REPORT TO THE

GOVERNMENT OF MALAWI

A Review of the Agricultural Research System of Malawi

International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, 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 non-profit autonomous agency, international in character, and non-political in management, staffing and operations. Most of its funds are provided by an informal group of approximately 30 donors: countries, development banks, international organizations and foundations, which make up CGIAR.

ISNAR is the youngest of the 13 centers in the CGIAR network, and it is the only one which focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on organization, planning, manpower development, staff requirements, financial and infrastructure requirements, and related matters, thus complementing the activities of other assistance agencies. Additionally, ISNAR has an active training and communications program which cooperates with national agricultural research programs in developing countries.

ISNAR also plays an active role in assisting these national programs to establish links with both the international agricultural research centers and donors.

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Summary

By invitation of the Ministry of Agriculture (MOA) and in accord with a jointly agreed-upon terms of reference, the International Service for National Agricultural Research (ISNAR) reviewed the agricultural research system in Malawi. The objective of the review was to advise on how the research system could be improved so it could better serve Malawi's development.

The review team assumed that the primary purpose of the agricultural research system in Malawi is to provide a flow of improved technology to the various groups of producers of agricultural products. This view is consistent with the perception of MOA, and several recommendations of the review team are expected to make the research system more capable and more efficient in fulfilling this function. The review team further assumed that the research system is responsible for describing costs of production and policy-impact analyses that will help the government formulate policies that further social and economic development goals; one of the recommendations is expected to improve the performance of the research system in this area.

Malawi's young research system is well positioned to develop into a service that will efficiently serve Malawi's needs, but its growth will need to be carefully structured if it is to be effective. Major areas needing attention in the near future include:

* working relationships that provide better linkages between researchers and their various groups of client farmers and policy-makers;

* management procedures for physical, human, and monetary resources that focus them on a few priority tasks;

* forced-pace training of scientists (and more of them), to do the priority research;

* full incorporation of the relevant college staff into the research system to do priority research;

* improved physical and monetary resources for well-defined priority research.

Malawi is investing less than one-half of 1% of its agricultural GDP in research. This does not provide its researchers enough facilities and operating funds to allow them to do the expected and needed priority work. A steady flow of adequate funds for replacing equipment as it wears out or is broken, consumable supplies and materials, and internal transportation, is the most critical need. The present level of

operating funds at the three main stations is only K8,000 per scientist man-year (SMY) and must cover many costs that are usually considered a part of institutional overhead. While specific program requirements, not general guidelines, should dictate operating funds, Malawi should expect operating costs per SMY to increase several fold if the research system is to become more productive. Substantial investments in facilities will also need to be made as a more comprehensive and efficient research system is developed. Returns on investments in agricultural research are often around 40% to 50%, much higher than most public sector investments, so Malawi should not hesitate to make the needed investment in agricultural research.

> Recommendation 1. While the investment level needs to match defined program needs, not guidelines, Malawi should not hesitate to increase its investment as rapidly as the research system can effectively absorb it until it reaches at least 1% of the agricultural component of the GDP. As the research system becomes more productive and the technology used by farmers becomes more complex, the investment level should move toward 2%.

The network of research stations in Malawi, as in most countries, has developed in response to a series of specific perceived needs. Only three of the stations include physical plants that represent a substantial investment. There are perhaps too many stations in the lower Shire and too few in northern Malawi. When the various agroclimatic zones and Malawi's overall needs are considered, some stations may be poorly located. Rather than just continue developing all the stations that have been started, Malawi has an opportunity to develop a network of stations that are well matched with the major agroclimatic zones and have specified functions.

> Recommendation 2. MOA should, through a careful analysis, plan the phased development of a network of stations to efficiently serve its needs. Specific functions should be defined for each station, as should near-term needs for facilities, scientists, equipment, supplies, and operating funds. (We understand that this analysis is already under way.)

Research to serve the tea and tobacco estates seems adequately handled by the research units in the respective commodity associations. Sugarcane produced on estates has not yet developed major production problems, and a minimal research effort has been sufficient. Estate sugarcane can be expected to develop production problems that will require a modest research effort. Tobacco production by smallholders can be expected to have a different set of problems (or require different solutions to common problems) than tobacco production on estates. The Tobacco Research Authority (TRA) can probably adjust its research program to accommodate the problems of smallholders, if those problems are brought to TRA's attention.

Research managers in the Ministry of Agriculture, who have major responsibility for research to serve smallholders, are attempting to cover the entire needed range of research areas and related services with too few trained personnel, and inadequate facilities and monetary resources. Other countries in similar circumstances have found that their research systems produce more usable improved technology for their clients when available resources are concentrated on a relatively few programs, and the work in these programs is coordinated on a national basis. In such programs, teams of researchers that provide the needed set of talents carefully define their objectives and the resources needed, and work on all the critical components of a commodity or subject, so the resulting technology is usable by the client farmers. Near-term priorities for national coordinated commodity programs include maize, beans, groundnuts, sorghum, and cotton.

> Recommendation 3. Malawi should develop national coordinated commodity research programs for the major smallholder enterprises, link them closely with extension, focus major effort on them, and make the needed resources available to the involved scientists.

Research budgets are now related to stations. While this facilitates timely availability of operating funds, it does not provide research managers with sufficient awareness or control of the resources allocated to various research programs. Budgets need to provide for the overhead costs of the institution, and for specific training, service, and research programs. Development and periodic review of research activity descriptions that state the context and rationale of the research, progress to date, methods to be used, evaluation criteria, and resources needed, will allow resources to be allocated to specific research programs, and facilitate program evaluation and change. Fund expenditure, in conformity to approved budgets for specific research programs and essential common services, should still be managed at the station level.

> Recommendation 4. Malawi should develop research management procedures that relate budgets to specific research programs and services and that facilitate regular evaluation of progress, changes in programs, and resource allocation decisions.

A recent proposal for restructuring the Department of Agricultural Research (DAR) calls for establishing a committee to make resource allocation decisions. Three of the committee members would be the directors of the three major research stations; decisions would affect the amount of resources received by their stations. If future budgets are related to research programs (many involving more than one station), decisions on program components and priorities will affect the resources available to each station. We do not think it advisable to put station directors in a position of endorsing cuts in programs at their stations. Under such circumstances cuts or increases tend to be on a percentage basis, which avoids program priority considerations. The proposed committee, however, would form an excellent forum for discussing research

organization, programs, approaches, and priorities, and should be developed for those purposes.

> Recommendation 5. Decisions on allocation of resources should be the responsibility of the chief agricultural research officer of DAR, following consultation with station directors and other appropriate persons.

Malawi has gained much from its links with international centers (including CIMMYT, ICRISAT, CIAT, and IITA), but is not yet fully exploiting these resources. Productive relations with centers can be facilitated by exchanges of visits by center personnel and Malawi research program leaders, and by active involvement of Malawi in international testing programs. Short-term visits to centers by research program leaders will keep them informed of the wide range of materials, information, and cooperative relationships available through centers. Longer-term training of researchers at centers will make them more effective. Resources are needed in each national coordinated program to fully exploit the resources available at the relevant centers and from other external resources.

> Recommendation 6. Considering the advantages to be gained from fully exploiting information and materials from external sources, we recommend that researchers responsible for major research programs take needed action to ensure their familiarity with related work of institutions outside Malawi, and to systematically exploit those resources. We recommend that budget provision be made for the needed visits by Malawi researchers to outside institutions and for the practical research training available at those institutions.

Malawi researchers and extension staff recognize that the links among researchers, extension staff, and client farmers have not resulted in a satisfactory flow of usable improved technology to smallholder farmers. Both researchers and extension staff have taken several steps to improve these working relationships. The National Rural Development Program (NRDP) focuses development efforts on the eight agricultural development districts (ADD), and the research system is meshing its interactions with extension staff and smallholder farmer clients through the ADD centers. DAR has made specific stations responsible for the primary linkages between each ADD and the research system, and has proposed posting a research officer in each ADD to facilitate that linkage.

Several factors warrant consideration as research and extension develop more effective working relationships. The experience in the Ngabu ADD, where four research staff have worked regularly with extension staff and smallholder farmers, has been fairly successful in identifying improved technology that seems usable. Expecting a single research officer to be well informed on all agriculture seems unrealistic. Certainly, one research officer in an ADD could not be expected to form an effective link with research colleagues in several national research programs, so a reasonable amount of specialization is needed. Each ADD will also need some specialized talent to facilitate surveys and on-farm tests designed

to learn client smallholders' circumstances and responses to preferred technology. Each ADD will thus need a small team of researchers, the composition of which should correspond to the major smallholder enterprises in the area and include at least one person with competence in "farming systems research." These researchers should be an integral part of the research system, and linked directly with the relevant national coordinated commodity programs. (The work of the unit is described, see pp. 38-40.)

> Recommendation 7. Research teams should be developed to serve each ADD as rapidly as capable staff and facilities can be made available. The level of effort for each ADD should allow for needed specialization.

The staffs at Bunda and Chancellor Colleges represent a major potential research resource that is largely untapped. Bunda College staff have responsibility for two specific research programs, but many more of the staff (which is increasing in numbers and competence) could be involved in priority research. Such involvement would not only help supply the technology needed by Malawi's agriculturists but would help the staff maintain the relevance of their course content and curricula. Staff and student involvement in research would seem to be essential as postgraduate training is developed.

> Recommendation 8. DAR should make every effort, including provision of resources, to directly involve college staff and postgraduate students in the mainstream of agricultural research, especially as integral parts of national coordinated programs.

Malawi develops agricultural policies that have major effect on which groups of farmers produce certain crops, the prices farmers pay for various inputs, and the prices they get for their products. When policies and prices are set with a limited information base they may have unexpected effects or fail to help achieve development goals. A modest economic and social science analysis unit in either EPD (Economic Planning Division, Office of the President) or the Planning Division of MOA could do some of the needed research and analysis, and could contract with Bunda and Chancellor Colleges for some analyses. Biological research programs will also have to supply solid information on costs and returns of various production practices.

> Recommendation 9. MOA and commodity association research units should conduct production research to show costs and returns to inputs by various groups of producers. EPD and/or the Planning Division of MOA should be encouraged to conduct economic and social research to analyze effects of current and proposed price and production policies on various groups of producers. The researchers need to supply such information to policy-makers in usable form.

Malawi's researchers number about 75. Only four of them (excluding expatriates) have Ph.D. degrees, the accepted standard training for a researcher, and about 10 have M.Sc. degrees. A few are being trained abroad now, and the number of Ph.D.-holders may increase to about 12 and the M.Sc.-holders to 35 or so within the next few years. This commendable training effort will still leave Malawi with most of its research staff having only a B.Sc. degree, which does not prepare most people for a career in research. Trained personnel will be the limiting factor in Malawi's research system for the next several years, if other recommendations are carried out.

Malawi will need to exploit all available opportunities to adequately train its researchers. While Ph.D. training, and some M.Sc. training will have to be done outside Malawi for some time, there may be an opportunity to augment the Bunda College staff with external resources and train a group of 25 to 35 researchers to the M.Sc. level in plant science, with limited specialization, at Bunda College. Bunda College would retain a capacity to continue M.Sc. training in a few key disciplines. This group of new M.Sc.s would form a major resource for the research system and quickly raise its performance to a substantially higher plane. They would also form a collegial group that would facilitate cooperative research for many years.

> Recommendation 10. Malawi should examine whether training a group of 25 to 35 persons to the M.Sc. in plant science at Bunda College is feasible, and proceed with the training if it is. Alternatively consideration should be given to training a similar number of scientists spread over five years at Bunda College, or through overseas fellowships combined with a local postgraduate program.

Useful research requires trained and motivated scientists. Working conditions and terms of service should enable the research system to recruit and retain competent scientists. Promotion opportunities for researchers in Malawi are insufficient to motivate researchers to stay in research. Many move into the private sector or take administrative jobs. In this report we suggest some steps that can help provide a rewarding career structure. Promotional posts in the superscale should have specific job descriptions and qualifying experience requirements. We endorse the proposal to establish a board to recommend researchers for promotion. As researchers are more adequately trained for their work, they become qualified for more jobs. As the job choices available to researchers increase, their career structure becomes more important to research managers.

> Recommendation 11. A special extended scale rising to P3 should be created for researchers, as has been done for similar specialists in the health service.

Malawi's near-term need for trained scientists should not obscure the difficulties of over- or under-supply of trained researchers in a relatively small country. The planning of the research station network and programs, the planning of national coordinated commodity programs for

the major smallholder enterprises, and the planning of the ADD research units will provide much of the information needed for a manpower demand analysis. To this should be added an analysis of demand in other components of the research system. This should then be combined with an availability analysis and developed into a plan for development of agricultural research manpower.

> Recommendation 12. Malawi should develop a plan of its scientific manpower needs and their sources, based on specific research program plans.

Malawi is in position to sharply increase the capability of its agricultural research system and make it much more effective in providing smallholder farmers with the technical information and improved materials they need to increase their productivity. The above recommendations, if carried out, will help use both internal and external resources to better advantage and allow the research system to fulfill its obligations as Malawi improves the well-being of its people.

Chapter 1

Introduction

Malawi is a country of contrasts. Its long, narrow shape and sharp altitude changes cause considerable agroclimatic variability, and diversity has also characterized its agricultural development. Unlike most new African nations, Malawi has adopted policies that have encouraged production by estates. Estates have increased their production markedly, and Malawi's foreign exchange earnings have increased accordingly. Malawi smallholders have not done as well. With a population growth rate of about 3%, smallholders have apparently maintained per capita availability of foodstuffs, but only because more people cultivated more land.

While the growth of Malawi's estate agriculture (and related exports) has been noteworthy, for more than a decade Malawi has also been concerned about the development of its smallholder sector. Much of Malawi's recent attention to smallholders has been channeled through a series of integrated rural development programs. In the early years these programs provided major inputs of physical infrastructure, including roads, health facilities, and wells. Investment costs per family served were too high to be sustained, however, and more recent integrated rural development programs have placed less emphasis on developing physical infrastructure and have concentrated on increasing production by smallholder farmers. In spite of intensive extension efforts during the past several years, success in increasing production by smallholders is not well documented.

An implicit assumption in the National Rural Development Program (NRDP) was that the improved technology necessary to increase agricultural productivity was available. In some cases it was, but in many cases it was not. This led Malawi to examine the agricultural research system to see how it might be changed to better assure a flow of improved technology to help Malawi meet its development objectives.

The Government of Malawi asked the International Service for National Agricultural Research (ISNAR) to help in a study of the Malawi research system. During a visit to Malawi by Drs. William Gamble and Floyd Williams in February, 1982, a terms of reference (see Annex A) for the analysis was developed and agreed to by the Ministry of Agriculture (MOA) of the Government of Malawi and ISNAR. ISNAR brought together a team which visited Malawi from April 13 through May 5, 1982. (See Annex I for itinerary.) The major findings of the team were discussed with leading MOA personnel before the team left Malawi.

This report sets forth the important findings of the review. The first section of the report briefly examines the recent performance of the agricultural sector in Malawi and some of the factors that have affected

the pattern of agricultural growth, including the use of improved technology. The second section examines the more important aspects of the present research system, including the major institutions, their resources, and their linkages with other institutions and clients that affect the efficiency and efficacy of the research system. The third section focuses on the important problems of the research system and suggests changes that can help it become more effective.

Much has already been written about Malawi and its agriculture. A brief sketch of Malawi is presented in Annex B. Background material within the report, however, is kept to a minimum.

Chapter 2

Agriculture in Malawi

The importance of agriculture to the people of Malawi can hardly be overstated. Some 85% of Malawi's 6.3 million people are directly involved in agricultural production, and many others derive their livelihood from service to agriculture. But the value of agricultural products is comparatively low, and agriculture contributes only 43% of the Gross Domestic Product (GDP), while industry contributes 20% and services 37%. Smallholders contribute 84% of the agricultural GDP, but three-fourths of their contribution does not enter the monetary economy[1].

Malawi is virtually self-sufficient in food, except in years of drought. Malawi farmers also produce about 90% of Malawi's exports, which were worth about K226 million in 1980. (In this paper one Malawi Kwacha can be considered equal to one U.S. dollar). The principal exports are tobacco, tea, sugar, and groundnuts. Malawi's farmers use few imports, and in a recent year fertilizer constituted only 4% of imports. (For more background information see Annex B.)

Malawi expects much from its agricultural sector in the coming years. The government projects a 5.2% economic growth rate, and expects agriculture to roughly maintain its share of the rising GDP -- a formidable task. The government wants to increase exports as a share of the GDP; it has also noted the need to diversify exports and to improve incentives for smallholders to produce export crops. The government expects the sector to produce nearly all foodstuffs for the people and to build a controlled food reserve for unfavorable seasons. It also apparently wants to keep low prices for staple foods in cities, and to restrain rural wages to help assure a more competitive position for exports. Some of these objectives may well prove conflicting. In any case, Malawi expects major sustained production increases from its agricultural sector.

Agricultural components of the GDP are as follows:

Gross Domestic Product in 1980	K	1243	million
Amount contributed by agriculture	K	530	"
Contributed by estates	K	83	"
Contributed by smallholders	K	447	"
Monetary component	K	111	"
Non-monetary component	K	336	"

[1]Adapted from: Malawi Government. 1982. Mid-year Economic Review 1981-1982. Zomba, Malawi: Government Printer.

Past increases in smallholder production appear to have come mainly from expansion of the cultivated area and increases in the labor force due to population growth. Since there is scant room for further expansion of the cultivated area in the more populous areas, and the desired production growth rate far exceeds expected increases in the labor force, productivity[2] of both land and labor will have to increase. Such increases can take place only in an environment especially conducive to rapid agricultural development. (See Investing in Technology.)

Recent Performance of the Estate Sector

Agriculture in Malawi consists of two subsectors, smallholders and estates. Smallholders account for about 85% of total agricultural production and about 30% of agricultural exports. Smallholders cultivate about 80% of the tilled land, producing mainly food crops, meat, and poultry. Estate crops are tea, flue-cured and burley tobacco, and sugar. Estates control 470,000 ha (about 9% of the tillable land), contribute 15% of total agricultural production, and produce about 70% of agricultural exports.

As noted earlier, at independence Malawi adopted policies that favored production by estates. These policies were effective, and a recent draft review[3] of the National Rural Development Program (NRDP)[4] mentions a 17% annual real growth since 1968 in the estate subsector. Increased production from estates is easily documented from sugar factory and commodity export data. Production of the major export crops by estates has grown steadily. Between 1968 and 1977, output of combined

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[2]The productivity of a system is a measure of the relationship between total outputs and inputs. An increase in productivity occurs when outputs increase while inputs are constant; when outputs are constant while inputs are decreased; or when the increase in outputs is proportionally greater than the increase in inputs. An increase in productivity indicates a positive change in the efficiency of resource use. Improved technology usually brings an increase in productivity.

[3]World Bank. 1982. Malawi -- National Rural Development Program Review. Washington, D.C.

[4]Malawi channels much of its agricultural development efforts through a National Rural Development Program (NRDP). Under NRDP, the nation is divided into eight agricultural development divisions (ADDs). These are further subdivided into some 40 development areas and some 180 extension planning areas. Most ADDs have a headquarters office and service compound which is the focal point for agricultural development activities for the ADD, including extension. While all Malawi is included within an ADD, not all areas of the country are covered under funded development projects. Most of the projects are largely funded by donors. Projects focus resources on a set of defined activities within the geographic area. Within active project areas there are about 750 smallholder families to each extension field assistant. Extension pressure is lower outside project areas.

estate crops increased over four-fold[5]. Production of burley and flue-cured tobacco increased by about 80% and over 400% respectively, between 1970 and 1977. During the same period tea production increased by about 70%. Two sugar estates will soon cultivate 14,000 ha, and production has increased from 49,000 metric tons in 1974 to 177,000 in 1981. (One of the sugar production units includes an arrangement for smallholders near the estate to produce sugarcane, and in 1981 over 300 smallholders were growing cane on 2-ha plots.) Estate production increases are attributed to expansion of area under cultivation, better management on some of the estates, and greater use of inputs (fertilizers, herbicides, nematicides, and insecticides). (Fertilizer sales to the estates by OPTICHEM Ltd. in 1980 was 32,830 metric tons.) Some estates that were poorly managed and had excessive debt reportedly went bankrupt during the late 1970's, but estates that are managed by professional and experienced managers have recorded high production and profitability. Employment in the estate subsector expanded from 42,600 in 1969 to 148,300 in 1978, and estates provide about half the total paid employment. Other major factors that have contributed to better performance in the estate subsector are the availability of credit and lucrative prices, particularly for auctioned tobacco.

Recent Performance of the Smallholder Sector

Smallholder production trends are more difficult to document. Detailed information on cultivated areas and production or yields has not been available except for a few small areas. A draft report on NRDP attributes a 3% growth to smallholder agriculture. This attribution seems acceptable since food supplies seem to have kept pace with population increases. While the historical database needed to measure smallholder productivity is largely missing, the evaluation units in the agricultural development divisions are soon expected to provide an adequate database to measure future changes.

Maize yields are central to increasing smallholder agricultural productivity since nearly every farmer grows maize, and about half the land cultivated by smallholders each year is planted to maize, the staple food. Most farmers grow flint maize and save some for seed. Yields are stable at about 1,000 kg/ha under average weather conditions. The local flints respond slightly to fertilizer application, if other factors (usually rainfall) are not limiting. In a recent year about 10% of smallholders borrowed money to buy fertilizer. The number using fertilizer on maize is unknown, but the probability of crop failure or near failure from low moisture may discourage the use of fertilizer and encourage the planting of a larger area. (Accepting low yields from a larger area rather than seeking higher yields from a smaller area spreads moisture risk.) Considering the risks deriving from rainfall patterns and the low total family cash flow of K100 or less per year, an investment of even K25 or K30 for fertilizer and seed looms very large to a smallholder family.

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[5]World Bank. 1981. Malawi -- The Development of the Agricultural Sector. Eastern Africa Regional Office.

Until quite recently, Malawi's maize research has concentrated on dent maize. Malawi research has selected synthetic, composite, and hybrid dent and semi-flint varieties, but except for the dent hybrids, undesirable qualities have been found in the selections. Technology is available for dent hybrids that allows growers to achieve yields of 3 or 4 tons/ha. Some smallholders that have confidence and credit, and intend to sell the crop, use that technology and produce dent hybrids for sale. However, most smallholders do not plant maize strictly to sell, but market maize that is excess to their needs for food or to get cash for essential purchases. The flint maize reportedly has more insect resistance than the hybrids and thus stores better, and it yields more usable product from home processing than the hybrids. Smallholders thus prefer flint maize and have not generally accepted the dents. Maize researchers have only recently started intensive testing of a range of flint maize varieties and composites that have good potential for replacing indigenous maize with higher-yielding varieties.

Tobacco is grown by about 10% of smallholders and is a popular cash crop. Their production of fire-cured, air-cured, sun-cured, and oriental tobacco is controlled to help assure product quality and market stability. Tobacco yields on smallholder farms are fairly static. Yields of dark fire-cured tobacco (the type grown by 80% of smallholder growers) in the northern division have fluctuated around 375 kg/ha. Farmers reportedly use only some of the recommended practices, yet the management practices used are fairly demanding. ADMARC (Agricultural Development and Marketing Corporation) has a market monopoly for smallholder tobacco and pays farmers only about one-fourth of the auctioned value of tobacco. That smallholders do not use the full package of recommended technology may indicate that profitability, not technology, limits smallholder yields.

While flue-cured tobacco is usually restricted to estates, some smallholders in Kasungu District are licensed to grow flue-cured tobacco on leasehold land, provided they sell their tobacco through the Kasungu Flue-cured Tobacco Authority. The authority gets management and technical help from the Commonwealth Development Corporation (CDC). Under the authority, over 1,000 smallholders use complex management practices and grow from 1 to 9 ha (most grow 1 ha) of flue-cured tobacco. The farmers get the auction value of their crop, less the cost of services provided by the authority. Average growers net some K700 per year, and good farmers net K3000. In contrast, in 1978 ADMARC paid smallholders K11.5 million for tobacco that had a net sale value of K41.5 million. ADMARC's gross profit was K26.8 million and net profit was K25.9 million. (For more discussion of tobacco production see the World Bank report, and Kydd and Christiansen[6].) The Kasungu smallholder tobacco production experience indicates that with proper organization, smallholders can produce a high-value crop that requires considerable management. The continued production of most tobacco on estates and not by smallholders thus becomes a government policy decision.

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[6]Kydd, Jonathan and Christiansen, Robert. 1982. Structural Change in Malawi since Independence: Consequences of a Development Strategy Based on Large-scale Agriculture. World Development 10:355-375.

Some 4,000 smallholders grow about 2,000 ha of tea under the auspices of the Smallholder Tea Authority. A similar authority is working to develop a smallholder coffee industry. Both receive help from the Commonwealth Development Corporation.

Cotton is a traditional cash crop for about 60,000 smallholders. Present yields range between 260 and 480 kg/ha, although with available technology, including timely planting and pest control, yields of over 1,000 kg/ha can be realized. While lack of capital, and nonavailability of inputs and sprayer spares are reportedly constraints to cotton production, the management practices used seem to be controlled by product price. With slightly more favorable prices, insect control would receive more attention from farmers and insect control technology would become limiting. Insect population monitoring accompanied by well-timed and selective spraying may lower plant protection costs, but requires timely access to equipment and materials. This technology is in hand, or nearly so, at Makoka, but training farmers and extension staff in its use requires a substantial and sustained effort by researchers. The cotton technology extension system seems to have deteriorated, which may have contributed to lower cotton yields. The World Bank analysis indicates that cotton production is fairly price-responsive, but that farmers are also generally responsive to relative prices among commodities. So when cotton price increases over time are low in comparison to other commodity price increases, cotton production declines, even though prices are increasing.

Groundnut production fluctuated widely from 1969 to 1976, then decreased sharply in spite of increased prices. It has recently recovered but not reached previous levels. Decreases have been attributed to disease, unfilled pods, and inadequate prices. The crop is labor-intensive and vulnerable to fungal and viral diseases. Prices have not been sufficiently high to make pest control profitable. Inadequate production technology for pod filling (perhaps calcium deficiency) and pest management may be partially responsible for low groundnut yields, but prices also have had a major effect. As with tobacco, ADMARC has made substantial profits on groundnuts. It appears that smallholder tobacco and groundnut producers are being taxed to subsidize other crops, inputs, or other ADMARC functions.

Annual rainfall variation has such marked effects on rainfed crop yields that yield trends are difficult to discern, even when area and production figures are available. However, when technology for guar, a new crop, was developed and the crop introduced in the Ngabu ADD in 1976, the area planted increased steadily through 1979, then dropped by 40% and held constant. Reportedly, the drop in planted area was in direct response to a drop in price.

Cattle population increased by about 18% between 1976 and 1980, while sheep and goats declined by nearly 17%. The cattle herd is about 820,000 head, and offtake is about 10%. The pig population stagnated at 1.9 million head. Poultry production improved, largely through distribution of improved stock and vaccination. The smallholder sector accounted for about 90% of cattle, sheep, goat, and pig populations. The increase in cattle population is attributed to an increase in dip tanks and improved cattle husbandry practices. Milk throughput at the three major dairies increased from 3.2 million liters in 1976 to 5.3 million liters in 1980, but decreased by 26% in 1981 from the 1980 production level.

Research Contributions

While the economic environment has not generally been conducive to smallholder adoption of better technology, there have been some examples of successful development and adoption of improved technology. Improved technology for groundnuts has also been developed and used. (The groundnut research program should soon benefit from the recent agreement with ICRISAT for a regional facility for Africa in Malawi.) Good progress has been made in selecting cassava varieties resistant to mosaic virus and having attractive culinary qualities. (The team was particularly impressed with the way research on this important food crop was being linked to the farm level.) A beginning has been made with the use of cassava for animal feed. Macadamia nuts have come through the research phase and into commercial estate production, processing, and marketing in a remarkably short time. Beef production through the operation of feedlots and through stall-feeding by smallholders has made good progress, as has milk production in the milksheds of Lilongwe, Blantyre, and Mzuzu. Although much of the maize research has produced less than the desired results, there has recently been good progress in identifying improved flint cultivars for the lower Shire valley. The progress seems directly related to the close working relationships among researchers (including linkages with CIMMYT), extension staff, and farmers, and the availability of the needed resources for many on-farm trials. The same researchers are also making good progress with sorghum, following establishment of effective working linkages with ICRISAT. New cultivars of both flint maize and sorghum should make a measurable impact on smallholder productivity in the Ngabu ADD, if varieties are released when appropriate.

Crop production increases in the estate subsector have resulted from a favorable economic environment and from technology that was developed over a long period, or (in the case of sugarcane) introduced.

Potential near-term contributions from research to serve smallholders are quite promising. Smallholders use such a large portion of their land and labor resources to produce maize for food that maize technology is central to improving smallholder productivity. Better smallholder maize technology would free land and labor that could be used for other productive enterprises, and increase the family cash flow. Similarly, technology that would allow integration of draft oxen into smallholder farming would (after satisfying transport requirements) supply power for early-season land preparation and weeding, allowing more crops to be planted earlier and thus take advantage of the full growing season. Better sorghum technology for the lower Shire valley could provide smallholders a more dependable cereal supply than does maize. A concurrent modest poultry research program could probably develop technology to use surplus sorghum to increase smallholder poultry production, increasing rural incomes and consumer demand.

The marketing structure and pricing, lack of capital for purchase of inputs, high risk associated with large debts in relation to annual family cash flows, and restrictive policies that have prevented smallholders from producing more profitable tobacco crops have had a major influence on the level of technology used by smallholders for all farm enterprises. If smallholder productivity is to increase, they will need a more favorable economic environment and a flow of improved technology that fits their needs. The more favorable economic

environment should develop as the research system provides policy-makers a more comprehensive information base for their decisions. Improved technologies that fit smallholders' needs will come from a reorientation of the research system and an infusion of essential resources.

Chapter 3

The Present Research System

The Institutions

The major agricultural research institutions are the Department of Agricultural Research (DAR) within the Ministry of Agriculture (MOA), The Tea Research Foundation, The Tobacco Research Authority (TRA); and Bunda and Chancellor Colleges.

MOA is primarily responsible for research to serve smallholders, and those estate crops for which there is not a separate research organization. Within MOA, the Department of Agricultural Research (DAR) is headed by the Chief Agricultural Research Officer (CARO). The Chief Veterinary Officer (CVO) heads Animal Health and Industry, and the Chief Agricultural Development Officer (CADO) heads the large Department of Agricultural Development (which includes extension). All serve the same Deputy Secretary of Agriculture. The President is the Minister of Agriculture. The CARO is largely concerned with research to serve smallholders, but tea, sugar, and tobacco, largely estate crops, are also grown by some smallholders. To some extent the tea and tobacco research agencies, under their respective commodity associations, serve both smallholder and estate interests. The staffs of Bunda and Chancellor Colleges do research in a few farm enterprises and in the social sciences. The Economic Planning Division of the Office of the President is responsible for research to support policy formation, but has not developed that capacity.

Research Within the Ministry of Agriculture

The policy of DAR is to plan and conduct research that will produce results which can be directly applied by farmers and users of the agricultural products. Research activities of DAR are carried out at three major and eight minor research stations. Each station has its own budget and is administered and controlled by an officer in charge.

Bvumbwe Research Station, a main station located in the Shire highlands, was initially established to investigate the problems of tung production and to provide improved tung planting material. It is now primarily a horticultural research station. Its activities include a wide range of studies on soil fertility, moisture, and physical properties; variety and management trials on vegetables, fruit, tree nuts, maize, wheat, and cassava; plant protection; and crop storage.

Chitedze Research Station, a main station near Lilongwe, does both crop and livestock research. The main programs include soil fertility and plant nutrition, farm machinery development, maize breeding and agronomy, groundnut breeding and management, wheat seed technology service, crop storage, pasture improvement, and livestock production. Recently, with

leadership from University of Florida personnel, farming systems and agricultural economics research have started at Chitedze, but they have not yet had much impact on research activities in the more traditional areas. There are proposals for incorporating irrigated crop research into the station's programs.

Makoka Research Station, a major station near Zomba, is almost entirely devoted to cotton research and cotton seed production, although it is not located in a major cotton-growing region. Cotton research includes breeding for several specific objectives, and developing insect management, weed control, and agronomic practices. Its production research program seems comprehensive for its staff composition, but it lacks facilities for important fiber tests. It also accommodates the biometrics unit of the Department of Agricultural Research and the armyworm forecasting service.

In addition to the above three major stations, which collectively have 60 of the 72 professional researchers in MOA, there are eight minor stations. Baka Research Station does research on maize varieties, spacing, and fertility; beans; groundnuts; burley tobacco; coffee; forage grass; and cassava; and performs a wide range of trials on cotton and rice. It is essentially a testing site for national trials.

Chitala Research Station is basically a substation for Chitedze. It was established in 1929 for cotton research. The present scope of work of the station covers variety evaluation, agronomy, and crop protection trials of maize, groundnuts, cowpeas, sunflowers, pigeon peas, cassava, beans, sorghum, cotton, tree fruit and tree nut crops; a fruit tree nursery; and livestock.

Kasinthula Research Station is mainly for research on irrigated crops (maize, rice, horticultural crops, and cotton), but it also has some crops under rainfed conditions. It functions as a testing station for national maize and cotton research. Water consumptive use studies on maize, wheat, beans, and cotton have been undertaken and are continuing. Many tests are being done on vegetables and bananas, including variety, fertility, and moisture requirements.

Lifuwu Research Station does irrigated and rainfed rice research including rice agronomy and breeding, and produces rice seed. There are some agronomic evaluation studies on mangoes and cashews.

Lunyangwa Research Station serves as the main station for root crops (cassava and sweet potato) research. Other research activities at the station include trials on coffee, and agronomic evaluation work on legumes, cotton, pastures, livestock, and macadamias.

Mbawa Research Station was initially established as a stock farm and a livestock quarantine facility. The station's functions have gradually changed to studies of crop production requirements in the Mzimba area. The work includes mixed cropping; adaptation trials on maize, groundnuts, beans, sunflowers, and upland rice; and some tobacco, agroforestry, pasture improvement, wheat, and livestock research.

Makhanga Research Station was developed for seed production and as the first cotton research station, but is now used for studies of rainfed and irrigated crops, particularly tree crops, maize, rice, groundnuts,

cotton, and cocoa. The station pumps water from the nearby river for furrow and sprinkler irrigation. Periodic severe floods have affected the usefulness of the station.

Ngabu Research Station was a minor testing site but was upgraded in the early 1970s to investigate crop production requirements in the Ngabu Agricultural Development Division. Its main activities are agronomy and variety trials of rainfed sorghum, millet, and guar. Maize, groundnuts, cowpeas, and cotton breeding and agronomy are also studied. A substantial on-farm verification trial program is run from Ngabu in cooperation with extension personnel.

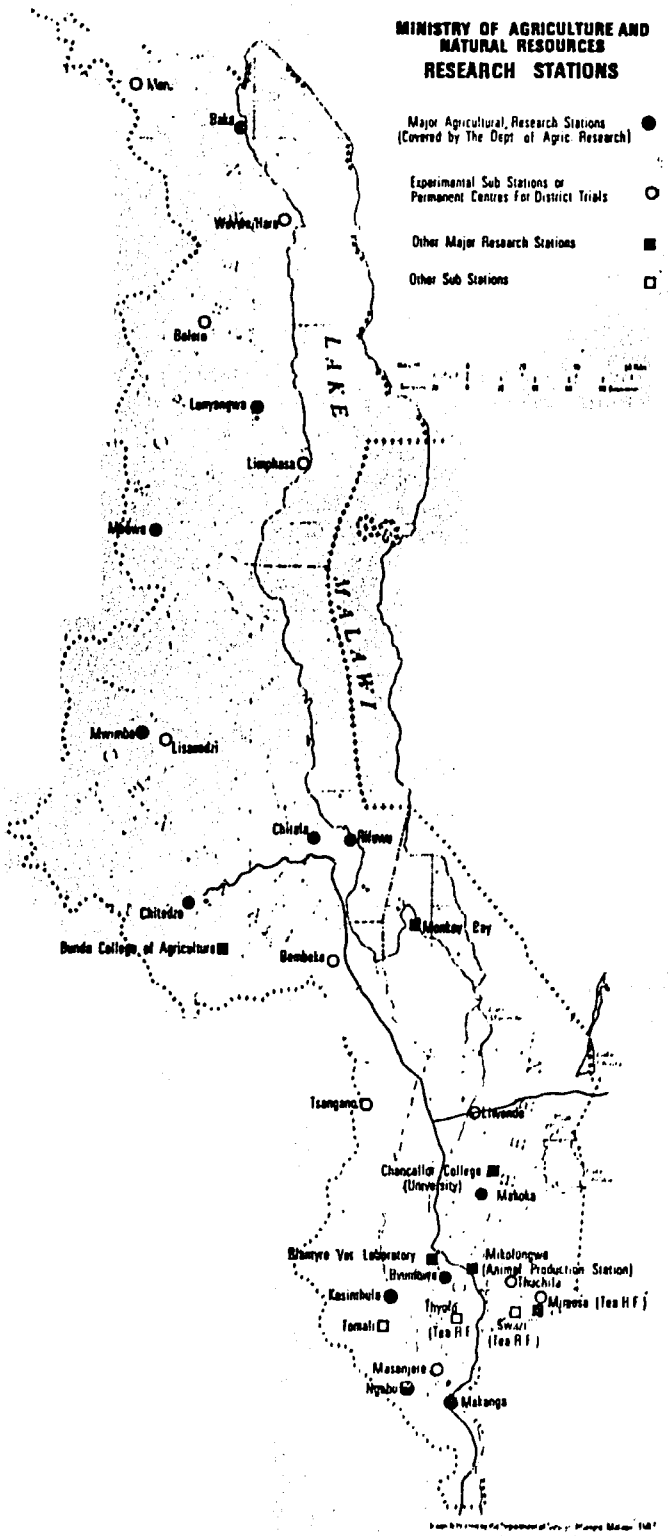
In addition to the above 11 research stations, there are substations and district trial posts sited in different agroecological zones. Staff at several minor stations are also involved in on-farm trials in their areas. (See Institutions and Programs.)

At the national level, responsibility for livestock and poultry research is divided between the CVO and the CARO. The CVO has a wide range of responsibilities including veterinary research, livestock production, livestock marketing, veterinary service training, and such field services as meat grading, milk plant sanitation, artificial insemination of cattle, and the dip tank program for control of tick-borne diseases. The CARO is responsible for animal research at the Dzalanyama ranch and Chitedze. Bunda College has a separate livestock research program. The sharing of research responsibilities between the CARO and the CVO for animal nutrition, herd and flock management, and animal breeding programs is not well defined. The development of on-farm livestock production practices is the responsibility of the CARO.

Most livestock research is on beef and dairy cattle breeding and management. Malawi Zebu bulls are under performance tests, as are crossbreds of Malawi Zebu and exotic beef breeds. Cattle husbandry research is mostly focused on performance of beef and dairy animals on various rations of local feeds. Much of the livestock research at Bunda College both demonstrates management techniques to students and provides data. Forage research at Chitedze focuses on productivity of various indigenous and introduced forages (including browse) under several management regimes. MOA trains draft oxen (and farmers to drive them), and Chitedze has a research program to develop improved oxen-drawn farm implements -- indications of MOA's interest in this form of mechanization.

Chitedze plans substantial research in livestock management, including forage production. Seven research staff are assigned to these programs, including two expatriates. Two of the five Malawians are in training in the United States. The planned feed nutrient analysis capability warrants examination to determine whether it is more efficient to derive the needed information locally or to rely on laboratories in other countries. The increased livestock research at Chitedze, the related research and teaching at Bunda College, and the research in the Animal Health and Industry Department indicate Malawi's increasing priority for livestock research, but the involvement of three diverse institutions presents challenges for effective coordination.

The locations of the MOA stations are shown on the map on page 14. Approximate funding of research in MOA over the last few years is shown in Table 1. The 1981 operational budget and staff numbers according to grades at each MOA station are shown in Table 2.



Map 1. Agricultural research stations in Malawi

Scope of Effort and Program Formation in MOA

The brief listing of work at each research station (derived from station reports) indicates the breadth of the research programs. A recent listing of MOA research projects also indicates that MOA covers a wide range of research topics and provides several related services. Current work in the various institutions includes research on the major cereals, legumes, root and tuber crops, horticulture (vegetables, tree crops, and floriculture), cotton, and coffee. They also cover irrigation, soil and animal sciences, crop storage, farming systems, agricultural economics, and farm machinery. A coordinator heads each major project, and it is intended that all research done in Malawi on a given subject be done in consultation with the project coordinator. There are some 24 project coordinators in MOA, while the recently established Phaseolus bean program is coordinated from Bunda College. The Tobacco Research Authority and the Tea Research Foundation have independent programs on these crops. Project coordinators are expected to visit program sites at least once in a season, but transport and communication problems have kept them from visiting test sites regularly. (See Annex C for team comments and questions on research stations and programs.)

When the research system was much smaller, each research project was reviewed and the work program decided at an annual meeting of all leading research and extension personnel. This brought some communication among research disciplines and between researchers and high-level extension staff, but became unwieldy as the research system grew. The annual meeting of all researchers was recently abandoned, and now the work programs in many projects seem to be decided by the project coordinator, following consultation with colleagues and with some ADD headquarters-level extension staff. Both cotton and tobacco researchers still use annual meetings with extension staff and others to help set their research agendas. (See Linkages.)

Some projects appear to be the work of one scientist, but others involve several. When several scientists are involved, much of the project work is done at the station where the coordinator is resident, then potential technologies are tested by placing trials in other ecologically appropriate stations. Much of the research done at the smaller stations conforms to directives of national coordinators based at the three main stations. The collective workload at the smaller stations could be better coordinated and may exceed their capacity. District trials are conducted on farms in target areas to evaluate performance at the farm level and to demonstrate the technology to both extension staff and farmers, but many on-farm trials are excessively complex for such relatively uncontrolled conditions, and produce little or no usable information. Further, careful solicitation of farmer views, usually a major objective of on-farm trials, is seldom done. (See Linkages, especially Links with ADD Personnel and Farmers.)

Funding of Research in MOA

Expenditures for agricultural research occur under revenue and development accounts. Table 1 shows expenditures under both accounts for the past several years, and identifies the portion of the revenue account

Table 1. Expenditures for agricultural research, 1976 to 1981 (MK000).

Year	1976	1977	1978	1979[a]	1980[a]	1981[a]
Development	562	542	1120	533	2262[b]	1100
Revenue	1016	1081	1350	1657	1875	2060
(Salaries and wages)	(357)	(406)	(657)	(670)	(741)	(829)
(Non-established staff)	(104)	(175)	(229)	(258)	(295)	(303)

[a]Revised estimates.
[b]Includes about K1.7 million for USAID project.

The revenue budgets show apparent real increases over previous years in 1978 and 1979. Other years show little, if any, increase over inflation in revenue accounts.

Staff and operating budgets (1981) at the MOA stations are shown in Table 2.

Table 2. Location, operating budget, and staff of MOA research stations, 1981.

Research Station	Location (ADD)	Operating Budget (excluding salaries) (MK)	Professional Officers (graduates) (MK)	Technical Officers (TO, STO, CTO)	Technical Assistants (TA, STA)
Bvumbwe	Blantyre	131,500	21 (15)[a]	20	43
Chitedze	Lilongwe	180,700	28 (25)	23	46
Makoka	Liwonde	117,900	11	6	37
Baka	Karonga	48,350	1	2	10
Chitala	Salima	38,040	–	2	12
Kasinthula	Ngabu	89,200	4	3	10
Lifuwu	Salima	64,340	2	1	8
Lunyangwa	Mzuzu	56,725	2 (1)	4	9
Mbawa	Mzuzu	46,380	–	5	9
Makhanga	Ngabu	56,525	–	1	8
Ngabu	Ngabu	67,900	3	2	4

[a]Figures in parentheses show persons in place; some are on study leave and some positions are unfilled.

It is noteworthy that although the three larger stations have some 80% of the professional officers, they have just less than half of the operating budget. At the three larger stations there is about K8,400 for operations for each professional officer, but these funds also cover many costs that are usually considered institutional overheads. Information on expenditures for research on specific commodities or services is not readily available since budgets are associated with stations, not programs or services. (See Management.)

Research at Bunda and Chancellor Colleges

Within the University of Malawi, both Bunda and Chancellor Colleges do research to support agricultural development. In consultation with MOA, Bunda College has responsibility for leading the national research efforts for beans and pigs. Research policy at Bunda College is described in Annex D. Both colleges receive support from the University Research and Publications Committee, which provides modest support for staff research projects. A number of these projects are related to agriculture, and Bunda receives about half of the total university research budget. The amounts involved are normally small, less than K3,000 per staff member participating in a project. The total two-year university research budget was only K55,000 in 1979/80, which covered publication as well as research costs.

In addition to funds from the university, some college staff receive research support from outside sources. The United States Agency for International Development (USAID) supports the Bunda College bean research program, and the United Nations Education, Science and Culture Organization (UNESCO) supports a study of structural changes in the Malawian economy by the Centre for Social Research at Chancellor College. Some college staff have received support from such organizations as the National Bank to carry out special studies related to agriculture. Some support "in kind" is provided by MOA in the form of labor and supplies for trials on farmer fields and at MOA research stations in which Bunda College staff participate.

Bunda College has some 1800 ha of farmland that is used for teaching, demonstration, research, and commercial production. About 475 ha are in forest, some 500 are tilled, and 150 are in pastures. They have nearly 400 beef and 200 dairy cattle, 250 sheep, 250 pigs, and a few thousand hybrid broilers and layers.

A staff member at Bunda College leads the national research program on beans. Other major research subjects at Bunda include farm equipment evaluation and development, nutritive evaluation of livestock feeds, comparison of livestock management systems, comparison of extension methods, costs and returns to oxen and man as a power source, and crop drying and storage.

Chancellor College staff in the departments of biology, chemistry, economics, and geography, and in the Centre for Social Science Research do some research that supports agricultural development. A portion of their research is funded by the university, but often staff members use their personal resources. A few small research grants are received from external agencies. Several research activities pursue fairly basic information, but many also address topics that form components of

agricultural technology problems. Chancellor has not yet planned a postgraduate program, but the honors program in chemistry may offer some opportunity for student involvement in research. (See Links with Bunda and Chancellor Colleges.)

The Commodity Associations

The Tobacco Research Authority (TRA) is developing a new research facility near Lilongwe and has a station at Mwimba. Needed laboratories, and processing and field research facilities are being developed. Supported by a tax on auctioned tobacco, TRA expects to have sufficient resources to do the needed production and farm-processing research. Historically, tobacco production in Malawi was strongly linked to Southern Rhodesia for technical and other support, and technical cooperation with Zimbabwe continues. TRA's research emphasis is on breeding and agronomy, but there is some work on fuel efficiency during processing and on fuelwood agronomy. The present scientific staff includes three expatriates (agronomy, breeding, engineering). TRA provides two extension officers to train Department of Agricultural Development extension personnel. There is also some reliance on commercial input suppliers for extension advice.

Malawi has the oldest established tea industry in Africa and achieves high yields. The industry does its own research through the Tea Research Foundation, which enjoys a high scientific reputation. The tea research station is located at Mulanje. Scheduling difficulties prevented any members of the ISNAR team visiting the tea research station.

Apart from testing improved cultivars there seems to be little research on sugarcane. The sugar industry maintains close links with the Mount Edgecombe Sugar Research Station in Natal and receives new varietal material through MOA plant quarantine procedures. The industry employs a plant pathologist/agronomist. (See Research for the Estate Sector.)

Policy and Price Research

There seems to be little research or economic and social analysis designed to help the government set agricultural policies and prices. The Planning Division of MOA helps plan development projects, which involves some related social, technical, and economic analysis. The Economic Planning Division (EPD) of the Office of the President reviews project proposals for economic feasibility, budgetary implications, and conformance with government policy, but has not yet developed a research capacity to support policy and price decisions. (See Links with Policy- and Price-formers.) (For more discussion of policy and planning see Annex F.)

Scientific Personnel Resources

MOA research personnel serve within the Malawi Civil Service. Most scientists are recruited into research after receiving a Bachelor of Science degree in agriculture. Some are recent graduates from Bunda College; others received training while DAR employees and, upon graduation, were re-appointed as professional officers. A few scientists

have received training to the M.Sc. and Ph.D. levels. A current project with the University of Florida will have 25 scientists receiving training to the M.Sc. and 8 to the Ph.D. levels in several U.S. universities over the five-year period of the project.

Once recruited, most scientists stay in the same salary scale and within a particular grade, indefinitely. Promotion posts available to professional officers are limited to 15 in the P8, 4 in the P7, 2 in the P6, and 1 in the P5 scale. The P8 scale is the level of program leaders, and the P7 of major station directors. Two assistant CAROs are at P6, and the CARO at P5. The promotion posts do not have specific job and essential experience descriptions. Selection is by the Public Service Commission, mostly on the basis of written and oral examination, and with emphasis on knowledge of administrative procedures.

According to a draft paper by Dr. J.H.A. Maida[7] the Malawi research system at the time of independence had 23 researchers. While 21 of them were expatriates, they included only one Ph.D. and one M.Sc. Malawi's research system thus began with a staff composed largely of expatriates, few of whom were adequately trained for a career in modern agricultural research. Since independence, Malawi has largely replaced the expatriates with Malawians, and about one-third of the present researchers will soon have a master's degree. Table 2 lists the numbers of scientists and supporting staff in the MOA stations. The changes in the research staff over time are shown in Table 3.

The approximate pool of scientists employed on the Bunda College teaching staff is listed in Table 4. The discipline mix is not represented, since most departments include staff from several disciplines.

Table 4 numbers include several who are on study leave; 14 are expatriates. The number of Malawians with advanced degrees will increase as people return from study leave, but the number of expatriates will likely decrease.

Table 5 presents an approximate distribution of MOA scientists by disciplines, derived from recent station reports.

The pool of scientists at the MOA stations includes about 55 B.Sc.s, 10 M.Sc.s, and 10 Ph.D.s (6 of whom are expatriates). Malawian Ph.D.s include two in soil science (both in charge of major stations), and one each in agronomy and nematology. Many B.Sc.s have had quite similar training, so indicating that the disciplines they seem to be working in have significance only for those who have gained substantial expertise through work experience. Many of those assigned to crop agronomy in Table 5 are also doing plant selection, and thus also work as plant breeders.

Staff assignments among programs are not easy to usefully aggregate across MOA stations, but Table 6 reflects an attempt to do so.

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[7]Maida, J.H.A., 1982. Development and administration of agricultural research and its contribution to agricultural development in Malawi. Mimeographed, 26 pp.

Table 3. Numbers of researchers in Malawi, 1964 to 1980. (Adapted from Maida, 1982)

Year	Superscale		Professional Officers		Technical Officers		Technical Assistants	Total
	E[a]	M	E	M	E	M		
1964/65	4	0	17	2	13	11	124	169
1965/66	4	0	14	5	10	14	77	122
1966/67	4	0	15	6	10	14	82	131
1967/68	4	0	15	6	11	16	82	134
1968/69	4	1	18	9	5	19	119	175
1969/70	3	2	18	9(1)[b]	1	24	119	176
1970/71	7	2	17	9(1)	1	29	120	185
1971/72	7	3	17	11(2)	0	30	120	188
1972/73	6	4	14	14(1)	0	38	124	200
1973/74	5	5	2	18(1)	1	37	124	193
1974/75	2	8	11	27(3)	1	37	126	200
1975/76	2	8	8	34(2)	1	47	134	220
1976/77	2	13	7	36(2)	0	55	191	304
1977/78	1	17	6	41(4)	0	73	202	340
1978/79	1	22	5	48(1)	0	84	202	360
1979/80	0	22	1	50(1)	0	84	204	361
1980/81	1	22	2	50(4)	0	85	206	366

[a]E indicates expatriate; M indicates Malawian.
[b]numbers in parentheses indicate resignations.

Table 4. Bunda College staff by department and training.

Department	B.Sc.	M.Sc.	Ph.D.
Agricultural Engineering	3	3 (1E)[a]	1 (1E)
Crop Production	3	4 (1E)	4 (3E)
Livestock Production	2	4 (1E)	6 (2E)
Rural Development	1	4 (2E)	3 (3E)

[a](E) indicates number of expatriates included.

Those listed in disciplines in Table 6 appear to be doing disciplinary research or service. Excluding those absent for training, soil science and agronomy combined get some seven SMY (scientist man-years), as does entomology, while plant pathology has three. Farming systems plus economics has four SMY. Cotton gets about 10 SMY, maize 4, and groundnuts 4. The major crops also get fractions of SMY from personnel

Table 5. Approximate distribution of MOA scientists by discipline and training, April 1982.

Discipline	B.Sc.	M.Sc.	Ph.D.
Soil Science	3	2	2
Soil Microbiology		1	
Crop Agronomy	25(E)[a]	3(E)	2(E)
Plant Breeding	7	1	1(E)
Entomology	6	2	
Plant Pathology	4	1	1
Plant Physiology			1(E)
Seed Technology		1	
Farm Machinery	3(E)		
Animal Science	2		1(E)
Farming Systems	1		1(E)
Economics	2		1(E)
Statistics	2		

[a](E) indicates an expatriate included within that number.

at the minor stations. Many important crops get one or less SMY. Collectively, maize, beans, and groundnuts, the three crops of great importance to smallholders, probably have about 10 of the available 70 or 75 SMY. (See Developing National Coordinated Programs, and Research Budgets and Activity Descriptions.)

Linkages

Formal linkages between researchers and extension staff to convey results are made through extension circulars, handbooks, and meetings. Some 65 extension circulars and handbooks on various crops and advocated husbandry practices are available to extension personnel and farmers. Each month extension distributes a total of about 3000 copies of circulars. Technical information in circulars is reviewed by DAR before publication. Additional contacts from extension to farmers include on-farm visits, radio programs, puppet shows, and farmer training at residential and day-training centers. Most extension efforts are directed to groups of farmers. Numbers of extension workers and extension activities are considerably higher within NRDP-funded-project areas than outside such areas.

Research-extension linkages to affect research program content have been primarily through an annual meeting of leading researchers and extension staff. Recent research results were discussed, and extension leaders commented on technology performance and production problems at the farm level. This annual meeting was recently stopped because the size of the group became too large for effective communication. (See Links with Extension.)

Table 6. Approximate research officer assignments at the three major stations, April 1982.

Assigned Area	Bvumbwe	Chitedze	Makoka
Soil Science	4.5 (1)*	2.5	
Agronomy	1		
Plant Protection	2 (1)	2	
Entomology	3		
Armyworm			1
Plant Pathology	2 (1)		
Nematology	2		
Seed Technology		1	
Post Harvest	1		
Crop Storage	2 (2)		
Produce Inspection	1		
Farm Machinery		3(E)	
Pastures		3(1)(E)	
Livestock		4(1)(E)	
Farming Systems		2(E)	
Economics		3(1)(E)	
Horticulture	1 (E)		
Potatoes	1 (1)		
Tree Nuts	1		
Coffee	1		
Cotton Breeding			3
Cotton Agronomy			2
Cotton Entomology			2.5
Maize Breeding		4(1)(E)	
Maize Agronomy		1(1)	
Groundnut Breeding		2(1)	
Groundnut Pathology		2	
Groundnut Agronomy		1	
Groundnut Microbiology		1(1)	
Groundnut Physiology		0.5(E)	
Grain Legumes		1	0.5
Biometrics			2
Misc. Crops	1	1	

*Numbers in parentheses indicate persons on training leave. An "(E)" indicates an expatriate assigned.

Informal linkages affecting research program content include on-farm trials, and a wide variety of such trials are done by researchers in some of the smaller stations. Other informal communications occur through consultations between research program leaders and ADD headquarters personnel. Linkages for cotton technology include on-farm trials and training of extension staff in new technology at the research station. Cotton researchers review their results and planned program annually at a meeting with extension staff and other development leaders. They also

maintain contact with cotton ginners and commercial input suppliers. The Tobacco Research Authority uses a similar approach to develop its research agenda.

Linkages between researchers and ADD personnel have been a special concern. MOA has recently designated one research station as having responsibility for each ADD (although some changes and upgrading of stations is still required to implement this), and has proposed having a single research officer assigned to each ADD headquarters. Some research programs have been planned following consultation between research coordinators and ADD headquarters personnel, and ADD personnel have participated in meetings to bring their perceptions of the performance of technologies to research evaluation and planning.

The Ngabu ADD is unique in having four research officers in a research station on the same site as the ADD headquarters, which brings frequent contacts among researchers, extension staff, and farmers. These researchers have nearly daily contact with extension staff both at ADD headquarters and in the ADD area. On-farm tests in the Ngabu ADD involve farmers, extensionists, and researchers. The researchers also do experiments under the usual controlled conditions, both as part of national research programs and for the Ngabu ADD. (See Links with Clients, and Links with ADD Personnel and Farmers.)

Linkages between researchers and policy-makers seem mostly limited to the formal routes through the CARO and Principal Secretary to the Planning Division of MOA, and the Economic Planning Division (EPD) of the Office of the President. No senior research personnel seem to be involved regularly in national level meetings to set agricultural development policy. One or two draft research papers written by Chancellor College staff were seen that were relevant for agricultural policy-makers, but a mechanism to get them to policy-makers was not evident. Some current research at Chitedze on smallholder economic and social characteristics will likely also be relevant, but heretofore, researchers apparently did not often consider policy-makers as clients. (See Links with Policy- and Price-formers.)

Linkages among researchers within stations are usually through the station director, except for commodity programs that have a team of scientists assigned, wherein communication is through the coordinator. Communications among stations occurs through the CARO, but informal communications were also evident in some cases, especially between Bunda College and Chitedze researchers. The CARO plays a key role in communications among stations. Links between Chancellor College and MOA researchers however, were generally not well developed.

Linkages with external institutions are developed between the TRA and the tobacco research program in Zimbabwe, and sugarcane varieties are introduced from the Mount Edgecombe station in Natal. The bean, maize, groundnut, and sorghum research programs have recently developed linkages with the relevant international centers (CIAT, CIMMYT, and ICRISAT), and have become part of the associated global research networks. The cooperative relationship with the University of Florida has brought effective links with that university in several areas, and promises access to the broader research community in the United States. Resident expatriate personnel and development assistance programs provide valuable links with the research community in the United Kingdom.

Chapter 4

Improving the Research System

The critical role of a flow of improved technology in sustained agricultural development has been widely recognized. In 1966, Art Mosher[a], writing in "Getting Agriculture Moving," named five facilities and services that must be available to farmers for sustained improvement of agriculture. These were:

* a local source of supplies and equipment for the farmer;
* a market for the farmer's products;
* a transport system to serve the rural areas;
* an incentive for the farmer to produce more;
* a flow of improved technology to the farmer.

These factors can be stated in various ways, but all will be needed if agriculture in Malawi is to develop.

Agricultural research and the technology that flows from it have two critical roles in providing the factors essential for sustained agricultural production. First, economic analysis and other economic and social research provide important inputs for the formulation of government policies that control the political and economic environment within which agricultural production takes place. Secondly, a sustained flow of improved production technology to the farmer increases the productivity of the farmer's land, labor, or capital, and forms the engine that powers sustained agricultural development. No country can expect to sustain agricultural development without assuring the availability of all the essential factors, and the national agricultural technology system is a key resource. (A national technology system must also assure that the human resources needed to sustain the system are available and productive; hence its intimate association with the nation's educational system.)

Developing Indigenous Capability

While Malawi has much to gain from imported knowledge and materials and must exploit those resources fully (see section on linkages), most of Malawi's problems and opportunities can only be addressed under Malawi conditions. Most imported technology will not be directly usable but will need to be molded to fit local conditions. All imported technology

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[a]Mosher, A.T. 1966. Getting Agriculture Moving. New York: Praeger.

will need to be adequately tested on experiment stations and under farmer conditions. The molding of technology components to fit local conditions will require much of the same resources as does the development of technology itself, that is, an effective agricultural research and extension system. External resources can make an effective research system much more efficient, but they cannot substitute for an effective national research capability.

Investing in Technology

In 1980 the Malawi government spent K363 million: K188 million on recurrent and K175 million on development accounts. For agriculture plus veterinary services the development account was K18.6 million, 11%, while transportation got 38%. Within agriculture, expenditure (development plus recurrent) on research was about K2.4 million (excluding tobacco and tea and the new University of Florida project), while the National Rural Development Program (NRDP) expenditure was about K20 million. (Not all the NRDP expenditure can be considered as extension in the usual sense. A recent review of NRDP suggests a cost of K4000 per year per extension field-worker, so the present expenditure on extension may be about K6 million.) The expenditure on agricultural research was thus only 0.19% of the GDP, or 0.45% of the agricultural component of the GDP. If Malawi wants to maintain growth in agriculture and to increase productivity of its smallholders it will have to invest considerably more in agricultural research.

Returns on public sector investments in agricultural research have been very high in comparison to other public sector investments. Recent studies of public sector investments in agricultural research (using regression analysis) have indicated internal rates of return of 40% and 63% in India (aggregate) and 75% in the Philippines (rice only). Several studies in both developing and developed countries show rates of return of around 40% to 50% (see Ruttan[9]). Few alternative public sector investments show such high rates of return.

Returns on past investments can serve to guide governments on appropriate levels of investment. (Methods for estimating returns prior to a specific research investment have not been considered very useful, owing to the nature of research. See Ruttan[9], for a recent summary of studies on returns to research investment.) Malawi yields are low, and yield-increasing technology that can be adapted to Malawi's needs likely exists for several major crops. Investments in well-planned, problem-solving research in Malawi should give high returns in the fairly near term, in comparison to alternative public sector investments. Priority research investments should provide resources (including capital, operating costs, and trained personnel) for comprehensive research programs on the major smallholder farm enterprises. Experiences of other nations indicate that Malawi should not hesitate to increase markedly its investment in agricultural research.

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[9]Ruttan, Vernon W. 1982. Agricultural Research Policy. Minneapolis: University of Minnesota Press.

Recommendation: Assuming the present research resources are used more efficiently (see later), the team has every confidence in recommending that Malawi increase its support for agricultural research as rapidly as that support can be effectively absorbed, to a level of at least 1% of the agricultural GDP. The rate of increase of investment should be limited only by the effective absorptive capacity of an efficiently operating research system. As the research system becomes more productive and the technology used by farmers becomes more complex, the investment level should move toward 2%.

Institutions and Programs

While Malawi has 11 research stations, only 2 major stations, Bvumbwe and Chitedze, have enough scientists and funds to implement comprehensive research efforts involving scientists in several disciplines, in more than one program area. Three others approach adequacy for one program each, while the rest are, in effect, testing sites at which work is done in response to national program leaders, most of whom are resident at the main stations.

Persuasive arguments can be made that a decentralized research system is more responsive to local clients than a highly centralized system, but the argument for a decentralized system assumes that each unit of the system has sufficient resources to allow it to be productive. The available manpower, physical resources, and operating funds at all 11 stations deserve indepth analysis to determine whether the present staff and the available physical and monetary resources can reasonably be expected to produce the information expected from them.

Livestock management research needs to be closely associated with crop and soil management research, but much of the breeding, nutrition, disease, and physiological research for large livestock requires specialized facilities and can tolerate relatively weaker linkages with crops research. Chitedze does some research on animal husbandry, nutrition, breeding, and forage management. Bvumbwe has a herd of cattle for milk and beef production. It does not use them for research but does some forage cutting trials. Malawi may need a main research station that focuses on animal production. If so, Mbawa might be developed as the main national animal production research station and be responsible for research on pastures, fodder, hay, and silage. Responsibility to develop better smallholder cattle production practices would then rest with the professional officers in animal husbandry under the CARO. In each research activity the disease and health control practices would need to be directed by the professional officers in the veterinary department under the CVO.

There is little current research on poultry. Since chickens are efficient converters of feed to meat and eggs, and can add to household incomes with small investments, research on poultry production by smallholders may deserve a higher priority for MOA support. Research objectives should relate to how smallholder income can be increased by improved poultry breeding, nutrition, and management. Smallholder opportunities, attitudes, and interests in poultry production will likely need investigation. Poultry research to serve smallholders may offer opportunity for cooperative research between Bunda College and the private sector hatcheries.

A Planned Network of Stations

The present network of stations resulted from responses to a series of perceived needs or opportunities over a prolonged period. Individually, each station filled a need, but collectively they do not efficiently fill Malawi's present needs. As a result of this growth process (which is quite common), some agroclimatic zones seem to be inadequately served by stations, while other zones may contain a station that is no longer needed. Supplies, equipment, and operating funds seemed to be needed at every station, an indication that too few resources are being spread over too many locations. Most stations need substantially more professional and supporting personnel and physical resources if they are to do the work expected of them. The spreading of meager resources across an inefficient network of stations exacerbates the effects of inadequate resources. Some specific issues in relation to several stations and programs are noted in Annex C.

With the development of NRDP, the training of research personnel under the USAID project, and the interest of international agencies in national research systems, the time is appropriate for Malawi to do a comprehensive analysis that will lead to the planned development of a network of experiment stations that are properly located, adequately equipped and staffed, and provided with the needed operating funds. Each station in such a network should have specific roles, and the several functions of each station could be phased in over time. Some stations should be planned as major research centers, others as substations or testing sites.

The analysis should begin with consideration of physical and biological factors, and continue to include political and economic factors, including present and future manpower availability and assumed growth of agriculture. The needed soil, topography, climate, crop, and vegetation information seems largely available. Persons having the talents needed to do the analysis are available in Malawi, but they would have to allocate a substantial block of their time to the work. One or two outsiders having complementary talents might help insure that personal circumstances were not compromising recommendations. Before such an analysis begins, those involved need a clear understanding of Malawi's agricultural development goals and what MOA expects from its research system.

> Recommendation: MOA should do an analysis that will lead to a plan for the phased development of a network of research stations that will efficiently serve Malawi's agriculture, including livestock.

Research for the Estate Sector

Generally, Malawi seems able to rely on the commodity associations for technology to serve the estates. Tea and sugarcane are likely to remain largely estate crops. When grown in continuous blocks, production problems of sugarcane are likely to be similar for smallholders and estates. Tea may have some special production technology (pruning method) for smallholders, but generally, both sugarcane in continuous blocks and tea will use common production technologies whether grown by smallholders or estates.

Tobacco, and the fuelwood for processing it, may have different sets of problems, and different solutions to common problems, for estates and smallholders. TRA is starting a research program that will cover several main components. It will probably have enough resources and can be relied on to serve the estate tobacco growers. As smallholder production of different types of tobacco increases, research on different problems (or different solutions to problems that are common to smallholders and estates) will be needed. While TRA can probably do this research, MOA should assume responsibility for ensuring that smallholder needs are being met. Cooperation between TRA and MOA researchers is established and both the CARO and CADO are involved in the TRA research planning meetings.

Fuelwood for curing tobacco may become a major impediment to tobacco production for both estates and smallholders, and TRA is starting a modest research program on fuelwood use and production. Given the voices heard in the planning of tobacco research, there is little probability that the fuelwood technology needs of the smallholder, to the extent they differ from those of estates, will be met unless MOA and TRA cooperate in this effort. TRA might well continue to lead research on fuelwood, but research to serve any special concerns of the smallholder may have to be funded by MOA. There is also opportunity for MOA cooperation with the Forestry Department on other aspects of agroforestry, including annual and tree species intercropping, forage species, and nutrient cycling. Training in agroforestry concepts for ADD-level foresters may prove quite useful.

While the reliance of estate tobacco growers and TRA on commercial suppliers for some production technology can be efficient, most countries provide government services to monitor such relationships. Such monitoring services seek to ensure that correct use is made of inputs to control pests and diseases or suppress weeds while having regard to other forms of control (e.g., rotation of crops, implementation of closed seasons, integrated pest control), to ensure that products are not affected by dangerous residues, and that safety standards for workers are maintained.

Apart from testing imported cultivars, there seems to be little research on sugarcane. When a crop is new and well managed, it frequently enjoys a few fairly trouble-free years. Malawi can expect sugarcane production problems to develop. The estates will probably take care of their problems, but if smallholders produce small patches of cane (as contrasted with large continuous blocks of cane worked by smallholders) along with other crops, they will develop a different set of problems, or will need different solutions to problems they have in common with estates. Available sugarcane production and processing technologies make it a crop especially suitable for growing in large blocks where planting, disease and insect control, and harvesting can be carefully controlled. Tobacco production and farm-processing techniques make it especially suitable for smallholders. Thus, in contrast to the case in tobacco (wherein many thousands of smallholders can produce and farm-process tobacco as efficiently as can estates), if special smallholder technologies are needed for sugarcane, Malawi should examine the cost effectiveness of developing them. A research program to serve a few thousand smallholders producing a crop having a relatively low gross return may be uneconomical.

Operating Budgets

The overall revenue budget is currently about K28,000 per SMY. About 55% of that covers personnel costs, leaving 45% for all other costs. If that amount were available for usual program operating costs the ratio of personnel to operating costs would be reasonable for Malawi's economy. However, that is not the case. Station utilities, maintenance, and minor building costs (usually considered institutional overhead) may take a third or more. The funds available for casual labor, transportation, minor equipment, and supplies, the immediately critical items for productive field research, may be about K4,000 per SMY at major stations. The inadequacy of operating funds is evidenced by short supplies, worn equipment, and inadequate transport facilities at all major stations.

Program needs, not arbitrary guidelines, should determine operating budgets, but a highly productive research system will require much more funding per scientist than is now available. If a well-planned research effort is to succeed, operating costs per SMY should be expected to increase several-fold. This becomes an important factor in an assistance program, and donors may need to help underwrite program operating costs for a number of years. Within a few years, however, MOA will need to supply adequate operating budgets, and this should have a major influence on the plan for the development of the research system.

Management

Examination of the present research portfolios, staffing, and facilities of the research stations leaves little doubt that two major factors impeding the flow of usable technology from Malawi's research system are the lack of sufficiently trained personnel and program operating funds. These, and related facility needs, are expected to be defined as part of the plan for developing a network of research stations. These needs have overshadowed opportunities for improving the productivity of presently available research resources. While attention should be directed to training personnel and acquiring more adequate operating funds and facilities, substantial improvements can also be achieved by better managing the present resources, and better management is conducive to getting more resources.

Developing National Coordinated Programs

National coordinated commodity (or resource) programs shift attention from research by disciplines to research to solve problems or exploit opportunities, which usually requires timely contributions by scientists in several disciplines. Several nations having scarce research resources have made them more productive by focusing them on a few carefully selected farm enterprises, using the national coordinated program approach. Enterprises, usually commodities, are selected not only on the basis of their importance, but also of the perceived opportunity for quickly producing usable improved technology and getting it adopted. For each chosen enterprise, the important problems or opportunities are examined within their on-farm and marketing context for each agroclimatic zone. Pieces of expected usable technology are identified and a concerted effort made to produce them. Such efforts usually require

cooperative work by scientists in several disciplines and in several locations.

Successful national coordinated programs have been characterized by collegial decisions on what was to be included in the program. These decisions are developed at an annual workshop, wherein results are reviewed and work planned for the following year. The resources needed to implement the work at each station are carefully noted and provided, either through the station or program budget. Other characteristics of successful approaches to national coordinated programs including focus, involvement of needed disciplines, role of coordinator, and working relationships, are described in a recent article by Bill Wright (see Annex G). These principles will guide Malawi researchers as they seek to make their research system more productive.

Although Malawi has several "coordinated projects," some of the current national projects seem to be more dictated than coordinated by the national coordinator. Others seem to represent the work of a single scientist. Much of the work at the smaller stations apparently conforms to directives of national coordinators, and the "cooperating" scientists may have little voice in deciding what is included in the research program. The concept of a team of researchers of various disciplines sharing a set of common objectives and collectively planning, implementing, and evaluating a research program to achieve the stated objectives is largely lacking and needs to be developed. Transport constraints have largely prevented the frequent visits needed to facilitate the work of a national coordinator, and scarcity of adequately trained personnel has inhibited the development of teams of researchers.

Many research personnel now perform services, do research in a discipline, or have sole responsibility for a crop, reflecting the perceived need to cover many subjects and services with very few staff. The maize project at Chitedze however, has an agronomist working with three breeders and claims some part of an entomologist's time. The groundnut project includes professionals from four major disciplines. The pasture project at Chitedze and the bean project at Bunda also involve more than one discipline. Malawi thus has established working conventions that lead easily to the adoption of the national coordinated commodity program as a working mode. Maize, beans, sorghum, groundnuts, and cotton would seem priority commodities, and the researchers have some experiences that will facilitate development of national coordinated programs in these commodities. Others can be developed as experience is gained and additional resources become available.

> Recommendation: We recommend that national coordinated commodity research programs be developed in the major smallholder enterprises and that the needed resources for their efficient implementation be made available to the program cooperators.

Managing Program Components

Recent reports of results of research at each station reveal some weaknesses that can be partially alleviated by changing management procedures. To overcome these weaknesses there is need to:

* have a more explicit statement of the rationale for the research (or service) effort;

* state more clearly attainable and quantified objectives;

* assure that all important performance characteristics are to be measured;

* describe accurately the personnel and other resources required to do the work.

The rationale for specific research seems often assumed, rather than stated. Presenting a concise rationale for a research activity will help researchers consider the effects of the expected technological change in the circumstances of their clients, thus placing their research in a larger context. It also encourages consideration of what research has been done on the topic, both within and outside Malawi, assuming resources are available for a reasonable literature review.

Precise or achievable objectives seem to be missing in several projects, and it would seem impossible for managers to know when the objectives were achieved or to judge progress toward them. Objectives need to be defined so they are achievable and progress toward them measurable, such as a percentage change in performance characteristics in comparison to a control, with other desirable characteristics at least equal to the control.

A single performance characteristic, usually yield, is used in many projects, and other characteristics that are important to the intended user are excluded. Use of a single characteristic (i.e., field yield) for selecting materials for further testing while ignoring other characteristics important to the technology client (i.e., processing yield, pest resistance) leads researchers to produce technology that clients reject. This may result from insufficient awareness of the problems, circumstances, and needs of the clients (and steps may be needed to relieve that insufficiency), but if management challenges scientists on evaluation criteria, it will encourage them to use and develop their collective awareness of client circumstances. At the appropriate time, research programs need to include on-farm technology tests that measure important performance characteristics and elicit client response. The ADD research units will make major contributions to research plans by supplying technical insight into client farmer responses. Researchers and managers will be less likely to use inappropriate criteria and misinterpret results when evaluation criteria and the statistical procedures to be used are clearly stated in the research plan.

Research budgets are now related to stations, not activities, and recent increases in station budgets seem fairly uniform. Allowing stations to control their expenditures reflects sound management in that it facilitates timely availability of operating funds, and this practice should be continued. However, station budgets should be identified with specific research and service activities, not just with departments. Development of budgets that identify resource use with specific research activities will encourage both annual reviews of progress of each research activity and changes in methodology when an approach is not productive. Budgets will show clearly how resources are being used, and

force all concerned to consider what activities are to be decreased if another is to be increased or a new one added without additional resources.

Research activity descriptions that concisely state the context and rationale for the work, progress to date, approach to be used, evaluation criteria, statistical procedures, and resources (manpower, facilities, funds) needed would greatly facilitate program and budget decisions, both within and among stations. (A national coordinated commodity program consists of a set of activities.) Such descriptions could be used for research, service, and management functions. They show direct relationships between problems to be solved, opportunities to be exploited, or services to be performed, and the resources needed to do the work. Such procedures have been used for many years in the United States Department of Agriculture to both facilitate resource allocation decisions and to know what work is being done in a large research system. A somewhat similar procedure is being used by the Tobacco Research Authority. The principles could be used in Malawi for both resource allocation decisions and for information retrieval. A range of available mechanical or electronic sorting techniques could then facilitate information retrieval.

Introducing research activity descriptions usually requires some instruction. One way to introduce research activity descriptions would be for the CARO to organize a workshop for research program leaders and officers in charge of stations. In the workshop they could develop the principles of accurate activity descriptions, then do a few descriptions of actual activities, reviewing and improving them in small working groups. (If the descriptions are not both accurate and concise they are not useful.) The research activities forming two or three national coordinated commodity programs could be developed as examples.

Resistance of scientists and research managers to the discipline of accurately defining what they intend to do, why it should be done, and what resources will be needed, should not be underestimated. The principles are more easily used in research to produce technology than in basic research, but that limitation is less important if formal cost-benefit analysis is foregone. The interdependence of people in various disciplines and institutions characteristic of national coordinated programs adds complexity, but such a program consists of a set of related activities, each of which is expected to produce usable technology. The concepts and needed discipline are more easily introduced if additional resources needed for the coordinated program are available to cooperators through their involvement in the program.

Proper use of activity descriptions allows an annual review by researchers and at each level of management of the progress of the work, its continuing priority, and the resources needed to do it. They can reveal inadequate attention to the context of the work, what others have done, the need for additional disciplines in the team for some tasks, insufficient evaluation criteria, inadequate availability or consideration of client response, improper use of statistical procedures, and nonavailability of essential resources. Using these procedures, however, takes considerable time of scientists, program leaders, station managers, and central office managers. As these procedures are adopted and researchers gain facility in their use, both researchers and research managers will identify resources that are being used for low priority

work or for pursuing unattainable objectives. Available resources can then be redirected to higher priority work.

> Recommendation: Malawi should develop research activity description procedures that will provide sufficient detail to relate budget and other resources to specific research activities, and that will facilitate resource allocation decisions and information retrieval.

Decisions on Allocations in DAR

A recent proposal for restructuring DAR calls for establishing an agricultural research committee chaired by the CARO, and consisting of the principal agricultural research officers from DAR headquarters, the officers in charge of the three large research stations (Chitedze, Bvumbwe, and Makoka), the chief agricultural development officer, and the secretary of the National Research Council. Additional officers would be co-opted. The duties of the committee would be:

* to approve and appraise all agricultural research programs and output in the light of available human, material, and financial resources;

* to allocate the Department of Research funds to approved programs;

* to form appropriate subcommittees to give effective control of specialized research activities and publication of extension and technical documents.

Decisions on the content, approach, and relative priority of research programs need to be made with the best information available. Leading researchers have the essential technical understanding and thus need to be involved in discussing research programs. The proposed committee could form a top-level group for the review and suggested redirection of major research programs, and could help assure a more collegial approach had been used in decisions on the content of and approaches used in national coordinated programs. When proposed budgets are directly linked to defined programs however, decisions on programs are also decisions on allocations among stations. Under such conditions it is probably unrealistic to assume that each station director will endorse program cuts in his station and shifts of resources to other stations. Reductions in budgets tend to be uniform among stations in such circumstances, and critical decisions on priorities are not made. As Malawi concentrates more of its resources on a few well-defined national coordinated programs and uses activity descriptions to review progress of the component research activities, decisions on priorities among programs and among activities will be easier, more obvious, and more effective. While the presentations and views of the nation's senior researchers ought to provide valuable guidance, the final decisions on resource allocations among stations can effectively reflect shifts in priorities only when they are made by DAR headquarters staff. In turn, station directors can function more effectively when they have reasonable flexibility to shift funds among programs.

> Recommendation: The team recommends that, after consulting with appropriate persons, the DAR headquarters staff led by the CARO, take responsibility for allocating resources among programs and

stations. The agricultural research committee should be developed as a forum for discussion of research organization, programs, approaches, and priorities, and to bring major national research issues to the attention of those in government and other organizations who affect the agricultural research environment.

Linkages

Links with International Centers

Malawi need not rely on only its own resources to produce the needed flow of technology to allow its smallholders to be more productive. There are few opportunities for importing technology and using it without change, but the international agricultural research centers (IARCs) and other external research institutions (in both developing and developed countries) are valuable sources of component materials that can be adapted to Malawi conditions. Such resources can significantly shorten the time needed to provide technology for Malawi. By cooperating with IARCs, Malawi researchers become important members of global research networks and supply information of value to many developing countries.

The bean, maize, groundnut, sorghum, and cassava researchers are developing valuable working relationships with CIAT, CIMMYT, ICRISAT, IITA, and other institutions. In some instances, however, the resources of external institutions are not being fully exploited by Malawi.

Productive working relationships with international centers and with other nations require resources. Time and travel funds must be available for Malawi research leaders to visit international centers to gain knowledge of the total program and to establish the personal contacts that facilitate highly interactive and productive working relationships. Other researchers will need to be given extended training at outside research centers. Training, much of it in practical research methodologies, forms a large part of the program at each IARC. While this training is not inexpensive, the enhanced productivity of researchers following such practical training indicates it is an excellent use of both funds and researcher time. Outside researchers can also be encouraged to visit Malawi to facilitate communication and development of cooperative working relationships.

> Recommendation: Considering the advantages to be gained from fully exploiting information and materials from external sources, we recommend that researchers responsible for major research programs take needed action to ensure their familiarity with related work of institutions outside Malawi and to systematically exploit those resources. We recommend that budget provision be made for the needed visits by Malawi researchers to outside institutions and for the practical research training available at those institutions.

Links with Clients

The clients of agricultural research in Malawi include farmers, traders, processors, and government policy-makers. The farmer clients within an agroclimatic zone also form several groups that have varying

circumstances affecting what technology they can use. Some research project objectives, trial evaluation criteria, and discussions with researchers and extension staff indicate that researchers often focus their attention on the production of a commodity and give little consideration to either the various groups of clients they serve or the specific and varying needs of those groups.

Researchers can usually produce usable improved technology when they have an intimate, comprehensive understanding of the conditions under which the technology is to be used. This requires an understanding of not only the physical, chemical, and biological environment, but of the social and economic environment as well. When researchers have grown up in the immediate environment of their clients, they may have absorbed a sufficient awareness of the important social and economic environment, but in most cases special efforts will have to be made to continue to acquire that awareness.

Usually, the circumstances affecting the decisions of their various groups of clients can be understood by researchers only through their extensive interactions with a representative sample of each of the client groups. Further, these interactions, to be efficient, need to be adequately structured. In the last few years, a substantial body of experience in structuring such interactions between researchers and smallholder farmers has been developed. Some have termed this "farming systems research," but the term has been used to indicate so many different kinds of research that it does not convey a specific concept. What is needed is a set of activities by researchers and extension staff that: (a) efficiently brings to researchers an understanding of their clients' circumstances so they can produce needed and usable technology, and (b) trains the extension staff in the application of the new technology and in interpretation of client response to proffered technology.

Links with Extension

Malawi recognizes the need for closer working relationships among researchers, extension staff, and farmers if a flow of improved technology is to be developed and used by smallholders. The current on-farm trials, the proposal to station one researcher in each ADD, the designation of a research station as responsible for each ADD, and the placement of several research officers in the Ngabu ADD are all evidence of Malawi's concern.

Working relationships that bring researchers, extension staff, and client farmers into direct contact are generally much more efficient than formal communication channels in identifying client needs and sustaining a strong two-way information flow. Visits to farms, on-farm trials, demonstrations, constraints research, and consideration of economic and social aspects of technology must be part of this process.

It is important for research and extension leaders to meet to discuss major problems and strategies, but the single annual meeting of all research and extension leaders used in the past has become too large to allow effective communication. An alternative would be to have the research leaders (two or three) for each major farm enterprise spend two or three days at each ADD each year. The ADD hosts could arrange for

visits to local research stations and on-farm trials and similar situations where farm-level problems and conditions for each enterprise could be observed and discussed. The exposure of researchers across enterprises would also heighten their perception of conditions at the farm level.

Training opportunities also provide effective communication between research and extension staff. Other countries having many smallholders (but probably a lower extension-staff-to-farmer ratio), have used annual commodity refresher courses to facilitate effective communication between research and extension staffs. These courses bring the same relationship between research and extension as Malawi had in the case of cotton. They may be useful in "non-NRDP project" areas and for farm enterprises that are not important enough to warrant coverage within the ADD research unit. The courses are described in Annex H.

Links with ADD Personnel and Farmers

Malawi has chosen the NRDP and its components as development modes. The research system needs to mesh its activities with those of the ADDs in ways that will help researchers produce usable improved technology and get it adopted by smallholders. The structuring of physical facilities, operating modes, and programs by the research system must respond to the opportunities presented by the current NRDP activities, but must also reflect the longer-term needs of the research system as the rural development environment evolves.

The team endorses the designation of one research station as having first responsibility for each ADD. We note that there is not a significant research station in each ADD and we assume that the proposed analysis of and resulting plan for Malawi's network of research stations will include consideration of research station links with ADDs. Considering the research system as a whole, some ADDs may be adequately served by a small resident research unit in a substation environment, as the Ngabu ADD is now well served by the Ngabu research unit. Other ADD research units will be part of a major research station (i.e., Chitedze). We note too that designation of responsibility for ADD liasion will not relieve either a major or minor station of its national responsibilities, which would also be considered in the proposed analysis.

Malawi has experience to demonstrate that a well-informed research officer interacting on a limited subject with a group of equally well-informed extension staff can bring usable technology to smallholders, and can effectively communicate farmer responses and problems to their fellow researchers. The cotton program once had this capability in the form of an extension specialist who worked with his fellow researchers and with a group of specialized cotton field assistants stationed in the major cotton-producing areas. Similar approaches have worked in other countries, and the principle of limited specialization to bring the required level of expertise to the extension-research-farmer working relationship needs to be applied.

The proposed assignment of a single research officer to each ADD, who would be responsible for all agricultural technology, would probably not be effective in meshing the research and extension efforts. The extension staff would expect the single research officer to be fully

informed about improved technologies for all farm enterprises. He would not be, and the friction between research and extension would likely be exacerbated rather than lessened. Neither would one research officer be sufficiently informed of farm-level conditions for all farm enterprises to communicate with researchers at the needed technical level. The task of linking researchers, extensionists, and farmers is too complex to be accomplished by one research officer, whether stationed in ADD headquarters or in a designated major research station.

> Recommendation: The team recommends that research units be developed to serve each ADD as rapidly as capable staff and needed facilities can be made available. The level of effort for each ADD should be sufficient to allow needed specialization among researchers. The effort needed to mesh the research system with the ADDs is to be seen as one factor affecting the formation of an overall national research system.

Level of Effort

In most ADDs there are four or more major farm enterprises that need to be considered. The complement of researchers needed in each ADD is one that can be responsive to the major farm enterprises in that ADD. Given the importance of maize, every ADD would need a cereals agronomist. Whether that person could also handle rice or sorghum and millet would depend on the intensity of the work and should not be prejudged. Many ADDs will need a pulse agronomist to handle beans, groundnuts, guar, or pigeon peas, as appropriate. Many ADDs will need one researcher in animal husbandry; several will need a cotton agronomist. Each ADD would need an economist to help organize the surveys and other research to understand clients' circumstances and responses. Most of these will have to be trained, and all the ADD researchers will need on-the-job training for their specialized work.

Function of the Unit

The ADD research units would have two major functions: to test potential improved technology at the ADD and farm level, and to communicate effectively to the larger research community the factors that must be considered by researchers to produce technology that can be used in their area. The ADD researchers would form the major communication linkage among researchers, extension staff, and farmers, at the most informed and potentially most efficient level. The ADD researchers would consider the needs of the farmers in that ADD as their first concern, but they would also recognize that they had significant responsibilities as part of the nationwide research network.

Whether as part of the staff at a main station or at a minor station, the ADD research unit needs to be clearly identifiable. Assigning the ADD responsibility to researchers who already have a full program and who can devote only a small portion of their time to ADD work is not likely to form effective units. Conversely, a group that spent most (say 75%) of their effort on ADD matters could effectively remain an important part of the national research system. While most of their work would be in close collaboration with their extension colleagues, and perhaps much of the funds for their work could be supplied by the ADD, the research personnel would report to the CARO through the appropriate station director.

The ADD research unit staff would do much of their work in farmers' fields in close cooperation with the extension staff, but they would also need some research facilities under their full control and readily accessible to them and to the extension staff. In some ADDs that will pose no problem, but in others additional physical facilities may be needed at a branch station for both on-station and on-farm tests. In all cases, the ADD research unit will need considerable resources at its disposal.

Working Relationships with Extension Staff

The work of the ADD research units would involve them immediately in day-to-day working relationships with extension staff and farmers. A description of the types of work they would do may be useful.

Ideally, the ADD research unit would work with the ADD evaluation unit and extension staff to do surveys to develop understanding of farmer conditions, to identify potential interventions that are expected to increase productivity, and to monitor farmer responses to preferred technology. This requires one or more researchers in the ADD unit who are experienced in this research approach[10]. There are not enough Malawi researchers trained in this technique to use it in all ADDs immediately, but it could be applied in one or two units, and additional researchers could receive on-the-job training in these techniques. The farming systems research unit at Chitedze and the CIMMYT research unit at Nairobi may be able to help in this training. A near-term goal might be to have one researcher in each ADD research unit experienced in this approach to client needs awareness and technology development.

Each ADD researcher would also have a network of simple research trials (2x2s, or 3 or 4 varieties, etc.) on farmers' fields. In most instances these would be key trials at the farm level and form an integral part of a national coordinated commodity program. These are designed to help identify productivity constraints at the farm level; to learn which of two or three technology options do well under local conditions; to learn farmer responses to a proposed technology; to learn how proposed technology performs under various levels of management (including low levels of inputs, or non-optimum planting dates or weed control); or to derive similar information that must be developed on farms. This critical information is fed back into the national coordinated commodity program and helps structure the content and direction of the future research effort.

The level of farmer involvement in these trials should depend on the purpose of the trial, but generally one would want to err on the side of excessive farmer involvement. This is not to suggest that trials should be placed on farmers' fields and forgotten. Farmer perceptions should be carefully solicited and accurately recorded. The primary purpose of many

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[10]See CIMMYT publications entitled:
CIMMYT Economics. CIMMYT Today No. 13. 1981.
Planning Technologies Appropriate to Farmers, Concepts and Procedures. 1980.
From Agronomic Data to Farmer Recommendations. 1976.

on-farm trials is to gather information on how potential technology performs under farm conditions and how it is received by farmers. It is research, not demonstration, and farmers, extension staff and researchers all need to be involved.

The number of on-farm trials done by each ADD research unit will be considerable, and will require substantial resources, especially transport, supplies, small equipment, and supporting personnel.

ADD researchers will also have some trials under experiment station conditions that will need to involve extension staff. Potential technologies must be tested under controlled conditions before they are placed in farmers' fields. Extension staff need to understand these trials and help interpret how the technology needs to be adjusted prior to extensive on-farm trials.

Some on-farm trials should identify the profitability of new management practices under various circumstances of input availabilities (including several levels of purchased inputs and labor), and their acceptance by the farmer before widespread technology demonstrations begin.

All on-farm trials should be developed with the full cooperation of extension staff, but when a new technology appears quite feasible, researchers and extension staff should have joint responsibility for widespread on-farm trials before extension begins demonstrations. These are the final tests for the new technology, and they provide extension staff (field assistants) an opportunity to share responsibility for testing the technology before they have to accept full responsibility for demonstrating it to farmers. On-farm trials become the principal point of interaction between research and extension.

Working with Other Researchers

As part of their responsibilities in the national research system, ADD researchers will be cooperators in some research activities that require controlled conditions. They may be involved in early-generation selection trials that, as part of a national coordinated program, need to be done in a selected series of locations. In some instances they may need to select early-generation materials adapted to their geographic area and feed results back into a breeding program at a main research station. They may need to do complex tests of multiple factors that need to be done in selected locations. Through a national coordinator, they may be cooperating in international tests that are designed to test results across international agroclimatic gradients. If complex nutrient-response experiments are needed, they will have to be done under controlled conditions, but usually on farmer's fields, an added complication. In brief, the ADD researchers will need small areas where they can do complex experiments with a high level of reliability, and they will need the equipment, supplies, and staff support to do such experiments.

Links with Bunda and Chancellor Colleges

Bunda College has a major component of the research talent in Malawi, and staff at both Bunda and Chancellor Colleges are already doing important research. Links between MOA and Bunda are fairly well developed, but

links between MOA and Chancellor do not adequately encourage Chancellor staff to get involved in MOA research.

As Bunda College starts resident postgraduate degree training, it will need to become an even more important component of Malawi's research system. Staff at both colleges will need to be encouraged to regard the conduct of research as part of their duties and receive adequate support for research in terms of funds, equipment, time, and facilities. While a research background is of obvious importance for students whose careers will be in research, it is also important that students who will work in other fields obtain an appreciation of the vital role of research in agricultural development. Staff involvement in research is communicated to students and helps them develop an inquisitive attitude.

The current assignment to Bunda College of responsibility for specific commodities provides one means of involving college staff in agricultural research. However, these agreements, which appear to be working reasonably well, should not be perceived as the only way of involving university staff in agricultural research. Instead, university staff should be perceived as a pool of expertise which can be accessed in a variety of ways.

Research and teaching are such highly compatible and reinforcing functions that it is widely accepted that effective, sustained, college-level teaching requires a companion research effort, if not by all teaching staff, at least by many in each department. Further, the scarcity of highly trained agricultural scientists in Malawi argues strongly for optimum use of all scientists, including a research role for college staff that complements their major teaching function. The primary responsibilities of the colleges are to their teaching programs; however, involvement in research not only assists the national effort in agricultural development, but is also a vital force in enriching and progressively upgrading courses and curricula. Research at the colleges should be an integral part of the research to directly support Malawi's agricultural development, and not simply a reflection of the personal interests of individual staff members. Highly trained college staff are a valuable resource and should be enlisted to accomplish important objectives.

Currently, staff at Bunda College have heavy teaching loads. Consideration should be given to somewhat lighter loads for staff that become productively involved in research. It may not be feasible in the near term to consider joint research and teaching responsibilities for many staff members, as is done in institutions in Europe and the United States, but this might be both possible and desirable as staffing situations improve at the colleges. Further, the initiation of M.Sc. programs in various departments should provide additional capacity and opportunities for the involvement of the colleges in agricultural research.

The most important way for college staff to be involved in research is as part of national coordinated research programs. Optimum use of available resources would have college staff taking responsibility for a given part of a national research program and receiving funds from MOA for that work. Presently, modest research funds are provided to the two colleges by the Ministry of Education. If the policy of involving college staff in the mainstream of agricultural research is to be seriously pursued,

MOA will need to supply funds to do the research. This would facilitate liason with MOA researchers. More formal decisions would then be made on college staff involvement, program development, evaluation of research, and integration of college staff research into the national research effort. In turn, the university needs to acknowledge the need for high staff-to-student ratios for effective teaching of laboratory and field sciences and for postgraduate education, and the compatible relationship between such teaching and research, and make the needed adjustments in staff and budgets.

> Recommendation: Considering the important research talent present in the staff of Bunda and Chancellor Colleges and the curriculum enrichment provided by staff research, we recommend that DAR make every effort, including provision of resources, to directly involve college staff and postgraduate students in the mainstream of agricultural research to serve Malawi, especially as integral parts of national coordinated programs.

Links with Policy- and Price-formers

The practices used by the farmer and the production level he achieves are controlled by his knowledge, the availability of needed inputs, and the physical, economic, and family and social circumstances that surround him. Government policies affecting market structure, rural wage levels, crops produced, and the prices paid (real and relative) to the farmer for his products, form the major components of the farmer's economic environment. Prices paid to farmers are critical in his decisions on purchasing inputs. Using purchased inputs and seeking higher production levels expose the farmer to greater risk, which he perceives in relation to the cash flow of the family and the reliability of other factors affecting production, especially rainfall. In view of the foregoing, it is essential for government to have accurate information on the circumstances of the farmer before it can establish realistic policies and prices.

Historic production levels and yields indicate that smallholders respond to input and output prices and use available production technology that fits pricing circumstances. A recent World Bank[11] report suggests that Malawi smallholders are also responsive to relative real producer prices for alternative crops. Analysis of cross elasticities among crops and inputs is thus needed to forecast effects of changes in prices of inputs and products and to guide policy decisions. The relative advantages of the smallholders and estates in producing and marketing tobacco are under government control. Shifts in the policies controlling tobacco production have important implications for the cash flow of smallholders, their corresponding risk tolerance, their ability to use more inputs for other crop or livestock production, and their demand for products and services from other sectors of the economy. These are but two examples of the kinds of analyses that an adequate research system should make available to policy-makers. The required database for such analyses

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[11]World Bank. 1981. Malawi -- The Development of the Agricultural Sector. Eastern Africa Regional Office.

(accurate smallholder area and production figures), while largely missing until now, will soon be available from the ADD evaluation units.

Until recently, many important agricultural commodity prices have been largely set by ADMARC. Sometimes ADMARC consulted with MOA and EPD personnel, but neither MOA nor EPD had the analytical base needed to support good decisions. In some ways ADMARC behaves as a profit-seeking monopoly; thus while it supplies some essential services (which, if all costs were considered, might be supplied more efficiently through the private sector), its decisions on prices cannot be expected to reflect more than ADMARC's concerns.

With some exceptions, researchers have given inadequate consideration to the political, economic, and social constraints affecting decisions by their clients. (For example, concentrating the maize research effort on hybrid dent maize has important implications for which groups of smallholders will be able to use the resulting technology.) Commodity researchers seem to have considered the economic, marketing, and policy environment outside their area of concern, or perhaps influence, and the economic and social science research area has received little attention. Commodity and economic researchers can best serve policy-makers by providing them information on input responses, farmer attitudes, ability of various groups of farmers to accept risk, and similar factors that have major influence on use of improved technology and are, in turn, affected by price and policy decisions. Decisions on prices and policies can then be made with a broad base of knowledge.

Neither MOA nor EPD has the research staff to do the social and economic impact analysis of present or potential agricultural policies or prices (see Annex F). Analyses affecting agricultural policies seem usually to be associated with donor-funded projects. While some such projects may be comprehensive, others would probably be concerned with a small segment of agriculture. Policy decisions derived from project-specific analysis may ignore important consequences external to the project.

If the government intends to set input and product prices and control production of agricultural commodities, it needs an economic and social analysis unit that provides it with objective analyses for setting prices and policies. This capacity could be developed in either EPD or the Planning Division of MOA, or some combination of the two offices. The unit could contract with Chancellor and Bunda Colleges for some economic and social science analysis, rather than build a large internal capacity.

> Recommendation: MOA and commodity association research units should conduct production research to show costs and returns to inputs by various groups of producers. EPD and/or the Planning Division of MOA should be encouraged to conduct the economic and social research to analyze effects of current and proposed price and production policies on various groups of producers. The researchers need to supply such information to policy-makers in

Manpower Development

Conditions and terms of service in a national agricultural research system should enable it to recruit and retain competent and qualified personnel. To do this the system must provide adequate career incentives to scientists and supporting staff. There must be an institutional environment conducive to research, and the system must recognize and reward individual achievements.

The present system of recruitment relies largely on interviews, which do not always accurately assess capabilities. Research demands personnel having certain minimal qualifications and capability to acquire and develop special skills. Recruitment for research positions should be based on a job description that specifies the work to be done and appropriate educational and experiential qualifications. The qualifications should exclude those who do not have the needed education and experience. Once recruited, researchers deserve a statement of expected tasks, and a periodic review of their performance with their supervisor. Service conditions should provide for transfer of individuals whose performance indicates their talents may be better used outside research.

Malawi's present system provides for reasonable terms of service. The promotion structure and procedures, however, do not stimulate personal motivation and maximum output from research staff. The availability of promotion posts is limited to those currently filled by the CARO and 2 assistant CAROs in scale P6, 4 in P7, and 16 in P8. The rest are in a single (long-A) scale for professional officers with no prospect for promotion unless new posts are created at the superscale.

More promotion posts should be created for graduates and supporting staff (technical officers and technical assistants) and those with laboratory skills. To allow for this there should be special extensions to the present scales. Promotion to such extensions should be on the basis of proven merit, not automatic. The CARO post should be upgraded to P3 to allow for creation of more intermediate promotion posts at P7 and P6 for the professional cadre. Entry to such scales should be through promotion board procedures and provision of the establishment for this form of promotion must be flexible (i.e., available on demand when the promotion board makes recommendations for individual advancement on this basis). A fixed number of posts which would automatically be filled would not meet the intention indicated for such promotions.

Promotional posts in the superscale do not have specific job descriptions. This has the disadvantage that inadequately qualified and inexperienced candidates could be promoted to these posts. The present promotions procedure of the Public Service Commission, with nearly total reliance on written or oral examination without clear job specifications and qualifying experience requirements, may lead to disregard of important competence and experience in both the professional and nonprofessional cadres. If clear job descriptions and experience requirements are developed, some candidates can be eliminated on the grounds that they do not meet the minimum qualifying criteria. This saves time for promotion boards, which can then enhance the quality and depth of interview procedures. Promotion boards must be balanced in composition to eliminate bias, and must give fair and equal care to all candidates at interviews.

The current promotional structure is further constrained by lack of flexibility. At present an individual must move to administration to progress beyond scale P8. Encouragement should be given to research officers who prefer to stay within their chosen disciplines and continue to do research. Similarly, officers who are prepared to seek careers in research administration should be encouraged to do so. Care is needed in moving from research into administration, and there should be an opportunity to gain experience (or an acting appointment), to ensure that the officer concerned has the desired qualities of leadership.

The review team is of the view that a procedure and mechanisms for promotion of research personnel should be established that take into consideration research requirements, experience, and competence. Effective use of "efficiency bars" is one way of achieving this. A mechanism to control the promotion procedures indicated above is required. To this effect the team endorses the proposal to establish an agricultural research promotion board which will be responsible for processing and recommending candidates for promotion in DAR. The question of the need and rationale for giving similar treatment to nonscientific specialists with regard to promotion prospects deserves further examination.

> Recommendation: The team recommends that a special extended scale rising to P3 be created for agricultural researchers as has already been done for medical specialists and surgeons in the health service.

The development of competent leadership to provide direction and guidance to research scientists needs special attention in each national agricultural research system. The need to develop the capacity to lead multidisciplinary research programs is particularly important. There should be mechanisms, both formal and informal, for developing research leaders, and a process by which they are groomed for positions of higher responsibility. Development of leaders can be enhanced by:

* creating senior posts for leaders of multidisciplinary programs to which selected individuals can be deputed while their management potential is assessed;

* delegating some management responsibilities and assessing individual performance in dealing with these;

* seconding to leadership positions, locally or abroad;

* providing potential leaders with opportunities to attend management or leadership courses.

Training Researchers

It is sometimes assumed that researchers in developing countries need not be as well trained as those in more industrialized countries, but such is a misconception. Agricultural researchers need specialized knowledge and skills. The research needed in a developing country is different, but not less complex than that in a developed country. Frequently, the researcher in a developing country will need the more comprehensive awareness of a subject, for a developing country seldom has, or can

afford, a great specialization in researchers. This requires people who are well trained in one area and who have rather exceptional knowledge in related areas. A few of Malawi's researchers are well trained for their positions; most, however, hold only a first degree in agriculture or a related science.

While there are always exceptional individuals, the first degree cannot be expected to adequately prepare most people for a research career. Postgraduate training or considerable experience beyond the first degree is needed for most people to conduct useful research. Further, researchers need certain attitudes and motivations that are developed during postgraduate training. While it is possible to provide a few individuals with the opportunity to acquire higher degrees after they have entered the research service, it becomes increasingly difficult to do so as more first-degree-holders are recruited. Ultimately, it is not possible to offer postgraduate training to all graduates recruited into research service without a corresponding major increase in local financial provisions and increased foreign resources and facilities.

Malawi's professional researchers now number about 75. About one-third have sufficient training and experience to make them effective researchers if other essential resources were available, but perhaps 50 would be much more effective as researchers following short- or long-term training. The total number of researchers will have to increase as the ADD research units become functional and the needed disciplinary specialists are included in national coordinated commodity programs.

The USAID/University of Florida project correctly includes a major training component. (See Annex E for a description of this project.) About 25 people will be trained to the M.Sc. level and 8 to the Ph.D level during the five-year project. This will make a major improvement in the ability of Malawi researchers to do their work. This training effort may be near the absorptive capacity for external training, but it is just a good beginning on the needed training. As the research system moves more of its personnel resources to a few redefined national coordinated programs, and starts staffing ADD research units with an average of four research officers, it will be under great stress for both better trained and more researchers. Planning the development of a network of stations, defining several national coordinated commodity research programs, and defining the staffing requirements for ADD research units will help define the need for specific research personnel. However, training needs will be great, and at least 50 B.Sc. researchers will need further training. Many will need short-term or M.Sc. training and some will need Ph.D.-level training. The needs of the researchers for M.Sc. and practical training will have to be met by exploiting all available opportunities.

Bunda College plans to soon begin resident M.Sc. programs in a few subjects where it has special competence. The state of preparedness of Bunda to develop an M.Sc. program in plant science forms an important coincidence (and thus opportunity) with the M.Sc. training needs associated with rapid development of the research system. This combination of factors may offer opportunity to train a group of about 25 to 35 to the M.Sc. in plant science (including limited specialization) at Bunda College, rather than abroad. The group would be trained as a special effort at Bunda. The research system would get a substantial block of valuable talent, and Bunda would be left with a capability to continue to offer a M.Sc. in plant science.

Sufficient external resources would be needed to do an intensive M.Sc. in 18 to 24 months. The effort would draw on several of the regular Bunda College staff and replace part of their normal teaching duties with temporary expatriate staff. Other temporary staff would be supplied to teach some courses unique to the M.Sc. program, some for only a few weeks (for example, a course in methods for on-farm constraints analysis). One could expect to get the best talent available for such courses. About four full-time expatriates would be needed to share the student advisor function, and others would be needed to substitute for regular college staff involved in this special program. The curriculum would be designed to fit Malawi's needs, but would constitute a first-class M.Sc. program. A modest dormitory would probably be needed, and some other common facilities at Bunda may need strengthening. A temporary dormitory could probably be developed in the farm machinery sheds if needed, while the permanent dormitory was built.

This program, if feasible, would contribute importantly to enhancing Malawi's research system, although there would be some loss in immediate work while people were in the course. This would be more than offset by the value of the additional training, but even more so by the team spirit that such a group would maintain as they worked cooperatively in Malawi over the coming years. The program would complement the training supplied through the USAID/University of Florida project, which, in the future, could concentrate on training in other disciplines and for Ph.D.s.

Many questions would have to be examined before embarking on such a venture. What is the priority of the work the group is expected to do following training? What alternatives are available for doing the work? What alternatives are available for training the needed people? How many qualified and dedicated people will be available to receive the training? Will operating funds and other resources be available to use them effectively? What effects would this program have on overall government plans? Would such a program complement Bunda's plans? Can a suitable curriculum be developed? How much specialization (entomology, pathology, breeding) is possible, and desirable? Could those who expect to work on a specific commodity visit the appropriate IARC as a group at the end of the training program? Can the needed external resource personnel be identified? What would it cost and would the finances be available?

> Recommendation: The review team recommends that Malawi examine the feasibility of training a group of about 25 to 35 persons to the M.Sc. level in plant science at Bunda College, considering each critical question in turn, and proceed with the training effort if it is feasible. Alternatively consideration should be given to training a similar number of scientists spread over five years at Bunda College, or through overseas fellowships combined with a local postgraduate program.

Supporting Staff

The Malawi agricultural research system is at a stage when most research officers are inexperienced and especially dependent on their support staff, many of whom have several years of experience. Losses of senior and valuable technical officers and technical assistants, through frustration and lack of career prospects, should be minimized. This

category of staff appears to have limited opportunities to further prospects through training. To compensate for this their promotional prospects ought to be improved by increasing promotional establishments, and extending as well as upgrading the present scales to which those with proven outstanding ability and motivation could be promoted. Where opportunities exist, support staff should be encouraged to pursue further studies or attend short courses. Technical courses should be arranged to upgrade technical officers, whose contribution is acknowledged to be vitally important in agricultural research.

Evaluating Performance

The normal practice for evaluating personnel performance is by annual confidential reports. Staff are evaluated by the senior officer responsible for their work. Where adverse comments are included on the report, the individual's attention is expected to be drawn to them so he is aware that such comments have been made and to give him an opportunity to defend himself. This practice is satisfactory, at least in theory, although the opinion was expressed that it is not always applied. This method could be improved by involving additional senior scientists and administrators familiar with the work of the person being evaluated because a report by a single supervisor is not always objective. The practice of informing individuals of their shortcomings is vital to their career development and should be insisted upon unless there is a specific reason against it. This is an important aspect of personnel management which gives an opportunity to the staff member to correct deficiencies in his performance early in his career.

DAR has proposed creating an agricultural research promotion board consisting of the CARO, the CADO, the Secretary of the National Research Council, a representative each from the University of Malawi and Personnel Management and Training, and a research specialist relevant to the officer being considered. The board's responsibility will be to assess candidates for promotion and ensure that deserving officers are promoted. The team endorses the board concept.

Manpower Planning

The urgent near-term need for postgraduate training, discussed above, should not obscure the need for careful consideration of the longer-term need for technical manpower to serve Malawi agriculture. Malawi is a sufficiently small country to make relatively small excesses or shortages of research personnel quite important. Fortunately, its size also facilitates a fairly reliable estimate of demands for scientists.

The longer-term (10 to 15 years) effective demand by the research system for B.Sc.s and M.Sc.s from Bunda and Chancellor colleges, and for Ph.D.s from abroad must be examined. How many scientists, with what training, will be needed in each research program, in each service function, and in administration? How will those needs be related to productivity increases and to value of the agricultural product? In which disciplines will there be sufficient demand to warrant developing a postgraduate program? What demand will develop in the private sector? These and similar questions should be considered in an analysis of the longer-term demand for research manpower.

An analysis should begin with a careful statement of the presently available manpower, including each person's training, experience, position, and other relevant characteristics. Data on the functions each person performs in terms of percentage of time or man-days is collected at the same time. This should be sufficiently detailed to be able to allocate each person's time to discipline and commodity or service. Data on time of appointment, resignations, and next position provide information on attrition rates and causes.

Manpower needs based on "wish-lists" of research leaders, sample surveys, or projections of trends have not proven very useful. After decisions have been made on the priority research programs, and their approximate areas of concentration and priority, manpower needs can be developed by discipline and level of training across commodities, resource, or service. Projections can then be made with more than one realistic assumption on availability of funds and relationship to growth in value of the agricultural sector. Finally, the plan should include consideration of where the training will take place for each discipline at M.Sc. and Ph.D. levels, and how it will be funded.

> Recommendation: The 10-to-15-year manpower needs in Malawi's agricultural research system should be the subject of a special study, based on specific research programs and services, and on realistic estimates of fund availability.

Chapter 5

Near-Term Actions

Malawi can soon have a research system that provides a flow of improved technology for the agricultural sector, provided that a number of actions are taken on key issues. The system has developed rapidly since independence, but many more of its personnel will need training to the masters and doctoral level to effectively recognize and solve the agricultural problems. More resources will be needed, especially more funds for equipment replacement and operating costs. Researchers and managers will have to make difficult choices in allocating resources among research to serve various groups of client farmers and policy-makers, related services, and research to advance knowledge in a scientific discipline. Left to themselves, scientists will often choose the latter, which provides personal satisfaction and peer recognition.

Management will need to concentrate available resources on a few national coordinated commodity programs, and capitalize on available external resources, if they are to soon provide usable improved technology for Malawi's smallholders. A needed first step is thus a decision to allocate enough of the available resources to a few priority national coordinated commodity programs that they can soon provide improved technology that can be used by smallholders. Some of the service functions and current disciplinary research may have to be foregone, or the effort markedly reduced, to allow the reallocation of scarce resources to this higher priority work.

The national coordinated commodity programs can be defined in terms of sets of research activities. This will introduce this concept to researchers and managers and help assure that the resources needed to reach specific objectives are clearly identified. College staff can be fully integrated and be responsible for defined elements of some research activities.

As the national coordinated commodity programs are defined, including their working relationships with the ADD research units, talent deficiencies will be identified. These needs should form the priority for training. The training should be done within Malawi, to the extent possible. Personnel who must be trained outside Malawi should return to Malawi for their thesis or dissertation research when such can be arranged.

As the ADD research units are structured, personnel with competence in the "CIMMYT approach to farming systems research" will be immediately limiting. University of Florida and CIMMYT personnel could cooperate to introduce a group of agronomists to this work through a workshop and an on-the-job training experience in one or two ADDs. Persons trained in various aspects of agricultural micro- and macro-economics will be needed in the ADD research units and for the policy-related research in MOA or EPD. These needs can be included as a part of the near-term training program.

The analysis of the need for research stations in the various agroclimatic zones will include consideration of the role of each station in each national coordinated commodity program. This will facilitate identification of both personnel and facilities needed at each station.

The combination of plans for (a) the systematic development of a network of stations serving specific functions, (b) the resources to be allocated to a few priority national coordinated commodity programs defined as sets of research activities, (c) the allocation of adequate personnel and physical resources to the ADD research units, and (d) the training of personnel needed to accomplish this work, should form the major elements of a research capability development effort for which donor resources could be sought.

The above actions are largely within the capability of MOA. The suggested changes that affect the career structure of Malawi's researchers will have to be implemented in consultation with the Ministry of Public Service. These actions can be advocated by MOA, and MOA may need to enlist the support of other government units that must manage substantial numbers of professionally trained personnel.

Annex A

TERMS OF REFERENCE

REVIEW OF THE MALAWI NATIONAL AGRICULTURAL RESEARCH SYSTEM

1. The review is to be carried out during April and May, 1982 by a team supplied by International Service for National Agricultural Research (ISNAR) in consultation with the Ministry of Agriculture and other appropriate ministries and agencies of the Government of Malawi.

2. The review team will examine in retrospect the research program and organization in terms of general progress, special problems, adequacy of resources (including adequacy and appropriateness of external resources) and procedures for establishing priorities, allocating resources, evaluating progress, disseminating results to users, and obtaining feedback from users.

3. The team will give special attention to:

   (a) the efficacy of procedures and organization for meshing the Malawi technology production and distribution system with the National Rural Development Program;

   (b) the effectiveness of the mechanisms being used to bring to researchers sufficient understanding of the decision factors of technology users, especially farmers, traders, and policy-makers;

   (c) the present capability and the procedures used to assure an appropriate multidisciplinary approach for identifying problems and opportunities for improvement and for developing and testing potential improved technology;

   (d) the relative attention by researchers to estate and smallholder agriculture and its appropriateness;

   (e) the allocation of resources among research priorities and system components, and their appropriateness in relation to achieving national objectives, solving problems, and exploiting opportunities;

   (f) the objectives of the research projects and their appropriateness in relation to research priorities and national objectives;

   (g) the suitability of procedures for establishing research priorities, defining objectives, allocating resources, planning research projects, and evaluating progress in accordance with national agricultural and developmental policies;

(h) the adequacy of working relationships among research organizations within Malawi, especially the University of Malawi, with international organizations and with other nations;

(i) the adequacy of communications links among research units, and with technology users;

(j) the adequacy and efficiency of the physical infrastructure, equipment, and supplies for research in accordance with national objectives, the expected contribution of the agricultural sector to development and resource availabilities;

(k) the efficacy of monetary allocation, expenditure, and control procedures;

(l) the appropriateness of personnel development plans in relation to research system needs, expected contribution from agriculture and available resources;

(m) the terms of service and career development opportunities for research personnel and the job satisfaction needed to sustain an adequate and productive research system;

(n) any other subject which the team identify during the course of their review.

4. The outcome of the review will be a detailed report on the findings of the review and recommendations to improve the research system in the aspects mentioned above and in other aspects which may be noted during the review.

Annex B

THE CONTEXT OF AGRICULTURAL RESEARCH IN MALAWI

Malawi extends from about 9.4°S to 17.1°S; some 900 km north-to-south, but its average width is only about 150 km. Its area is 123,000 km^2, including 29,000 km^2 of Lake Malawi, which it shares with Mozambique. Malawi is on the East African Rift and has the usually associated vertical diversity, from 40 m to 3000 m above sealevel. Much of the lakeshore zone is a narrow strip between the lake and the parallel escarpment. Within recent geologic time the lake has retreated to the north. South of the present lake the valley widens and includes the Shire River which flows from Lake Malawi south to the Zambesi River. The lakeshore and the upper Shire valley are rift valley floor at about 500 m altitude. A 100-km section of rapids separates the upper and lower Shire valleys, and inhibits river navigation but supplies some hydroelectric power. The lower Shire valley, at 100 m to 200 m altitude, is again rift valley floor. There is considerable potential for irrigated agriculture in this valley, from both the Shire River and tributaries. (Much of this background is adapted from Hunting[1] and from Nelson [2].)

Along the rift, escarpments set off medium-altitude plateau areas, which range generally from 740 m to 1400 m. Scattered highlands, ranging from 1400 m to 3000 m, cover fairly extensive areas in the north, but smaller areas in the central and southern regions. The medium-altitude plateau areas are extensive and important for agriculture. Several rivers develop near the western border and flow eastward across the plateau to Lake Malawi. These rivers may offer opportunity for irrigated agriculture in the lakeshore region. Rainfall on the plateau is greater and more reliable than in the Shire valley and the adjacent lower lakeshore zone. On the plateau, rainfall ranges from 700 mm to 2000 mm and in normal years is sufficient for crop production. The southern lakeshore and Shire valley are more vulnerable to drought. Median annual rainfall there dips under 700 mm in some areas and in one year out of five a substantial part of the lower Shire valley may receive between 550 mm and 610 mm. In such areas only drought-tolerant rainfed crops can be grown with confidence.

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[1]Hunting Technical Services Limited. 1981. National and Shire Irrigation Study, Final National Report. Lilongwe, Malawi: Ministry of Agriculture.

[2]Nelson, Harold D. et al. 1975. Area Handbook for Malawi. Washington, D.C.: American University

The warm rainy season is from November or December to April or May, followed by a cool dry season until August and a hot dry season through October (see Agnew and Stubbs[3]).

Malawi is landlocked. Bulky imports and exports generally move by train across 350 km to 500 km of Mozambique and the port cities of Beira or Nacala. Within Malawi the railroad runs through the Shire valley and north to Salima (400 km), then west to the Zambia border (200 km). The northern two-thirds of the country is without railroads. The southern half of the country is fairly well served with bitumen roads, while the less extensive roads in the northern half are largely gravel and earth. Transport costs are a significant factor in the real cost of fertilizer and other inputs, and decrease the real farm gate value of outputs.

The southern third of Malawi is the most developed and has about half the people. Most of the manufacturing, agricultural processing, and service industries are here. It has the hydroelectric generating capacity, most of the tea estates, and many of the tobacco estates. The central region is developing rapidly, especially the new capital area at Lilongwe. The northern region is less developed, having 12% of the people on 29% of the land.

Under the 1966 constitution the Malawi Congress Party (MCP) officials and tribal chiefs select a president every five years. In 1970 however, the MCP convention acclaimed Dr. H. Kamuzu Banda President for Life by unanimous resolution. The cabinet is appointed by the President. President for Life Dr. Banda serves as Minister of Agriculture.

Malawi's people number about 6.3 million (increasing at about 3.2% per year), and the average population density is 65 persons per km^2. Four major cities contain about 10% of the people. Urban populations are increasing by 7.3% per year. Ethnic differences are not considered an important factor in agriculture.

Child mortality (age one to four years) is about 27 per 1000. About 14% of the children die during their first year. In 1978 about one-fourth of the under-five children were under 80% of standard weight. Diets are thought generally balanced, but inadequate.

Smallholders live in villages under the social control of family heads, village headmen, and chiefs. Land for farming is allocated by chiefs to headmen and family heads on a semipermanent basis. In one area near Lilongwe, families have been given essentially permanent control of land, but this is not common.

Individuals vary in social and economic stature and some acquire more land. Family units of husband, wife, and unmarried children manage the farm unit. Husband and wife belong to different kinship groups and kinship ties are often stronger than marriage bonds. Husband and wife do not totally share economic interests. Tasks, traditional sources of

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[3]Agnew, S. and Stubbs, M. 1972. Malawi in Maps. London: University of London Press Ltd.

revenues, and farm enterprise interests may vary with sex. Matrilineality is common in the central and southern regions, while patrilineality is common in the northern region.

Maize is the staple food in most areas and nearly all smallholders cultivate maize. The maize for food has priority for planting at the onset of the rains. Other food crops and any cash crop are second priority. Groundnuts and beans are also widely grown by smallholders. Intercropping is usual.

Table 1. Commodities produced, area, yield, and producers.

Commodity	Extent	Yield	Producers
Maize	1,000,000 ha	1,100 kg/ha	smallholders
		4,000-6,000 kg/ha	estates
Groundnuts	200-400,000 ha	400-500 kg/ha	smallholders
Sorghum and Millet	35,000 ha		smallholders
Rice	9,000 ha		smallholders
Potato	4,000 ha		smallholders
Cassava			smallholders
Beans	850,000 ha		smallholders
Seed cotton	37,000 ha	500 kg/ha	smallholders
Tobacco	3,000 ha	300-400 kg/ha	smallholders
	28,000 ha	1200 kg/ha	estates
Tea	16,000 ha		estates
	2,000 ha		smallholders
Sugarcane	15,000 ha	177,000 tons	estates
Cattle	820,000 head	10%	
Goats	763,000 head		
Milk	3.5 million liters		3 milksheds
Sheep	89,000 head		
Chickens	8.5 million		

The smallholder producing unit is often a nuclear family unit of five or six people. A substantial number of households are headed by women. The cash flow in the family unit, derived from sale of surplus production and wages from off-farm employment, is quite low, often well under K100 per year. A 1971 study (of a small area) (Mbawa, MANR, T.W. Biege) of above-average size farms, found about 75% had annual cash flows of K30 or less. The same study found that 20% of all expenditures were for farm inputs. They bought seed for beans, groundnuts, and cabbage, and half of the farmers bought fertilizers.

Credit for purchasing inputs is made available by government, mostly through farm groups. In 1981, about 100,000 smallholders each borrowed about K60 for fertilizer and seeds. Interest rates are 10% for group members and 15% for individuals. Repayment rates approach 100%.

The Agricultural Marketing and Development Corporation (ADMARC) operates a nationwide agricultural marketing system. It is the source of purchased inputs and operates 52 main markets and over 700 local markets (Hunting). ADMARC is empowered to buy all tobacco and cotton produced by smallholders. ADMARC also buys groundnuts, maize, rice, and pulses, but there are private markets for some foodstuffs. ADMARC sells fertilizer nationwide at about its cost at Blantyre, which indicates a subsidy at more distant locations.

ADMARC sets its prices in agreement with the government. The maize price was increased from K72 to K111 per ton during 1981. ADMARC bought 11,341 tons of tobacco for K4,792,000 in 1980 at an average price of K0.42 per kg. The average price of auctioned burley in mid-September 1980 was K1.23 per kg; and during the same week in 1981 it was K2.33 per kg. In 1980 the average price paid for cotton by ADMARC was K0.22 per kg. (Malawi Government. 1982. Mid-year Economic Review. Zomba: Government Printer.)

Maize production dominates smallholder agriculture. Virtually all smallholders produce maize for their staple food and many smallholders plant maize on two-thirds to three-fourths of the cultivated area. Collectively, some 1.2 million smallholder families plant just over a million ha of maize and harvest about a ton per ha. Other significant smallholder crops include beans, groundnuts, cotton, sorghum, millet, and tobacco (see table for details). Malawi smallholders keep some 820,000 head of cattle with an annual offtake of about 10%. About the same number of goats are reported. In some areas cattle supply transport and draft power, but their potential for supplying power may be under-exploited.

Collectively, smallholders till about 1.7 million ha each year. Intensity of land use varies among regions, and there is great diversity of perception of land pressure among government agriculturists. In parts of the central and southern regions some quite steep land is being cultivated, and there appears to be relatively little additional land that should be cultivated under socially optimum land use. The total area being cropped in any one year, however, is much less than the cultivable area. Considering that nearly all smallholder land is tilled by hand, one marvels not that land is idle, but that so much land is tilled. In many areas the area planted by a smallholder family is apparently limited by availability of good land and by their capacity to prepare the land and plant quickly after the onset of rains. Most crops must be planted soon after the rains begin to get reasonable yields. The farmer's first priority is for food, so the food maize crop is planted first.

According to Hunting, some 2.2 million ha of land available to smallholders is cultivable but unused, and some 1.2 million ha is fallow but cropped within the past five years. The implications for research may include potential for perennial crops to replace currently unmanaged fallow and to increase the cultivated area by developing usable technologies to relieve land preparation and planting constraints during the early growing season. The economics of best use of land resources on

Table 2. 1980 Land utilization estimate (million ha).

	Northern Region	Central Region	Southern Region	Total
Total land area of which:	2.69	3.56	3.16	9.41
Game parks	0.40	0.39	0.25	1.04
Forest reserves and forestry	0.30	0.29	0.28	0.87
Infrastructure and urban	0.08	0.14	0.13	0.35
Agricultural estates	0.11	0.25	0.13	0.49
Total	0.89	1.07	0.79	2.75
Land available to smallholders of which:	1.80	2.49	2.37	6.66
Noncultivable, grazing and unused	0.76	0.22	0.57	1.55
Cultivable but unused	0.56	1.05	0.64	2.25
Fallowed, but cropped within the last 5 years	0.25	0.52	0.43	1.20
Being cropped now	0.23	0.70	0.73	1.66

Estate agriculture is important as a source of foreign exchange and employment. Some 1200 estates control about 470,000 ha. About 1100 estates produce tobacco. In 1980 tobacco was grown on 62,000 ha and 54,000 metric tons were auctioned for K59 million. Tobacco exports were K105 million, about half total exports. About 25 estates grow 16,000 ha of tea, while smallholders grow 2000 ha. Tea production in 1980 was 30,000 metric tons, and tea brought K30 million in foreign exchange that year. Two sugar estates produced 147,000 metric tons of sugar, and sugar exports were K36 million in 1980. Sugar production in 1981 was up by 20% to 177,000 metric tons. Agriculture, forestry, and fishing supplied half the total paid employment (360,000 jobs) in 1980. The average monthly earning was K15 per person.

Annex C

COMMENTS AND QUESTIONS OF MALAWI'S RESEARCH STATIONS AND THEIR PROGRAMS

The terms of reference of this review did not include a comprehensive analysis of the role of each research station, its program, staff complement, resources, and operational mode. The team was not selected with this in view and had not time to do the analysis. The following comments on stations and programs are made to indicate the need for such analysis and the kinds of factors that should be considered as Malawi plans a network of varied research facilities designed to conform to Malawi's needs and circumstances.

The division of Malawi under NRDP into eight agricultural development divisions (ADDs) will affect the future development of research facilities. One research station has recently been designated as responsible for each ADD, but not all such stations are located within the ADD for which they are responsible. The officer in charge of the research station responsible for an ADD is responsible for coordinating trials within that ADD, and for making sure that problems specific for that ADD are reported and considered in further evaluation and planning by the research project coordinators. Most of the stations designated to serve an ADD do not have sufficient trained staff, physical resources, or operating funds to allow them to fulfill either their ADD service role or to be a substantial component of the national research system. These two functions are generally complementary, but the stations will need to be developed to serve both functions.

The Ngabu unit will be a useful model as Malawi meshes its research and NRDP efforts. It has four professional officers, three of which have had production agronomy training at international centers. They concentrate their work on a few major crops, work closely with the extension system, link into the national commodity research programs, and are involved in many on-farm trials.

The Kasinthula station is intended to develop technology for irrigated areas and crops (except rice) throughout Malawi. The analysis should examine whether the irrigation potential in Malawi is sufficient to warrant investment in a research station for crops produced with irrigation, or whether technology developed for most crops (except rice and sugarcane) for rainfed conditions could be adapted by farmers for production with supplemental irrigation.

One of Kasinthula's responsibilities is to determine irrigation water requirements (consumptive use) for various crops. (Bvumbwe also reports research on irrigation water requirements.) Much research has been done on this in India, Pakistan, the United States, and other countries. With known physical parameters of soils, insolation, and temperature, quite useful information on water requirements of various crops is highly transferable. A thorough search of the published literature and

correspondence with a few scientists concerned about irrigation water management could provide much information that can be interpreted for Malawi's irrigated agriculture conditions. Soil scientists in Malawi may be able to interpret the published information for Malawi's conditions with little additional research. The literature on how irrigation water management affects watertables, which is likely to be a problem at Kasinthula, also needs to be reviewed. This is mentioned to illustrate the importance of access to reports of past research both within and outside Malawi, and of communications with colleagues as research programs are planned.

The vegetable research at Kasinthula may quickly produce important technology for smallholder production of fresh vegetables for the Blantyre market. Responsibility for vegetable and fruit research may need to be divided between Bvumbwe and Kasinthula if the technology developed at the two stations will serve significantly varied agroclimatic zones. Vegetable researchers would benefit from a cooperative relationship with the Asian Vegetable Research and Development Center[1], which does research on several vegetables (including tomatoes and chinese cabbage), and functions as do other international centers.

The Lifuwu station may be well situated and have appropriate soils for rice research on Dambo soils, but its usefulness for research on other crops that are important in the area must be questioned. One then needs to ask how well and how efficiently the needed irrigated rice research might be done at Kasinthula, where more varied soils allow research on a greater range of crops. Single-commodity research stations may be quite economical under some conditions, but multipurpose stations usually offer greater efficiency of resource use in national systems. The same principles apply at Makoka.

The Makoka station was developed as a cotton research unit but is located outside a major cotton-producing area. There is some consideration of making Makoka a multipurpose station, and a legume research officer has recently been added to the staff. The suitability of the Makoka station for cotton research and its usefulness for research on other crops deserves indepth examination. The proximity of Makoka and Bvumbwe and the variability of their agroclimatic representation, and the past investment in physical facilities also warrant consideration.

A biometrics section to serve the Malawi research system has recently been located at Makoka. The rationale for locating the unit at Makoka was access to a major commercial computer in Blantyre. (Bvumbwe is even closer to Blantyre.) The unit now plans to use microcomputers, so proximity to the Blantyre mainframe computer is no longer important. The unit will however, need equipment that can be serviced locally, and

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[1]Asian Vegetable Research and Development Center, P.O. Box 42, Shanhua, Tainan 741, Taiwan, R.O.C. The Caribbean Agricultural Research and Development Institute (CARDI) and the University of the West Indies (both in St. Augustine, Trinidad, West Indies) also do research on vegetable crops and may provide useful materials and information for Malawi.

reasonable proximity to such service. There appears to be insufficient communication between the biometrics unit and the researchers it serves. Biometrics needs to be an important consideration in the planning of each research program. Communication is essential to assure that the necessary detailed data and ancillary information are supplied to the biometrician, so that the research results are accurately interpreted. A closer working relationship is needed, probably augmented by short training sessions for small groups of researchers on field plot design, data records, and use of statistical analysis. The location, equipment, and operational mode of the biometrics unit should be examined to see how these services could best be supplied.

Bvumbwe and Chitedze both have varied research programs based on disciplines, commodities, or subjects. Both also supply services such as seed and soil tests. Both are headed by soil scientists and have substantial research programs in soils, plant nutrients, and similar soil-related subjects. It is not obvious that the substantial resources used for soil fertility and plant nutrition research and services at these two stations represent the best use of very scarce resources in Malawi.

Generally, would those working in disciplines (soil science, economics, farming systems, entomology, pathology) and those assigned one person to a crop make a greater contribution by working as part of a few major commodity programs? Assignment to disciplines is appropriate in institutions that are designed to teach or to advance knowledge in one or more areas, but assignment to commodities or as members of task forces is generally more productive when institutions are expected to solve problems.

Both Bvumbwe and Chitedze may be spreading available manpower and funds over too many research topics and too many services for maximum benefit. Experience in several developing countries has been that research efforts become more productive when personnel, equipment, and funds are used to form teams of researchers that can identify the major constraints and opportunities, and rapidly solve problems or exploit opportunities. Assigning the same resources to such a variety of commodities or disciplines that many efforts are allocated only one or fewer scientist man-years seldom represents optimum resource use.

While the southern part of Malawi may have more research stations than are essential (each with too few resources to be highly productive), the northern part may not have enough. The northern half of Malawi has only three professional research officers in two stations, yet most of the potential for cultivating more land and for increasing productivity of land and labor through use of oxen power is in the north. Transport, community facilities, and agroclimatic variation are important factors to consider, but one or more of these northern stations likely rates high priority for physical development and staffing.

As a livestock research facility, the cattle ranch at Dzalanyamà has serious problems. There is controversy over whether the area should be managed as a forested watershed, as a producing cattle ranch, or as a cattle research facility. There is not clear administrative responsibility to resolve these basically conflicting use issues. Even if a decision was made to develop it as a research facility, heavy cattle losses from predators would likely remain a major problem.

Annex D

RESEARCH AT BUNDA COLLEGE

The following is quoted from the current Handbook, Bunda College of Agriculture, pp 60-63.

RESEARCH AT BUNDA

All staff at the College are encouraged to participate in Research and to work with the students on their research projects. Research projects within the University are expected to contribute to the intellectual life and department of the University and to the development of the country. As a College of Agriculture, Bunda cooperates with the Ministry of Agriculture and Natural Resources to ensure that projects undertaken are indeed related to the development of Malawi and to avoid wasteful duplication of effort. In some cases, Bunda staff are participants or consultants on research projects carried out at government research stations. And on the other hand the government at times provides personnel on some research projects.

Limited funds are available through the University Research and Publications Committee. Large and/or continuing projects are often funded from external sources, including international funding agencies as well as the government of Malawi with whom College Research Projects are coordinated.

Staff desiring to undertake research should carefully outline their projects and discuss them with Head of Department, who will after departmental approval assist the staff member in obtaining the funds required. Procedures for applying for funds from the University Research and Publication Committee are as follows:

PROCEDURE

1. All applications except those from coordinated projects, must be discussed at a departmental meeting before transmission to the committee, when they will be accompanied by the views of the department. Applications from coordinated projects, viz., the "Bean Improvement Program" and the "Pasture Research Project" should be discussed at a meeting of the members of the project, which will normally include the head of each department involved.

2. Each personal application should also be fully discussed by the applicant with the department representative before it is submitted to the committee.

3. The department should assess research priorities within the department and make this clear through its representative on the committee with respect to individual applications.

4. Applications should be presented by the applicant to the secretary of the committee at least 4 weeks before the Senate Committee meeting at which they are to be discussed.

5. Six copies of a brief report of the intended project should be presented to the committee giving details of:

   Title
   Objectives/Aim
   Methods

   and a complete breakdown of funds requested (e.g., number of bags of fertilizer, etc.).

6. The committee will meet to consider new grant applications three weeks before Senate Committee meetings, in order that the necessary forms can be forwarded to the University office during the following week.

7. Copies of the project proposals submitted to the committee will be discussed by the Chairman with the Principal in advance of the meeting at which they are to be presented, and, in the event of the Principal wishing to query or discuss any project, the committee will meet with the Principal.

8. Applicants whose projects have been approved by the committee will be required to complete three copies of Form 10565, obtainable from the College general office, and to return them to the Chairman of the committee as soon as possible, and within the next 5 days, for transmission to the Senate Committee, with one copy of Form 9794 (Progress Report).

9. Applicants for grants should be available for clarification of points arising, if required, at that part of the meeting at which their research grant applications are discussed.

CRITERIA FOR ASSESSMENT OF PRIORITIES BY DEPARTMENTS

The priorities of applications for research funds will be assessed taking into account the following criteria:

1. The relevance of research to Malawi's national interests.

2. The contribution it could make to the intellectual life and development of the University.

3. The extent to which local factors are peculiarly helpful to the research.

4. The amount of assistance involved currently and previously.

5. The expected continuance of the research project.

6. The obligation incurred in terms of appointment or a commitment to a higher degree program.

Annex E

THE USAID/UNIVERSITY OF FLORIDA RESEARCH DEVELOPMENT PROGRAM

The Malawi research system is receiving valuable and timely assistance through a program funded by the United States Agency for International Development (USAID). The program was developed by the University of Florida in cooperation with the Ministry of Agriculture (MOA), and Florida is helping MOA implement the program. The program provides about $2 million for training of about 33 Malawi researchers: 25 to M.Sc. and 8 to Ph.D. About half are already in training, at several U.S. universities. They will start returning in late 1982 and will make a major contribution to the research capacity in Malawi.

The program supplies about seven expatriate researchers to help do research while the Malawian researchers are being trained, and to provide training in Malawi. Six of the expatriates are working at Chitedze and one at Bvumbwe. Training in Malawi includes pasture agronomy, livestock management, crop yield dynamics, field plot techniques, production economics, multiple cropping, and farming systems research. The U.S. training is designed to fill specific positions.

In addition to the training and technical assistance, the program supplies funds for some critical capital items, including transport, housing, laboratory space, and service facilities, mostly at Chitedze and Bvumbwe.

This $9 million program is well under way with apparently no more than minor start-up problems. It forms an excellent base for further development of the Malawi research system. The next phase of the program can build on this base and expand to involve more of the research system. The development of an experienced and concerned staff at the University of Florida should prove a valuable asset as this assistance program is continued. Fortunately, USAID and a few other donors now recognize the long-term nature of a research system development process and are willing to fund a series of projects that move a national system along a development course.

Annex F

AGRICULTURAL PLANNING AND POLICY FORMATION

In Malawi most agricultural planning is done by the Planning Division of the Ministry of Agriculture (MOA). Additional planning is done in the Economic Planning Division (EPD) in the Office of the President, which is concerned with agriculture in the context of national planning and policies. The newly initiated analysis activities in Agricultural Development and Marketing Corporation (ADMARC), which center on agricultural prices and marketing, will also contribute to agricultural planning. Data collection and analysis from the evaluation unit of each agricultural development division (ADD) feeds into the central evaluation section in the Planning Division, MOA.

The Planning Division of MOA contains sections dealing with planning, projects, marketing and prices, and evaluation. Beyond reviewing studies prepared by external agencies, sectoral planning is not a major feature of the work of the division at present. The division has an important role in the identification and preparation of projects, which involves a considerable amount of social, technical, and economic analysis. The division also collects price and market information on domestic and export crops. In 1980 the results of this work were included in an internal publication on crop marketing and price projections which has been used in the preparation of projects, but it is not clear that the work has had much effect on price and marketing policies.

The division also assembles the ministry's annual budget submission. The budget exercise seems to attempt to reconcile finance guidelines with the departmental submissions and there seems little systematic assessment of performance of activities. The relatively fixed items in the revenue budget (such as salaries) and the commitments under various externally funded development projects leave little flexibility in the budget.

The Economic Planning Division of the Office of the President has responsibility for national planning, and reviews project proposals from the perspective of economic feasibility, budgetary implications, and consistancy with government policy. (The technical feasibility of agricultural projects is a matter for MOA to determine.) EPD also participates in the budget hearings, but apparently many critical decisions regarding the budget are made in advance of the formal hearing, partly in the context of negotiations over projects. EPD is supposed to do research to augment policy formation, but has no capacity to do so at present.

In most of the discussions and documentation on the agricultural situation and policy in Malawi there is little reference to national planning as such. National-level planning, in the sense of the preparation of a development plan, does not appear to be a critical part

of the decision-making process, but planning concepts may be used to provide guidance as to what was supposed to happen from the perspective of a certain time. National planning should be strengthened, but such strengthening should perhaps not be given top priority in the allocation of the very limited staff available.

Top priority in the use of economic analysis capacity might better be assigned to those subjects and levels of the "system" which are both important in terms of potential impact on agricultural development and amenable to using economic analysis. A subject may have great significance to the agricultural sector, but the decision-making process may not be amenable to using economic analysis.

Another critical consideration is the most effective institutional location for economic analysis capacity. Valid arguments can be made for some analytical capacity related to agricultural prices and policies at various points including the Planning Division of MOA, EPD, ADMARC, and possibly the National Bank, since each of these institutions has a somewhat different perspective. Most of these are represented on the Price Advisory Commission. However, price analysis alone might consume a major part of current economic analysis capacity in Malawi, especially if it were to be done in several units. A determination needs to be made of where rather limited capacity can be most effectively located.

At the agriculture sector level, the most detailed analysis work is being done by external agencies, notably the World Bank. This situation is likely to persist for at least the next five or more years. Undertaking a comparable effort in Malawi would involve diversion of significant resources from other duties or engagement of consultants. However, there are several deficiencies in external sectoral assessments from Malawi's point of view. Most notably the reviews reflect external donor agency perspectives, not Malawi's. In the short run this deficiency might be overcome by having at least one officer (SEO-level or above) from both the MOA Planning Division and EPD participate in agricultural sector reviews by external agencies, with a view to i) clarifying points of government policy; ii) noting areas of deficiency or disagreement; iii) advising their respective divisions or ministries on formal responses to draft reports; and iv) overseeing or performing additional analysis to cover areas of disagreement or deficiency. Scarce Government of Malawi (GOM) resources would thus not be used to repeat a set of basic analytical functions involved in sectoral planning, but would focus on key areas where disagreement or deficiency were most apparent. At the same time, GOM, particularily the Planning Division of MOA, should gradually expand its capacity in sectoral planning, but not at the expense of planning and economic analysis activities in other areas as discussed below.

For economic and social analysis intended to affect policy, priority should be given to analysis of agricultural prices in support of the work of the Price Advisory Committee. Only recently has it appeared that any attention was given to the recommendations of this committee. A greater role for the Price Advisory Committee could reflect a growing appreciation by decision-makers that economic analysis by external agencies may not correctly reflect government objectives and policy, and that an internal GOM capacity in this area can provide some safeguard against misunderstanding and error.

An agricultural price analysis unit could be formed in EPD, which could provide objective analysis. The chairman of the Price Advisory Committee is currently the chief economic officer of EPD. This will facilitate consideration of such analysis in final decisions on the recommendations to the ADMARC Board of Directors. At the present time the unit can consist of one staff member of EPD. Price collection and analysis work will continue to take place in the Planning Division (MOA), which will receive technical direction and advice from the unit in EPD. ADMARC is reportedly developing an internal analysis capacity. There should be close, operational links between the unit in EPD and the economics unit in ADMARC, assuring a flow of information on prices and the results of analysis. Attention should be given to marketing arrangements and regulations as well as input and output price structures.

Other research and analysis requirements at the policy level are likely to be periodic or episodic in nature, such as the relative emphasis that should be given to different crops, regions, or income groups. Such work might be undertaken by the same officers concerned with sectoral planning, aided as required by consultants from Chancellor College or Bunda College (notably the Centre for Social Research and the Department of Rural Development). As for sectoral planning, there should be a critical review of work done by external agencies rather than duplicating such studies. An effective critical assessment capability is probably the most one can expect to have in the near term, given the limited numbers of experienced professional officers.

Annual budgeting exercises are often more critical than periodic preparation of national plans. It does not appear that as much use is being made of the budgeting process in terms of assessing new and current programs as might be desirable and feasible. This may reflect the condition that after meeting basic revenue budget commitments (salaries and the bare minimum of supporting expenditures) and GOM commitments in project agreements with external donors, there is so little flexibility in the budget. However, budgeting provides an opportunity for MOA to assess the progress of various research activities and effect changes in emphasis by budgetary shifts. Budgets can be presented on a program basis as well as a research station basis. An economist attached to the office of the CARO could assist the CARO and the station directors in translating decisions about research programs into program budgets; interact with the Planning Division in the budgeting process; and monitor expenditures to allow the CARO to follow them on a monthly or quarterly basis. It is not suggested that the program budgets be assigned separate votes by the treasury. That would introduce excessive inflexibility.

ELEMENTS OF SUCCESSFUL NATIONAL CROP RESEARCH PROJECTS

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Agricultural Development Service,
Report/1981
1133 Avenue of the Americas, New York

A profound reorientation of agricultural research has taken place in many developing countries during the past 20 years. To accelerate the output of research results, developing countries are shifting from the traditional organization of research by disciplines (plant breeding, soils research, entomological research, etc.) to coordinated commodity research projects. India, for example, launched a national, coordinated maize project in 1957. Its success led India to reorganize research on other topics. By 1965 India had established a system of "All-India" coordinated schemes for rice, wheat, sorghum, maize, millet, and other crops and program areas. India's annual production of food grains rose from a plateau of about 80 to 85 million tons in the mid-1960's to 130 to 140 million tons in recent years, in no small part because of this new form of agricultural research.

In Turkey, research from a national multidisciplinary wheat project, established in 1970, triggered the growth of wheat production from about 10 million tons annually to more than 17 million tons. Turkey now has more than 10 coordinated crop research projects.

Mexico, Indonesia, the Philippines, Malaysia, Bangladesh, Botswana, and Guatemala are among the other nations which have successfully implemented such projects.

A coordinated, national, multidisciplinary research project is a powerful means for producing technology that can raise yields and rural incomes. There are four essential elements of an effective project:

- Research is carried out in all areas of the country where the crop is important
- A nationally respected scientist leads the project
- All scientific disciplines important to the development of new technology for the crop are encompassed
- Production problems are the focus of the project.

A multidisciplinary research project, by focusing scarce scientific talent on a country's priority crops, raises the payoff from research.

Moreover, coordinated research projects, in which scientists at all research locations participate in planning experiments and investigations, reduce duplication of efforts.

In coordinated research projects the emphasis is placed on developing technology for higher and more efficient production and on solving problems that limit yield increases. In other words, the project focus is on production-oriented research.

Finally, a national crop research project can be the impetus for holding regular meetings of all project scientists and other key scientists involved with research on the crop. By inviting other persons, such as marketing economists, agricultural extension officials, national planners, and seed production specialists, and including some of them on the program, the annual meeting of the research project can serve as a national forum for spreading and discussing the latest information on the commodity.

COOPERATION AMONG INSTITUTIONS

The most successful coordinated research projects include all scientists in the nation who are engaged in research on the subject, irrespective of their organizational affiliation. For example, in the All-India coordinated schemes, the participants are from the Indian Council for Agricultural Research, the departments of agriculture of the individual states, and the state agricultural universities. The Indian Council for Agricultural Research and the state institutions execute a memorandum of understanding that spells out how cooperating institutions will participate in the coordinated research project and that specifies the amount of funding or other support to be supplied by each.

Research in a coordinated research project is largely of an applied or adaptive nature because its principal goal is to increase crop production. In countries with urgent problems and limited scientific resources, establishment of coordinated research projects means research of a more fundamental nature receives lower priority. Nevertheless, it may be appropriate for university faculties to conduct some fundamental studies, and thesis research of graduate students could be oriented in this direction.

RESEARCH IN A NATIONAL CROP RESEARCH PROJECT

Generally a national crop research project has two broad responsibilities: varietal development and improvement of crop management practices. Varietal development usually requires a multidisciplinary plant breeding team to produce crop varieties that:

- yield well
- have resistance to most important diseases and insects
- are adapted to the ecology of the region for which they are intended and fit the farmers' cropping systems
- perform dependably under poor as well as good growing conditions
- have good quality, as judged by the consumer
- can be stored satisfactorily.

Crop management research should produce:

- improved agronomic practices, such as seedbed preparation, seeding dates and rates, fertilizer rates and methods of application, etc.
- improved weed control techniques
- improved practices for preventing losses caused by insects and diseases
- improved methods of harvesting and storing.

The technology -- proven combinations of varieties, methods, and inputs -- should focus on the problems farmers face, be economically feasible for farmers, and be acceptable to them.

THE VARIETAL DEVELOPMENT COMPONENT

Because new varieties should have the capacity for high yields resistance to the important diseases and insects, and good eating (or processing) quality, their development can be done best by a multidisciplinary team composed, typically, of plant breeders, plant pathologists, entomologists, and quality specialists.

In a newly organized research project, the varietal improvement team assembles varieties, breeding lines, and other sources of germ plasm from all over the world. (Mature breeding programs try to utilize as wide a diversity of germ plasm as possible.) The introduced varieties and breeding lines are usually grown in trials throughout the country to test their yielding ability, insect and disease resistance, quality, and other characteristics. Outstanding performers among the introductions can be considered for early release to farmers. At the same time, the varietal improvement team can begin to take steps to overcome any weaknesses found in such releases.

Ideally, the plant breeding program is organized so that most of the crossing or hybridization is done at just a few experiment stations, each of which represents a major ecological zone of the country. The breeding stations send other research stations collections of seed of experimental lines to be planted as observation nurseries (small amounts of seed of many lines) and yield trials (fewer lines, but sufficient seed for replicated plots).

Genetically segregating lines (F_2-F_3) may also be supplied to other research stations enabling scientists to select the germ plasm best adapted at their location. These selections are further improved locally, multiplied, and put into local yield trials. Lines that do well in local yield trials or national yield trials can be considered for release to farmers as named varieties. As lines in the yield trials become candidates for variety release, the seed of these lines should be multiplied and made available for agronomic studies and for other research activities. The best lines from the local yield trials are then put into national yield trials.

If plant pathologists and entomologists work with the plant breeders, varieties produced are more likely to be resistant to important diseases and insects. The pathologists conduct surveys to establish where diseases occur; collect and store disease inoculum for inoculating the breeding nurseries so that resistant lines can be identified; make

disease readings in the field and select resistant lines; and, sometimes, develop breeding lines in which genes for disease resistance are accumulated.

Entomologists periodically conduct surveys throughout the country to identify insect pests and to estimate damage caused by major ones. They devise techniques for screening breeding lines for insect resistance and, with the plant breeders and pathologists, select insect-resistant lines. They also help plan the crossing program to ensure that insect-resistant parental material is included. Pathologists and entomologists also study epidemiology and host-pest relationships to furnish understandings of disease and pest control.

Lines in the breeding program are also tested for acceptance by consumers. Among the factors that may be assessed are seed size and color, cooking or processing quality, milling characteristics, oil content, protein content, and storage life.

THE CROP MANAGEMENT COMPONENT

The aim of the crop research project is to develop ways to increase production per unit area and raise incomes for farmers. This requires, in addition to superior varieties, better techniques for managing the crop from preparation for planting through storage. A team of agronomists and other scientists are responsible for determining suitable practices for seedbed preparation, seeding dates and rates, fertilizer usage, weed control, insect management, irrigation practices (if applicable), and techniques for harvesting and storage. Depending on the crop, various specialists may be required. For example, if a project focuses on a legume, microbiologists should be a part of the research team to study the distribution of native rhizobia, to develop improved strains of the nitrogen-fixing bacteria, and to devise techniques for inoculating seed where necessary.

Much of the crop management work can be conducted on research stations where large or complex experiments can be precisely controlled and carefully monitored. Studies of seeding dates and rates, irrigation practices, and the initial research on weed and insect control are appropriate for experiment stations. But a significant proportion of the research must be carried out in farmers' fields, particularly tests of a variety's suitability for a cropping system and studies of fertilizer practices because soils vary from location to location and past fertilizer use strongly influences a soil's response. Only in farmers' fields do the broad range of physical, economic, and social influences on crop production become apparent. While it is difficult to control experimental variation in farmers' fields, it is important to maintain scientific rigor and the quality of the experimental techniques.

Crop management research can be conducted as a component of a national crop research project, as a component of a cropping systems (or farming systems) research project, or partly in both kinds of research projects. In cropping systems research, scientists study an individual crop as a component of the sequence of crops grown by the farmer. Each of the "All-India" coordinated crop research schemes incorporates crop management research. In Senegal's new research organization the national crop research projects are essentially plant breeding projects, and

almost all the crop management research is done by farming systems research teams located in each of the country's major ecological zones.

Even if cropping systems research teams have been organized, it is desirable, if there are sufficient scientific personnel, to place agronomists in each national crop research project so that management practices can be determined for breeding lines that are likely to be released as varieties. A breeding line's response to a management practice may determine whether it is suitable for release. For example, a line with low seedling vigor might escape detection in breeding plots where seeds are planted shallower than they are in farmers' fields.

Crop management studies, whether conducted in a crop research project or by a farming systems research team, must address the real problems of the farmer, and all crop management research must be finally tested on farmers' fields in farmers' cropping systems. Surveys of farming communities made jointly by social scientists and biological scientists will expose farming constraints and needs. This information is fed back into the research system to focus attention on farmers' high priority problems. Economists and other social scientists evaluate the suitability of prospective recommendations for the farmer's economic and social circumstances. They also carry out research to determine what influences farmers' willingness or reluctance to adopt new recommendations. These studies are essential for guiding research.

Having social scientists work side by side with other agricultural scientists in a commodity research project has two important advantages. First, the social scientists will be abreast of research findings. When they analyze technology, it will be today's technology, not yesterday's. Second, when biologists and other scientists help conduct economic and social studies, they will understand and respect the findings.

THE ROLE OF THE COORDINATOR

Coordination in research does not mean a program imposed on compliant associates by a domineering leader. Rather, it means directing and integrating research -- on a crop or a problem -- to ensure a balanced focus on the problems that the farmer faces. Simply, it means "organized cooperation." The person responsible for coordination sees that the research planned by the team is carried out on a timely basis and with high standards. The coordinator must be a scientist but, because his role as coordinator requires priority attention, his direct involvement in research may be limited.

A good research project coordinator characteristically is a scientist of high professional standing who is respected by his co-workers and is capable of inspiring them. Much of the coordinator's activities are directed toward solving the problems encountered by scientists in the research program -- supplies, transport, funds, etc. Consequently he must travel to all research sites frequently to evaluate progress, to give advice, to encourage the scientists, and to help remove obstacles to their efforts. Perhaps most important, the coordinator must be impartial. He must not give preference to any research station (the headquarters' station, for example) or scientific discipline in funding, recognition, or attention. He should fairly represent each scientist, each scientific discipline, and each research station in the entire project.

An important consequence of the coordinated approach to crop research is that improvements in the quality of the research are stimulated by the comparison of results of different research stations on a common format and the visits of the coordinating staff and project scientists to the various stations. Individual researchers can benefit greatly from the coordinator's advice and by visiting other experiment stations to see research in progress. A constructive competitive spirit often develops. Individual scientists compare their results with those of the most skilled and experienced researchers, and attempt to elevate the quality of their own research efforts to match the standards set by the best scientists in the project. The quality, and therefore the usefulness, of experimentation can be materially enhanced as a result of this pooling of experience and exposure.

The coordinator should be thoroughly acquainted with all research in all disciplines of the project. As well as conveying information from center to center, he gathers information from international research institutes, other international sources, and programs of other countries, and transmits this knowledge to the appropriate researchers in the project. The coordinator studies all the elements that restrict agricultural production -- whether biological limitations or problems of inputs, storage, transportation, or marketing -- and advises agencies of government about bottlenecks they need to eliminate. In short, the coordinator should be the country's best informed individual on the commodity he represents, providing information to administrators, planners, politicians, and other policy makers, as well as to scientists.

Another responsibility of the coordinator is to compile and organize the research information produced by the project in all disciplines (varietal improvement, cultural management, pest control, etc.), and publish it in an annual progress report. A parallel duty is calling and organizing the annual workshop of all the researchers in the team.

Ideally, the coordinator should be responsible for assembling the annual budget for the project. To do this he requests budget proposals from researchers at each station, assembles them into a unified budget for the entire national project, and submits the budget to the appropriate authority in the research organization.

Because research management on the national level is a heavy burden, the coordinator cannot be deeply involved in experiments. But if the coordinator conducts research, it will help him stay abreast of his field and enhance his stature among his colleagues. Just how much research, if any, a coordinator can effectively do must be judged on a case-by-case basis.

Finally, the location of the coordinator's office is important. There are two main considerations: it should be in a region of the country where the crop in question is important and it should be accessible to decision makers in the research organization and in other government agencies.

THE ANNUAL WORKSHOP

The annual workshop is the heart of a productive research project. At the workshop the project scientists review the past year's research in all disciplines, formulate recommendations based on the results of that research, and plan future research. It is important that all scientists assigned to the project attend. At the workshop they become fully informed about the project's activities and participate in planning the research. Team spirit is built. Other scientists (from universities, for example) who conduct research on the crop should be invited to attend the annual workshop, too. Before the annual workshop, the coordinator compiles the year's research results, and sends them to all scientists so that they can study the data in advance.

The chief goals of the workshop are to review past research, to recommend the release of new varieties or crop management practices based on research to the extension service and to farmers, and to plan the future research program. The agenda for a 4-day meeting might be:

First day

Entire group meets to review, in general, the year's research results. This review is given by the coordinator and senior scientists from each discipline. National authorities report on factors influencing national production of the crop, such as supplies of inputs (fertilizer, insecticide, herbicide, etc.), marketing, storage, and other topics.

Second and third day

The scientists meet by specialty -- breeding, agronomy, pathology, etc. -- to review the research data in detail and to plan the next year's research. If possible, recommendations for the release of varieties and practices for farmers are formulated.

Fourth day

All the scientists meet to hear and discuss the research planned in the disciplinary sessions. Everyone is encouraged to comment on any research plan or recommendation.

If the workshop can be held at different research sites from time to time, project scientists will have opportunities to become familiar with the conditions under which the crop is grown throughout the country. This broadens their experience and increases their value to the country as a whole.

The annual workshop should be the occasion for bringing all national scientists who conduct research on the crop, regardless of institutional affiliation, together with national authorities on the most important subjects that influence crop production. In this way the annual workshop can become a focal point for gathering information on the state of the crop nationally, and thus is likely to influence government policy. -- B.C.W.

Annex H

INTENSIVE COMMODITY REFRESHER COURSES

Other developing countries having many smallholder farmers (including Pakistan and Bangladesh) have used annual commodity refresher courses to keep already knowledgeable extension staff up-to-date on new research results. Each year extension personnel review with the most informed research personnel the production techniques for each major commodity. This provides a quick refresher of standard production practices, and an opportunity for lead researchers to discuss informally their latest findings with extension staff (field assistants); it also provides the opportunity for extension staff to inform researchers how technology components are behaving under farmer conditions in various regions. Often, these courses can be completed in one day per location, but some farm enterprises may require more time, especially the first time such a course is presented. These courses could be used in Malawi until the ADD research units are fully staffed. Once the units are fully staffed, they could be used for those farm enterprises that are not sufficiently important to warrant coverage by a full-time ADD researcher.

In successful courses the participating researchers include the most informed people, and there should be rare exceptions to that principle. The national commodity coordinator, relevant involved staff from the major cooperating research stations, and key supporting discipline research personnel from major stations would usually be involved. The coordinator brings the state-of-the-art technology for the commodity for all regions; cooperating station research personnel provide valuable observations of local performance of the recommended technology; and supporting-discipline personnel provide indepth information on the relationship of recommended practices to special considerations such as disease or insect control.

While termed "courses" these encounters between extension and research staff should not develop communication only from the researcher to the extension staff. Researchers should use these meetings to listen carefully to the extension staffs' views of how technology performs at the farm level, and the problems facing the farmer. Extension staff should come to these meetings prepared to convey accurate and concise information on farmers' circumstances, technology performance, and important problems.

All extension personnel having contact with farmers usually participate in intensive refresher courses for those commodities that are important in their area. This is important for the efficient functioning of a technology system, since communication efficiency falls rapidly with sequential transfers of information. This may appear to consume too much of the researchers' time, but other countries have found it productive. In some countries 20% of the researchers' time is allocated to this

function. If there are 1600 extensionists that need to be involved in an annual short course on maize and if they are available in groups of 40 (a bit larger than ideal), the intensive courses for maize could be done in 40 days. To accomplish this within a short time (one month during winter) two teams of maize researchers could be formed to do the refresher courses. There should be adequate senior maize staff at Chitedze to do this. All principal station research personnel would be expected to be very familiar with all aspects of current maize technology and with current year research results, as they would be if they were working on a well-coordinated program.

To the extent possible, the refresher courses should be a "show-and-do" instead of just an oral presentation. Participants should learn to use new tools and receive copies of tables showing results of experiments or farmer field trials. (This emulates the former work of the cotton extension specialist.) If there is an extension bulletin on the commodity, the refresher course is a good place to distribute the bulletin, or to update it by notation.

Such refresher courses are an important use of extension staffs' time. Some Malawi extension staff already have a crowded schedule for training in the off-season. The schedule will have to be reviewed and priorities developed if the commodity refresher courses are to be accommodated.

Annex I

ITINERARY OF ISNAR REVIEW TEAM

13 April, 198	Team arrived in Lilongwe.
14 April	Team briefed by Mr. W.K. Banda, Principal Secretary, Ministry of Agriculture; and by Dr. T. Legg, Chief Agricultural Research Officer.
	Team discussions with Mr. R.M. Mbowera and staf at Headquarters, Lilongwe Agricultural Development Division.
15 April	R. Melville, G. Wellington, and F. Williams, discussions with Dr. K.M. Mwendemere (Officer i Charge) and staff of Chitedze Research Station.
	E. Gilbert and M. Nyiira, discussions with Mr. W.C.C. Mughogho (Officer in Charge) and staff a Chitala Research Station and with Mr. A.H. Kumwenda and staff at Lifuwu Research Station.
16 April	M. Nyiira and G. Wellington, visit Dzalanyama Ranch, discuss livestock program with Mr. M.B.B. Kasowanjete (Senior Agricultural Research Officer/Ranch Manager); with Drs. Richard Gray and A.P. Mtukuso of Chitedze Research Station.
	E. Gilbert, R. Melville, and F. Williams, discussions with Drs. Boshoff, Edje, Butterwort and Billingsley at Bunda College of Agriculture.
17 April	Team discussions at Lilongwe.
19 April	E. Gilbert and M. Nyiira, discussions with Mr. P.M. Maliya (Officer in Charge) and staff at Mbawa Research Station and with Mr. E.W. Tsonga and staff at Mwimba Research Station.
	R. Melville, G. Wellington, and F. Williams, discussions with Mr. E.S. Mwafulirwa and staff at Kasinthula Research Station and with Mr. J.D.T. Kumwenda and staff at Ngabu Research Station. Visited Shire Valley Cattle Feedlot.

20 April	R. Melville, G. Wellington, and F. Williams, discussions with Program Manager and staff of Ngabu ADD; and with Mr. A.E.D. Muwowo at Makhanga Research Station.
	E. Gilbert and M. Nyiira, discussions with Mr. H.M. Mlenga (Officer in Charge) at Bembeke Hill Research Station and Mr. P.H. Mnyenyembe, Agronomist.
21 April	E. Gilbert and M. Nyiira, discussions with Project Manager, Ntcheu Project.
	R. Melville and G. Wellington, discussions with Mr. E.S. Kabuye, Program Manager, Mzuzu ADD, and staff at Lunyangwa Research Station and discussions with Mr. R.F. Membozanga Sauti, Coordinator Root and Tuber Improvement Program, Lunyangwa Research Station, Mzuzu.
22 April	R. Melville and G. Wellington, discussions with Mr. F.M. Nyirenda and staff at Bakka Research Station.
	E. Gilbert, M. Nyiira, and F. Williams, discussions with Dr. J.H.A. Maida (Officer in Charge) and staff at Bvumbwe Research Station.
23 April	M. Nyiira and F. Williams, discussions with Mr. G.K.C. Nyirenda (Officer in Charge), Makoka Research Station; with E. Gilbert, discussions with Principal and staff at Chancellor College.
	R. Meville and G. Wellington, visited Meru Research Station with Mr. R.F. Membozanga Sauti, coordinator for root and tuber crop research.
24 April	Team discussions in Lilongwe.
26 April	R. Melville, M. Nyiira, and F. Williams, discussions with Dr. Barclay-Smith (General Manager) at Tobacco Research Authority Station.
	E. Gilbert, M. Nyiira, and F. Williams, discussions with Mr. M.H. Nyirongo, Principal Economist, and Mr. A.Y. Babe, Chief Economist of Economic Planning Division.
27 April	Team discussions with Mr. M.L. Muwila, Chief Agricultural Development Officer. E. Gilbert and G. Wellington, discussions with Mr. Doughty (Senior Economist, Evaluation), and his counterpart Mr. Chembesi, and Mr. Mtawali (Senior Marketing Economist).
	R. Melville and G. Wellington, discussions with Mr. Hugh Proverbs (Principal Animal Husbandry Officer).

	G. Wellington and R. Melville, discussions with Dr. G. Thangathanga, Chief Veterinary Officer.
29 April	F. Williams, discussions with Mr. J. Casey (Wood Energy Project) and with D. French, M. Douglas, and P. Bannister on agroforestry.
3 May	M. Nyiira, discussions with Mr M.M.A. Mphepo (Principal Extension Aids Officer) and Mr. C.J.A. Makato of Department of Agricultural Research.
4 May	Wrap-up session with Principal Secretary and staff of Ministry of Agriculture.

THE ISNAR REVIEW TEAM

Elon H. Gilbert is an agricultural economist. His doctoral (Stanford University) dissertation research, done while he was a visiting scholar at Ahmadu Bello University, Nigeria, was among the earlier detailed studies of the economic and social circumstances affecting the use of improved technology by resource-poor smallholders. He has taught and done research at the Universities of Ibadan, Colorado, and Florida, and at the International Institute of Tropical Agriculture. He did project planning and program work for the Ford Foundation in West Africa, and was an advisor for planning in Ghana for three years. Recently, he has accepted consulting work in a number of developing countries.

Ralph Melville, a graduate of Edinburgh University and the Imperial College of Tropical Agriculture, began his work in Africa as an entomologist in Kenya in 1936. He worked in technical agriculture as a scientist and administrator, and after a five-year break for military duty, went on to become the chief agricultural research officer. His tenure as director of agriculture in Kenya spanned the years of independence. From 1965 he joined the Overseas Development Administration (ODA) and was active in forming the Consultative Group on International Agricultural Research. In 1976 he retired from ODA, but remained involved in agricultural development through various consultancies and missions and as a member of international center boards. Mr. Melville died on December 8, 1982 at his home in Kent, after long years of dedicated service to agriculture in developing countries.

Zerubabel M. Nyiira is an agricultural entomologist. He was 23 years with the Ministry of Agriculture, Uganda, as a research officer, principal scientist, director of research, and chief research officer, and taught entomology and crop protection at the University of East Africa and Makerere University, Uganda. He served as a consultant to the OAU Committee on food losses in Africa, and as a member of the research appraisal board of the East African Natural Resources Research Council. For 12 years he was member and Chairman, Executive and Technical Committees of International Red Locust Organization for Southern Africa, Desert Locust Control Organization for Eastern Africa, and the International African Migratory Locusts Organization. He also headed a program of International Cooperative Research for three years before joining ISNAR as a senior research fellow in September 1981.

George H. Wellington received his doctorate in animal science at Michigan State University. His long career in animal science included work with farmers in Michigan, and teaching and research at Cornell University in New York. His research has concentrated on the growth and development of animals, and meat processing and utilization. His consulting work (much of it since becoming Professor Emeritus in 1978), has taken him to Syria, Brazil, and the Soviet Union.

Floyd Williams, a plant pathologist by training (Ohio State), began his agricultural research career at the Ohio experiment station in 1955. He later taught and did research at the University of Maryland before becoming a member of an interdisciplinary regional research team in India. He later worked with the agricultural research system in Pakistan for some six years. A similar period was spent in Washington D.C., working as a research advisor for the U.S. Agency for International Development. This assignment brought substantial renewed contact with the U.S. land-grant university system through the Board for International Food and Agricultural Development and with the international centers through the Consultative Group on International Agricultural Research. He joined ISNAR in early 1982 as a senior research officer.