resources. The board's role in overseeing the management of the means of carrying out research will be reinforced and clarified.

6. PROPOSED ORGANIZATION OF APEX BODY FOR RESEARCH POLICY

Three essential bases for a policy body are feasible: CSIR, MOA, and APCC (MFEP). As a general principle, the new organizational device should cause as little disruption to the existing structures as is compatible with carrying out the functions effectively.

Of many alternatives considered by the team, the three main ones appeared to be:

Alternative I - Agricultural Policy Coordinating Committee

This body was considered to have the potential of influence and power from its location and status in the hierarchy of Government. It may, however, not be adequately equipped to deliberate on agricultural research matters as it is presently constituted. A subcommittee could add appropriate co-opted members. The Team is of the opinion, however, that without prejudice the Director General of the CSIR should be a member of this Committee in his own right.

Alternative II - Technical Committee for Agriculture, Forestry and Fisheries

The TCAFF is the subcommittee charged by the CSIR to cover the agriculture, fisheries and forestry sector and advise on research needs, planning, and policy.

Alternative III - Agricultural Research and Development Advisory Committee

ARDAC is the subcommittee proposed in the Ministry of Agriculture (the largest user of agricultural research conclusions) for relating research with development.

The membership of the apex body should include in any of the alternatives senior representatives of the Ministries of Agriculture, Lands and Natural Resources, and Industry, Science and Technology; and of the Ghana Cocoa Marketing Board; the Director of Policy, Planning, Monitoring and Evaluation Division of MOA; and a range of senior representatives from

technical agencies, such as, for example, directors of research institutes, of Extension Services and Crop Services of MOA, the faculties of agriculture of the universities, the private sector, and perhaps others, subject to keeping the body an efficient size for operation.

The Team, after considerable discussion, concluded that perhaps a blend of Alternative I & II might provide the best formula. By this blend the expertise of TCAFF on research matters could be incorporated into the APCC in deciding on sound research policies and securing the appropriate budgetary allocation to support the necessary research. The Team considered that ARDAC could be modified to be used for an in-house forum by which the Ministry of Agriculture could identify the needs for, and strengthen its own research for development.

7. THE NEED FOR AN INTERIM ACTION PLAN

A national agricultural research policy and strategy, including long-term programs, needs to be elaborated, followed by an action plan that should be complementary and coincide in time with the agricultural development plan.

Prior to embarking into the planning process, and for the success of the planning effort, a number of adjustments have to be made, as proposed above.

These may involve some reshaping of the system. Under these recommended adjustments, CSIR continues to manage the resources and research activities of the institutes, as in the past. But the objectives and priorities of research, as well as allocation of resources between the various priorities, will need to be determined at the national level, through a joint effort, involving mainly the MOA, the research institutes, and the universities. This may imply some adjustments in the mission of CSIR and a change of its constitution to reflect the new mission and the proposed policy-making and planning mechanisms.

These recommendations will have to be discussed by the various groups concerned within the GOG, before consensus can be reached about the way in which, first, the agricultural research policy, then, the long-term programs and the action plan will be elaborated. This will undoubtedly take time. Moreover, since agricultural research objectives necessarily stem from the agricultural sector development objectives, the detailed elaboration of the national agricultural research policy and strategy can only start when the main features of the Medium Term Agricultural Development Plan are accepted.

Other elements needing time must also to be taken into consideration:

1. There will be a need to strengthen the capability for policy-making and planning for agricultural research, especially among those who will be relied upon to manage and provide leadership for the elaboration of the plan. This may require a

combination of training workshops and some experienced external assistance.

2. External assistance should be used with caution; it should be there to help national staff help themselves, rather than substituting for them. It is important in agricultural research planning that the process should bring about a consensus of all those concerned, on objectives, priorities and resource allocation, and strategies to achieve those objectives.
3. The plan should start from a firm appreciation of the current state of technology availability, either incorporated in existing extension recommendations or waiting to be applied. Such a basis does not seem to be set out explicitly, except for maize and cowpea. Written reviews for all of the major commodities are necessary. They would also serve as status review reports, as an agreed interface between research and extension, to assess priorities for both continuing existing research work and planning new work. They will help in determining the technical constraints that research should address, in order of priority.
4. The research review collected a good set of information on professional research staff. More information should be gathered on support staff. There seems to be an excessive number of lower-level staff per researcher that is worthy of closer study.
5. The research review focussed mainly on the capability of carrying out research (supply): the draft report of the Technical Committee for Agriculture, Forestry and Fisheries has focussed mainly on the scientific and technological needs for research and development. Preliminary reworking of the materials for priority ranking of research and rehabilitation needs in relation to the likely capability would be valuable, pending the introduction of formal procedures by the policy body when established.

These are some of the steps that might be included in an interim action plan in advance of the major policy discussions on the Medium Term Agricultural Development Plan (and research organization).

In addition, without preempting the results of the planning exercise, which might recommend closing down some research stations and up-grading others, rehabilitation of main research stations could be started, and the up-grading of library and technical information services.

Steps to improve internal management information services would also be independent of policy decisions, but would be valuable for planning by linking information on current research activities at institutes with the resources involved: human, financial, and physical. Relating straight-forward monitoring procedures can easily be computerized, and lead towards a formal project-budgeting procedure in institutes, that would enhance the Director's appreciation and control of activities.

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ANNEX 10

THE ROLE OF UNIVERSITIES IN AGRICULTURAL RESEARCH

Agriculture is recognized by everyone, the Government of Ghana policymakers, the scientific community, and donors, as a key factor in the country's economic development. The quality of education in agriculture is a prerequisite of the quality of leadership in planning agricultural development, the quality of agricultural research which can be conducted, and the quality of the extension delivery system.

The faculties of agriculture in the universities in Ghana have the prime responsibility of maintaining the professional quality of the leadership in agricultural development. They are in serious danger of losing the ability to maintain an adequate level of quality, due to the prolonged neglect of the physical facilities for educating and training modern agriculturists. Rehabilitation and refurbishment of the faculties and School of Agriculture are urgently required if standards of professional agricultural staff are to be upheld and upgraded to meet the challenges of the 21st century.

The role of the universities in national agricultural research is three-fold: it provides well-qualified graduate recruits for the research service, and postgraduate training; the staff and students carry out direct research; and members of staff play important advisory roles on a wide number of councils, boards, and committees concerning agricultural research.

Brief Description of Agriculture in the Universities in Ghana

The universities in Ghana are administered under the Council for Higher Education, which is the body that advises the Ministry of Education and Culture on university affairs. There are three universities in Ghana, all of which are involved in agricultural education, research, and extension.

Funding is granted by the government to the universities, which in turn are responsible for allocations to administrative units at their institution. The perception of the deans is that, within the financial exigencies of the university, agricultural education receives its fair apportionment.

The university system in Ghana has two faculties of agriculture and one school of agriculture. In total, there are approximately 124 academic staff, of whom approximately 54 hold Ph.D. degrees (Table 10.1). Within the overall national agricultural research system, university academic staff far exceed the other institutions involved in terms of academic qualifications, and research is a continuing priority when funding permits. Although other activities are encouraged and recognized during assessment for promotion, the prime consideration is scholastic activity,

as measured primarily by the quality and quantity of publication in refereed journals, technical reports, papers read at conferences, and other evidences of scholarship.

Consequently, participation in research activities is essential for progress in the system. However, the funding and resources required to conduct research are very limited. As a result, a significant portion of the research conducted is pursued via undergraduate research projects, few of which lead to publication. Minor support for research is available from within departments' budgets. A few academic staff each year receive research support from the universities' Research and Conference Committees. These grants are of a competitive nature and are awarded primarily on their scientific merit. Other research support is obtained occasionally from donor organizations.

The faculties of agriculture both have Departments of Agricultural Economics and Farm Management, Agricultural Engineering, Crop Science and Animal Sciences. In addition, the Faculty of Agriculture at the University of Science and Technology (UST) at Kumasi has a Horticultural Department, while the Faculty at the University of Ghana (UG), Legon has a Department of Extension Education and a Department of Home Science.

Between them, the two faculties graduate between 80-90 students per year. The degree program at UST is a 4-year honors program leading to a B.Sc. (Agric.) The largest areas of specialization have been in the plant and animal science areas. Currently 10 graduate students are enrolled in the Faculty, all in the Plant Science area. In addition, the Faculty offers 2-year diploma programs in Agricultural Education and Farm Extension and in Tropical Horticulture.

In the mid-1970s, the Faculty of Agriculture at Legon restructured its program and converted its 4-year honors program into a 3-year B.Sc. (Agric.) degree. Crop science and animal science have been the major areas of specialization for students, but in recent years, the number of students majoring in animal science has decreased and those majoring in agricultural economics have increased. The Faculty's graduate programs were affected as a result of the loss of several key academic staff in the early 1980s. There are only 18 students enrolled currently but, with the renewal of staff numbers in recent years, it is anticipated that the program will be strengthened within the near future.

National Diplomas in Agriculture are offered in General Agriculture, Animal Health, Mechanization, and at Legon Post-Harvest Technology.

The University of Ghana has three research stations: Kade, Nungua, and Kpong. These stations are funded directly through the university, not through the Faculty Budget. They are primarily involved in research but also serve as teaching laboratories for undergraduates. Academic staff from the Faculty have access to the research stations for research, and station staff are frequently called upon to give lectures at Legon. Lack of vehicles for travel has restricted somewhat the interaction between the research stations and the Faculty in recent years.

The School of Agriculture at the University of Cape Coast was established more recently (1975). Its mandate and role are somewhat different than those of the faculties of agriculture. The School's primary responsibility is the education of students for teaching agriculture at the secondary school level.

Consequently, the School provides a degree in general agriculture, with a specialist Diploma in Agricultural Education. As the size of the academic staff has increased in recent years, the School has expanded its activities, and academic staff are increasingly involved in research activities and some extension activity in association with MoA extension personnel.

The School graduates approximately 28 students per year and although the primary placement of these graduates is in the education field, some are opting for other positions in agriculture, where their general agricultural background is perceived as an asset.

Table 10.1 : Distribution of Academic Staff Involved in Agriculture at Universities in Ghana

Institutions	Academic Staff	Staff Vacancies	(Graduates per Annum)
<u>University of Ghana</u>			
Faculty of Agriculture ¹	37 (20) ²	17 ³	
Research Stations	12 (5)		
<u>University of Science and Technology</u>			
Faculty of Agriculture	44 (16)	15	80-90
Institute of Renewable Natural Resources	13 (4)	11	
<u>University of Cape Coast</u>			
School of Agriculture	16 (8) ⁴		28
Center for Development Studies	2 (1)		

Total University System	124 (54)		~ 110

- Notes: 1 Excludes Department of Home Science
 2 Figure in brackets indicates number of Ph.D. degrees
 3 Vacant positions currently frozen by government
 4 Includes part-time lecturers in agriculture

Physical facilities: Post independence, the faculties of agriculture were built up steadily, but as the economy of the nation declined in the 1970s and early 80s, full funding to the universities could not be maintained, and resources for teaching and research became more limiting, and physical facilities deteriorated.

Currently, for the most part, the main physical structures at Legon and UST, Kumasi, including classrooms, offices, and laboratories are adequate and would require modest refurbishing. However, beyond these, the state of the teaching/research resources has become a major concern to the academic staff. The libraries, the heart of a university, have received few new acquisitions since the late 1970s; equipment available, both field and laboratory, is generally obsolete even if functional. With the exception of a few instruments obtained as support with donor contracts, the inventory of equipment available for research and teaching is barely adequate; many other facilities essential for research and teaching activity, including transport, cold rooms for seed, plant and meat storage and modest greenhouse facilities are no longer functional; and funds to purchase laboratory supplies and other operating expenses are minimal. The resources available to the faculties may be sufficient for survival but greatly reduce the research options open to the academic staff, since many areas of research where considerable competence exists cannot be addressed because of lack of support.

Human resources: The main resource of a university is its academic staff. Collectively the academic staff in the faculties and School of Agriculture are basically well qualified: virtually all have postgraduate qualifications and almost half have Ph.D.s. They constitute about 70% of the nation's Ph.D. graduates in agriculture, and therefore constitute a valuable asset devoted primarily to training new leadership. Nevertheless, the faculties have suffered serious losses in the past. As real salaries declined and teaching and research resources diminished, many scientists left the country, and many of those remaining have had to devote some time to non-academic, economic pursuits. However, despite their low level of support, the academic staff have continued to meet their training responsibilities and have attempted to stay active in research. The quality of the academic staff is not the limiting factor in a serious agricultural education situation.

Facilities for undergraduates: The universities' first commitment is to their undergraduate students. A continuing supply of well-educated agricultural graduates is vital to the research and extension roles in agriculture which the government must ensure. While dedicated academic staff are of paramount importance for this, other resources are essential as well. An education in modern agricultural sciences requires adequate library resources with up-to-date textbooks and journals, appropriate equipment and supplies, availability of transport for field trips, and field laboratories. Access to information technology will become important. The agricultural graduates who must serve Ghana in the 21st century must be introduced to modern techniques to keep abreast of world developments, and to move freely into postgraduate work elsewhere. The undergraduates are the group most at risk from continued underfunding of the universities.

Facilities for postgraduate studies: Postgraduate education has virtually ceased in the faculties of agriculture, because of the deterioration in facilities and loss of some key staff. There is an urgent need to rehabilitate the capability of pursuing postgraduate studies.

Importance of postgraduate studies: While the national agricultural research services (and universities) can arrange for their staff to receive postgraduate training overseas (and there are considerable academic advantages in this, as well as personal, material advantages for individuals), there are many reasons why postgraduate education should also be available in Ghana.

Essential to the continuing vitality of university academic staff is the need for involvement in research. Research and all that is implicit in it, including literature searches, design of experiments, analysis and interpretation of data, and publication of results renew and revitalize the scholarship of the individual.

It enhances classroom performance and adds to the academic atmosphere of the department. Graduate students constantly challenge the intellect of their professors, thereby enhancing the likelihood of them remaining current and vigorous longer in their careers both in contributions to education and agricultural development. The research facilities that must be made available for the students also provide the opportunity for the well-qualified faculty staff to make significant research contributions to the country. The kind of research carried out need not be academically remote or impractical. With more effective linkage mechanisms (and directed funding) many of the graduate research projects can be incorporated into the national research program. The improvement of the facilities for postgraduate programs at the faculties of agriculture could be the trigger for a greatly enhanced contribution of the universities to national agricultural research and for a significant boost in the vigor and relevance of undergraduate education.

Funding of Research in Universities: Currently, funding for research is very low. There are occasional grants in support of research made from university sources and infrequent grants for specific research offered by donor organizations which, when awarded, demonstrate the university's ability to perform. However, for the most part, the large part of the research conducted within the faculties is composed of the undergraduate research projects which, though of value to the student, seldom create much of practical application to agriculture. Essentially, a significant agricultural research resource is precluded from making a research contribution commensurate with what its potential could and should be.

Linkages of Universities with Other Institutions: Because of the chronic shortage of operational funds for research, linkages and collaboration have been less vigorous and effective than they should have been, and there are fewer formal institutional linkages than would be desirable.

Although the relationships among the universities are cordial and they share many problems and challenges, there is little interaction and coordination among them. There has been some limited exchange of senior members for specific lectures on occasion, but formal coordination and approaches towards rationalization have not been pursued.

The linkages with the Ministry of Agriculture are not as strong as they should be and not as strong as they were previously. When the universities were more actively involved in research, there was a greater interaction with MoA officials, particularly with regard to preparation and distribution of extension materials and in-service training of MoA extension personnel by academic staff. Some interaction still occurs on an informal, ad hoc basis but, for the most part, the faculties are no longer perceived as major players in the research-extension continuum.

The provision of graduates for MoA positions represents a continuing link to the MoA which could be strengthened.

The relationship between the universities and the main research institutes of CSIR is substantial but again lacks formalization. Individuals from each group of institutions participate in the activities of the other group. Many of the academic staff sit on management, research, and promotion boards of CSIR institutes. Their experience, leadership, counsel, and objectivity contribute significantly to the effective operation of these boards. Similarly, institute members are frequently asked to lecture in specific university courses where they have special areas of competence. This cross-fertilization is important to those individuals involved. Active participation by university staff in the major research program thrusts through cooperative effort however, rarely occurs, undoubtedly to the detriment of each group and the national goals. Until mechanisms for funding such cooperative ventures are put into place, university staff will not be very active in these areas.

As individuals, senior members of faculty are frequently called upon to give advice to MoA administrators and, occasionally, administrators from other ministries.

External linkages have been significantly weakened in recent years. Funding restraints have reduced the flow of world scientific literature into the country. This represents the loss of the foundation of science upon which research is built. Similarly, lack of funding and resources has reduced to a trickle the amount of research conducted in Ghana and the researchers' ability to get it into the world scientific press. This continuing isolation makes it difficult, if not impossible, for Ghanaian university researchers to maintain their contacts with the world scientific community and, of greater concern, precludes them from utilizing the most modern ideas and approaches in their research and teaching efforts. However, many university academics are not completely isolated. Some have established linkages with IARCs, particularly IITA and WARDA, and these relationships frequently provide them with relevant literature, some opportunity to travel to regional conferences, and some cooperative testing of genetic material. Further, they have thereby the

opportunity to participate in conferences, short courses or seminars sponsored by the IARCs.

Conclusion

The universities represent the doorway to the future in that they train the future leaders. The faculties of agriculture must be permitted, encouraged, and supported to play an expanded role in the overall system of agricultural development. The viability of the system depends upon quality undergraduates from which the MoA can select those who can provide leadership in that organization. The refurbishment of the physical facilities is urgently required. The limitations to and the investment in development of a first-class graduate school at one or all of the faculties are considerable.

These would require a major upgrading of library acquisitions, laboratory and field equipment, supplies, and facilities. The benefits to Ghana would be substantial and continuing. Specifically, the contribution of the universities to the national agricultural research program could be greatly enhanced. However, more formal linkages with CSIR and, particularly, MOA extension personnel, would be essential. Hence a system must be found to institutionalize a specified role for the faculties so as to guarantee an interactive relationship with MOA extension personnel. Funding for research could hopefully be channelled by CSIR and MOA for university research. Such a scenario would require some rethinking and ultimate compliance from the university that these activities are indeed legitimate for university academics to pursue. Compliance should also ensure that such activities be given due recognition within the criteria for advancement within the university system.

Recommendations

- (1) That a one-time immediate commitment to upgrade facilities in the faculties of agriculture be made. Included would be a major input into library resources and the instrumentation for information technology; a major investment in state-of-the-art scientific equipment, including computers for teaching, data handling and experimental design; vehicular support for teaching programs; and acquisition of appropriate field equipment.
- (2) That the above commitment be accompanied by an ongoing commitment of support to sustain the system, with adequate operating funds for materials and supplies.
- (3) That, although the university has staff who are among the best qualified in the research system, provision be made for short renewal courses; and for upgrading younger staff to the Ph.D. level.
- (4) That, within the faculties of agriculture, a distinct recognition that linkages to the extension personnel and access to the extension system of the MOA is crucial; and that these activities be considered legitimate and valued by the university as they relate to promotion and salary adjustment.

- (5) That a research fund be made available to CSIR solely for allocation to projects of academic staff at the universities. Project proposals would require endorsement by the appropriate management board of a research institute of CSIR that it is an area of research of high national priority. Funds should be administered as three- to four-year grants which could include support for equipment, in-country travel, technical assistance, operating funds for supplies, and publication costs. Annual progress reports should be required and a final report, including data, interpretation, and significance to the country, should be made.
- (6) That the MoA should consider developing a long-term contract with the universities to provide funding via the university to increase the faculty establishment in agriculture to ensure the increase in appropriate research and dissemination of information by the faculty.
- (7) That postgraduate degree courses be strengthened in limited areas of specialization as soon as the refurbished facilities permit, and that support for appropriate in-country postgraduate training be sought from donor agencies.

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ANNEX 11

A JUSTIFICATION OF, AND A POSSIBLE ORGANIZATION FOR,
LIVESTOCK RESEARCH IN GHANA

Justification

The major justifications for funding and organizing livestock research in Ghana are that the livestock industry is an important and developing sector of the national economy, that any increase in the local production of animal products will simultaneously assist in improving the national diet and spare foreign exchange used for the importation of such products, and that an opportunity exists for a major expansion in the number and productivity of the ruminant livestock population.

The Contribution of the Livestock Sector to the National Economy

The share of agriculture (defined to include crop and livestock husbandry, forestry and fisheries) in the national GDP has varied from 46.6% in 1970 to 48.4% in 1987. In 1986 the contribution of livestock to the agricultural GDP was estimated to be 8.6% at current prices¹, or 4.2% of the national GDP; a not inconsiderable share. The real contribution is likely to have been somewhat higher, as the limited production of milk and skins, and the contribution of animal manure and the draught power provided by oxen to crop production was excluded from the estimations. The contribution of cattle to the livestock industry GDP is estimated to be somewhat less than 50% of the total, the poultry industry being the second largest contributor, while the sheep, goat, and pig industries contribute more or less equal shares of less than 10% each.

Possibilities for Sparing Foreign Exchange and Improving the National Diet

The economic decline between 1970 and 1982, during which the country's GDP fell at the rate of 0.5% per annum, led to a reduction in the importation of live ruminant animals from adjacent countries and of meat, dairy, and fish products. For example, by 1986 there was only a trickle of ruminant livestock entering the country (30 cattle, 107 sheep, and 56 goats), while imports of meat, dairy, and fish products had declined to a third of what their value per capita had been in 1970 (see Table 7.1). The real decrease per capita was almost certainly greater than is depicted in Table 7.1, due to inflation in world prices between 1970 and 1986.

¹FAO/World Bank Statistical Services, 1986.

Ruminant and non-ruminant livestock populations have expanded during the last 20 years (Table 7.2). The cattle population increased during the nineteen sixties, declined slightly during the seventies, and increased more rapidly during the eighties. Sheep and goat numbers increased rapidly throughout the period. The pig population has fluctuated widely in number but the total has trebled during the 20-year period, while the poultry population exploded during the late sixties and early seventies with the importation of new technology and new breeds. Poultry numbers have since been somewhat reduced and now appear to be more or less stable; expansion being checked by the limited availability of maize and other feeds.

The effect of livestock population increases on the availability of meat per capita has not been marked. It only increased from 7.8 to 10.3 kg per capita per annum between 1965 and 1987⁽²⁾. Indeed, at present there is less meat available per capita from the ruminant livestock sector than there was 30 years ago; it is only an increase from the non-ruminant sector that has slightly improved per capita supplies.

One reason for the decline in per capita meat produced from ruminants may be that although the number of ruminant livestock units has increased at about the same rate as the human population, average ruminant carcass weights had by 1987 declined to about 60% of their 1964 level².

The estimated percentage contributions of cattle, sheep, and goats to the total meat supply are 34, 11, and 8, while pigs and poultry contribute 14 and 35%, respectively³. Thus non-ruminant livestock provide approximately half the total meat produced from domestic livestock. Wild game are said to contribute up to 12% of total meat supplies⁴.

Foods other than meat that provide animal protein are milk, eggs, and fish. A very limited quantity of milk is produced and production, difficult in the tropics, is not likely to increase quickly, while egg and fish production are more or less static. Marine and freshwater fish production increased rapidly up to early seventies but have since stabilized⁵.

National survey data show that the average diet in Ghana is somewhat deficient in calories, protein, and fat and that it has deteriorated since

²FAO Country Tables; Basic Data on the Agricultural Sector, 1988, FAO, Rome.

³FAO Yearbooks Nos. 8, 18, 31 and 41 (1954, 1964, 1977 and 1987), FAO, Rome.

⁴CSIR, 1989.

⁵FAO, Country Tables, Basic Data on the Agricultural Sector, 1988, FAO, Rome.

1961-65⁶. Limitation of live animal and meat, dairy, and fish product imports, combined with more or less static meat and fish production, together with a steady increase in population, must have contributed to the deterioration of the Ghanaian diet.

If the deterioration in the national diet is to be reversed, and it is imperative that it should be, then additional animal protein food will either have to be imported or produced locally. Milk production is likely to remain negligible and production of eggs, poultry meat, and pork depends upon adequate quantities of maize and other feeds being available in excess of human requirements. There is therefore an immediate need to increase meat and fish production. At this time, for reasons already stated, a major increase in meat production can only come from ruminant livestock. It would entail a very large increase in the ruminant population and improvements in individual animal productivity. To achieve the latter requires a major research effort.

The Opportunity for Increasing the Number and Productivity of Ruminant Livestock.

Of the total land area of Ghana some 12% is classified as arable and 37% as forest, the remaining 51% being savanna or transitional areas between the forest and the savanna. The ruminant livestock population is not evenly distributed (Table 7.3), 77% of the total cattle population being managed in the northern savanna, with a further 17% in the southern grasslands, relatively few being managed in the forest and transitional areas. Sheep and goat populations, however, are distributed more evenly.

The present distribution is the result of a combination of ecological and cultural factors. Although a majority of Ghanaian ruminant livestock are to a greater or lesser extent trypanotolerant, areas heavily infested with tsetse flies generally remain unstocked, and agricultural systems in the wetter forest and transitional zones have not normally included an integrated livestock sector. In addition, many agricultural systems have been based on "hoe culture", and until relatively recently there has been no strong demand for working cattle. Also, in the savanna, there have been few attempts to integrate ruminant livestock with crop farming systems, possibly because the majority of livestock are managed by traditional pastoralists in a traditional manner.

Although present conditions have limited the development of the ruminant livestock industry, they could ultimately be exploited in order to ensure its expansion. With improvements in the carrying capacity of the savannas (by the development of dry-season water and feed resources) and the introduction of integrated livestock systems into the wetter areas, the present size of the ruminant livestock population could at least be doubled or trebled, utilizing existing natural resources.

⁶FAO/WHO, Ghana National Food and Nutrition Policy and Plan of Action, 1989/91, 1988. FAO regional office ACCRA.

The productivity of Ghanaian ruminant livestock is low. For example, trypanotolerant West African Shorthorn (WAS) cattle, the commonest breed in the country, grow at the rate of about 130 gm per day, achieve maturity at around 4 years of age, with first calving at 36 to 42 months. The possibilities for modest improvements in productivity are obviously very great, but will require a serious livestock research effort.

Other social and economic reasons

Intergrated livestock systems demonstrate specific features that are socially and economically advantageous, justifying the research effort required to develop them.

Once traditional pastoral managerial methods are abandoned, integrated systems are more labor intensive, improve employment possibilities (especially for women), and require a more intensive infrastructure and higher standards of management. The general livestock products are priced higher than most other agricultural products, providing the average small livestock farmer with additional and possibly more regular income and/or a living savings bank account.

Table 11.1: Meat, Dairy and Fish Product Imports, 1970 and 1986

Import by value (x \$1000)	1970	1986
Meat products	5,000	1,550
Dairy products	9,120	4,500
Fish products	15,710	15,000
Dollar value of total imports per capita	3.46	1.11

Source: FAO, Country Tables: basic data on the agricultural sector, 1980, FAO, Rome.

Table 11.2: Livestock Populations in Ghana, 1964-87

Type of Livestock	1964	Population ('000 head)						
		1965	1970	1975	1977	1980	1985	1987
<u>Ruminants</u>								
Cattle	--	750	903	898	--	804	1,132	1,284
Sheep	--	1,130	1,331	1,606	--	1,941	2,100	2,400
Goats	--	1,150	1,412	1,935	--	1,934	2,100	2,800
<u>Non-ruminants</u>								
Pigs	--	151	368	383	--	379	489	703
Poultry	2,343	--	--	--	10,500	--	10,986	11,000

Source: FAO Yearbooks 18,31, and 41. 1964, 1977 and 1987. FAO, Rome.
 FAO Country Tables: basic data on the agricultural sector. 1988, FAO Rome

Table 11.3: Regional Distribution of Cattle in Ghana, 1986

Region	No. cattle	As % of total cattle
Upper East	213,938	18.9
Upper West	260,091	22.9
Northern	404,262	35.6
Brong-Ahafo	36,104	3.2
Ashanti	12,958	1.1
Eastern	42,101	3.7
Greater Accra	70,879	6.2
Volta	94,058	8.3
Central	5,874	0.5
Western	3,755	
Total	1,134,870	100.0

Source: DAHP, MOA

A Possible Methodology for Strengthening Livestock Research

Research priorities

Further development of the non-ruminant livestock sector depends upon an adequate supply of suitable feeds (mainly maize) becoming available over and above current human requirements. This is not a livestock research problem. Therefore, as natural resources are available for ruminant livestock populations to be increased, particularly in the wet and transitional ecological zones, it is suggested that the major priorities in livestock research should be to improve the breeding, nutrition, husbandry and health of indigenous ruminant livestock and to develop systems that integrate them into field and tree crop agriculture.

Within this broad priority of interest it will be necessary to determine secondary priorities. The normal sequence in a livestock/development program in the tropics would be first to ensure that the animals remain healthy and that disease and mortality are reduced to a minimum, second to investigate the most suitable feeding and management methods for the specific ecological zone, and finally to provide the farmer with livestock that are as hardy as but more productive than his own.

Epidemiological, diagnostic, and veterinary medical resources, but not a research program, will normally be required to ensure that livestock remain healthy. Of course, an unknown disease problem may occur that requires investigation.

Farmers need ruminant livestock that are hardy and in particular trypanotolerant, but also more productive than existing indigenous livestock. A major research effort will be required to breed such animals. Such projects are inevitably long-term in nature and should be planned and commenced as soon as is practical. Priority should be accorded to the breeding of cattle, because their current contribution to the meat supply is far larger than that of the combined production of sheep and goats.

Improved livestock will require better husbandry and feeding practices wherever they are raised, and if ruminant livestock are to be integrated into cropping systems and bred in numbers in the forest and transitional zone, then a major feeding and management investigational effort will be required.

The present situation

Prior to independence, livestock research was unified, all aspects being the responsibility of the Department of Agriculture that ultimately became the Ministry of Agriculture. Livestock research is now fragmented, different aspects being conducted in the Animal Research Institute (ARI), the faculties of agriculture, and research stations of the University of Ghana (UG) and the University of Science and Technology (UST) at Kumasi, and the Animal Health and Production Department (AHPD) of the Ministry of Agriculture (MOA). The degree of fragmentation is such that in 1988/9 a total of 40 research workers (6 in ARI, 31 in the universities and 3 in the AHPD) contributed to a total of 6.54 person/years of research work on ruminant livestock.

Partly as the result of uncoordinated effort, there is also some imbalance in the research program and confusion with regard to linkages between research and extension staff and producers. An example of imbalance is that according to the survey there were 13 researchers contributing a total of 4.58 person/years to tsetse investigations in 1988/89, but only three workers contributing 3.12 person/years to all animal nutrition and pasture work. Apart from the tsetse investigational program, linkages between research and AHPD extension staff and ARI are almost non-existent. At the universities linkages depend primarily on personal relationships, while the links between extension workers and producers are indistinct at the MOA, because it is not clear whether all livestock extension work will be conducted by the AHPD.

The results of the fragmentation of effort and a general lack of funds, and/or facilities in all institutions are only too apparent, since promising long-term programs, such as the Nungua blackhead sheep breeding project at the UG, are curtailed or abandoned and only very short-term research projects proposed.

It is suggested that a possible solution to these problems under present circumstances is the development and conduct of a national coordinated livestock research program. This can only be accomplished with the willing cooperation of the ARI, the universities, and the AHPD of the MoA, because none of these organizations can muster sufficient funds, personnel, and laboratory and field facilities to conduct the comprehensive, long-term, livestock research programs that Ghana requires.

A possible methodology

The overall requirements for livestock breeding, nutrition, management, and health will be considered and possible respective roles for ARI, the universities, and the AHPD discussed.

Breeding research. The mandate of a national ruminant breeding program would be to select more productive cattle, sheep, and goats that are also hardy and trypanotolerant. Priority should be awarded to plans for cattle breeding, and since all breeding programs are necessarily long-term in nature, these should be prepared as quickly as possible. The investigations can and should be planned to involve extension workers and farmers.

Stations for cattle breeding should be selected in four major climatic zones. These would be:

- the wet, high forest zone;
- the intermediate or transitional zone;
- coastal savannas; and
- the northern savanna.

The criterion would be to breed more productive (measured in tons of liveweight gain) indigenous West African cattle. Milk production should not be entirely ignored, since it is important in calf growth. N'dama cattle could be used in the wet zone, WAS cattle in the transitional zone, and WAS or Sanga cattle in the savannas.

Two or more other stations in the wet and savanna zones should be selected as sheep breeding centers. Indigenous forest sheep should be bred in the wet zone, while an attempt should be made to evolve a new breed in the savanna, possibly by resuscitating the Nungua Blackhead breeding program. Goat breeding, based on selection in indigenous forest goats or on cross-breeding could be conducted at one other station.

Breeding plans would be designed by animal breeders working at ARI (cattle) and the universities (sheep and goats), where the correlation and analysis of records and results would be conducted. The most suitable station in each climatic zone would be selected, and the feeding, management, and health of the animals in the breeding programs could be the responsibility of the DAHP, but personnel from the ARI and the universities should monitor the situation in order to ensure standard good husbandry. Where possible, livestock farmers owning similar cattle in the vicinity of the stations should be induced to cooperate in the breeding programs by agreeing to the marking and limited recording of the

production of their animals; thus providing a larger number for selection purposes. Nutritional, management, and health problems arising in the breeding programs should be investigated by researchers from the ARI and the universities.

Such a national breeding program would be of long-term regional and international interest, and should be planned in association with ILCA, ILRAD, and the International Trypanotolerance Center in The Gambia. Within the expected lifetime of such a program, advances may be made outside Ghana in ascertaining the position on cattle chromosomes of the gene(s) responsible for trypanotolerance. If this occurs, it could have a major, but at present unknown, effect on the design of any breeding program.

Feeding and management research

Stations will also be required in the wet, transitional, and savanna zones for investigations planned to evolve new systems in which livestock are integrated with field and/or tree crops. Major nutritional and management problems are likely to be encountered in these programs, and scientists from the ARI and the universities should cooperate in seeking solutions.

In the savanna, if adequate water is available, a number of feeding/management options need investigation. These include the use of many different forms of feed supplement in the dry season, fodder banks, and the introduction of some form of key or rational farming.

Health research

Epidemiological and other surveys, diagnostic work, and clinical veterinary work are the responsibility of the DAHP, but disease investigation could be the province of the veterinary department of ARI and/or the universities. Disease investigations, however, require a 'critical mass' of research workers, not available for the foreseeable future at the ARI or at the universities.

Limitations on livestock research

Using farm-gate commodity prices and assuming overall funding at the rate of US\$ 50,000 per research worker, then if 1.0% of agricultural GDP is used for research, Ghana would be able to afford an agricultural research organization with approximately 460 scientific staff. At present Ghana spends 0.57% of agricultural GDP on agricultural research so that the employment of 460 staff would require a modest increase in research expenditure. As the livestock sector is estimated to account for 8.0% of the agricultural GDP and is growing and livestock research is relatively more expensive than crop research, it is reasonable to assume that 0.1% of agricultural GDP should be spent on livestock research. This would provide a scientific cadre of 46.

If there were funds for the employment of 46 livestock scientists, then it would be desirable that the cadre at the ARI should not rise above 20. This would mean 3 additional posts; possibly a ruminant breeder, a

ruminant nutritionist, and a livestock anthropologist. Ultimately the Director appointed at the ARI should be an animal scientist (breeder, nutritionist, or management specialist) and not a zoologist. The remaining 26 posts should be filled by livestock scientists from the AHPD (at present employing 13) and the universities (where a considerable number of livestock scientists carry out part-time livestock research).

The limit on scientific staff limits funds and therefore facilities. Nevertheless, from stations operated by CSIR, universities, and the AHPD, it should be possible to select suitable sites at which to conduct a national livestock research program.