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MALAWI AGRICULTURAL AND NATURAL RESOURCES RESEARCH MASTER PLAN

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LIST OF ACRONYMS AND UNITS

ACTS	African Centre for Technology Studies
ADD	Agricultural Development Division
ADMARC	Agricultural Development and Marketing Corporation
AGDP	Agricultural Gross Domestic Product
ALDSAP	Agricultural and Livestock Development Strategy and Action Plan
APRU	Agricultural Policy Research Unit
ARC	Agricultural Research Council
ARCT	African Regional Centre for Technology
ARDF	Agricultural Research and Development Fund
ARET	Agricultural Research and Extension Trust
ASAP	Agricultural Sector Assistance Project
ASC	Agricultural Sciences Committee
ASP	Agricultural Services Project
AVRDC	Asian Vegetable Research Development Centre
CABI	Commonwealth Agricultural Bureaux International
CARS	Chitedze Agricultural Research Station
CIAT	International Centre for Tropical Agriculture
CIFOR	Centre for International Forestry Research
CIMMYT	International Centre for Research in Maize and Wheat
CIP	International Potato Center
CONVERDS	Collaborative Network for Vegetable Research and Development in Southern Africa
CRSP	Collaborative Research Support Project
CSC	Christian Services Committee
CSR	Centre for Social Research
CTL	Commodity Team Leader
CVL	Central Vetrinary Laboratory
DAES	Department of Agricultural Extension Services
DAHI	Department of Animal Health and Industry
DAR	Department of Agricultural Research
DARTS	Department of Agricultural Research and Technical Services
DFID	Department for International Development
DRC	Domestic Resource Cost
EU	European Union
FANRR	Foundation for Agricultural and Natural Resources Research
FAO	Food and Agricultural Organization
FRIM	Forestry Research Institute of Malawi
GEF	Global Environmental Facility
GDP	Gross Domestic Product
GIS	Geographical Information System
GDP	Gross Domestic Product
GOM	Government of Malawi
GTZ	German Agency for Technical Development

ICEIDA	Iceland International Development Agency
ICIPE	International Centre for Insect Physiology and Ecology
ICLARM	International Centre for Living Aquatic Research Management
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Agency
IDRC	International Development Research Centre
IFS	International Foundation for Science
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
INIBAP	International Institute for Bananas and Plantains
IPGRC	International Plant Genetic Resources Centre
IPM	Integrated Pest Management
IRDP	Integrated Rural Development Project
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
ITC	International Trade Cooperation
IUFRO	International Union of Forestry Research Organisations
JICA	Japanese International Cooperation Agency
LLDP	Lilongwe Land Development Project
LRCD	Land Resources Conservation Department
M & E	Monitoring and Evaluation
MAGFAD	Malawi/German Fisheries Development Program
MAPPP	Malawi Plant Protection Project
MEPC	Malawi Export Promotion Council
MIPA	Malawi Investment Promotion Agency
MIRTDC	Malawi Industrial Research Technology Development Centre
MoAID	Ministry of Agriculture and Irrigation Development
MoNREA	Ministry of Natural Resources and Environmental Affairs
MTEF	Mid-Term Expenditure Framework
MZ	Malawi Zebu
NARS	National Agricultural Research System
NEAP	National Environmental Action Plan
NGO	Non-Governmental Organisation
NHBG	National Herbarium and Botanic Gardens of Malawi
NLDMP	National Livestock Development Master Plan
NORAD	Norwegian Agency for International Development
NRCM	National Research Council of Malawi
NRDP	National Rural Development Project
NSCM	National Seed Company of Malawi
ODA	Overseas Development Administration
OPC	Office of the President and Cabinet
R&D	Research and Development
RDP	Rural Development Project

RPC	Research and Publications Committee
SABONET	Southern African Botanical Network
SACC	Strategy Area Coordinating Committee
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SADC	Southern Africa Development Community
SAL	Structural Adjustment Loans
SAP	Structural Adjustment Programme
SARRNET	Southern Africa Roots Research Network
SCA	Smallholder Coffee Authority
SMIP	Sorghum and Millet Improvement Programme
SPGRC	SADC Plant Genetic Resources Centre
SSA	Smallholder Sugar Authority
STA	Smallholder Tea Authority
TAMA	Tobacco Association of Malawi
TRIM	Tobacco Research Institute of Malawi
TRF	Tea Research Foundation of Central Africa
UNIMA	University of Malawi
UDLP	Universities Development Linkage Project
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USA	United States of America
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

Conversion Factors and Units

ha	hectare
kg	kilogramme
m	metres
mm	millimeters
MK	Malawi Kwacha
Masl	meters above sea level
p.a.	per annum
m^3	cubic metre

Currency and Equivalent Units

Currency Unit	=	Malawi Kwacha (MK)
US$ 1.00	=	MK 43.00 (October 1998)

FOREWORD

The Malawi Agricultural and Natural Resources Research Master Plan provides clear guidelines for the execution of demand-driven research. The plan sets out research strategies in agriculture and natural resources to meet the challenges of improving productivity in the next decade. The research guidelines presented in this document have taken on board commodity-specific strategies in the agricultural and natural resources sectors in Malawi. The plan has closely adhered to the overall government development strategies and objectives as articulated in the Vision 2020 document. It is, however, not a rigid blue print, but rather a dynamic, rolling research strategy which will require continuous reviewing and updating to be in conformity with any possible changes in Agriculture and Natural Resources for the overall 10 year planning horizons adopted in this document.

The bulk of this Research Master Plan was a contribution of multi-disciplinary teams of local consultants who facilitated the production of eight sectoral reports. Another team of three local consultants was put in place to prepare the main document, assisted by an international consultant who made occasional visits to Malawi and provided advisory services. The work embodied in this master plan emphasises Agricultural and Natural Resources Sector analysis, production constraints, research needs and priorities, and government policies and goals for the sector. It is envisaged that the cost implications and overall budget for the plan will be developed at the implementation phase.

This Master Plan has put up a good foundation on how to enhance Malawi's research efforts to increase the sector's productivity. It has been an affective mechanism for developing a comprehensive overview of agricultural and natural resources research, highlighting crucial issues such as available resources in Chapter I; agricultural policies in Chapter II; organisation, infrastructure and resources of the research system in Chapter III; technology output and impact in Chapter IV; research priorities in Chapter V; improvement mechanisms to the whole research system in Chapter VI; and an implementation plan in Chapter VII. This has also succeeded in establishing a vastly improved research information and database. It is hoped that this is the foundation on which a sustainable National Agricultural and Natural Resources Research System shall be built on.

Increasing productivity in the Agricultural Sector and achieving sustainable utilisation of the natural resources is a big challenge to all Malawians in the light of poverty and limited financial and human resources. I, therefore, appeal to all scientists, extensionists, donors, the universities in Malawi and the private sector for their full support and commitment in the implementation of the research plan which, I hope, will result in increased productivity in agriculture and sustainable utilisation of natural resources.

A.A UPINDI
CHAIRMAN, NATIONAL RESEARCH COUNCIL OF MALAWI
AND SECRETARY TO THE PRESIDENT AND CABINET

ACKNOWLEDGEMENTS

The Agricultural Sciences Committee (ASC) of the National Research Council of Malawi (NRCM) was mandated, among other activities, to coordinate the preparation of the Agricultural and Natural Resources Research Master Plan. This was made possible with funding from the GOM/World Bank-funded Agricultural Services Project (ASP) in the Ministry of Agriculture and Irrigation Development. The ASC benefited greatly from the services of Dr E.H.C Chilembwe, ASC Coordinator and Dr I.M.G Phiri, ASC Research Officer, whose professional contribution in the coordination and preparation process of the master plan is greatly appreciated.

The NRCM would like to acknowledge the contributions made by several individuals and teams who worked tirelessly in the production of this research master plan, including: the team of local consultants Dr J.T. Munthali, Dr C. Mataya and Prof. V.W Saka; the international advisor Dr J. Coulter; the eight task force teams chaired by Mr W.F Kumwenda, Dr M. Ngwira, Dr J.D.T Kumwenda, Mr S.A Mapila, Mr M.W.M Shaba, Dr W.T Gondwe, Dr J.P Mtimuni, and Mr G.K Munthali, who worked tirelessly to produce detailed commodity reports which constituted the major input into this document. The following individuals are recognised for their editorial assistance; Dr G. Matita, Dr A.J. Chiyembekeza, Mr. J.B. Chuma, Dr A.R. Saka, Dr A.T Daudi and Mr C.J. Kharapuwa.

The Master Plan preparation process also received encouragement, support, advice and direction from ASC Board members and former Principal Secretaries of the National Research Council of Malawi including Dr S.S.Kamvazina, Mr D.C.W. Kambauwa, Mrs E. Mede and Mrs H. Kawalewale.

Special thanks go to the Secretary for Agriculture and Irrigation Development; Secretary for Natural Resources and Environmental Affairs; Principal, Bunda College of Agriculture; and all farmers, research scientists, heads of the research institutions and various government departments that were forthcoming with human resources, information and facilities related to this work. The Master Plan was prepared by Malawians, too numerous to mention individually, their efforts are generally acknowledged.

The NRCM would like to greatly acknowledge the financial and technical assistance received from the World Bank in support of the preparation process of this Master Plan.

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DR CHRISSIE N. MWIYERIWA
SECRETARY FOR NATIONAL RESEARCH COUNCIL OF MALAWI

EXECUTIVE SUMMARY

INTRODUCTION

Malawi is endowed with abundant renewable natural resources such as land, water, fish, wildlife and forests that can sufficiently provide a basis for sustainable socioeconomic development. However, its agricultural and natural resources sectors are characterised by low productivity which is a major constraint to food security at household and national levels. Malawi faces problems in the agricultural and natural resources sectors similar to those of other African countries south of the Sahara, which include: rural poverty; a rapidly increasing population with concurrent pressure on the limited agricultural land; loss of forest, fish and biodiversity; erratic and unreliable rainfall patterns; high incidences of pests, diseases and parasites; lack of labour saving technologies and low mechanisation levels; declining soil fertility; inferior crop varieties; insufficient postharvest technologies; poor processing and utilization of value adding processes; declining livestock populations; inferior livestock breeds and genotypes; and water pollution. These problems have worsened the country's socioeconomic status where more than 64% of the population is estimated to live below the poverty line.

Although many factors contribute to low productivity, science and technology has been cited as one of the major factors. The role of research is to generate improved technologies and new knowledge that will have impact on productivity. These innovations must be sustainable in terms of profitability to producers and be environmentally friendly. In Malawi, despite the fact that there has been substantial investment by government and cooperating partners in research services, the impact on agricultural and natural resource production has not been significant. Reportedly, research has not developed enough demand driven technologies and has overlooked fundamental aspects in technology development and transfer. These aspects include: (i) lack of a fully developed national agenda of priorities and strategies to address constraints faced by users of technologies; (ii) inadequate consultation and involvement of stakeholders in the development of research priorities and strategies; (iii) duplication of research efforts among various institutions; (iv) donor influence in research programmes; (v) unreliable and limited government funding for core research programmes; and (vi) limited involvement of stakeholders in development and funding of problem-oriented research programmes.

Because of the above perceived deficiencies in technology development, the Agricultural Sciences Committee (ASC) of the National Research Council of Malawi (NRCM) was mandated to prepare a national plan for agriculture and natural resources research. This plan deals with agriculture and renewable natural resources with a focus on forestry and fisheries for the latter. The plan is designed to outline research strategies to meet challenges in the agricultural and natural resources sector over the next decade and to set out research priorities that are consistent with government policies for sustainable productivity.

The ASC accomplished the task of preparing the research master plan by using a multi-disciplinary team approach involving local consultants who prepared detailed commodity reports on production strategies and research action plans in: (i) agricultural mechanisation: (ii) field crops; (iii) forestry; (iv) horticulture and plantation crops; (v) sustainable management and utilization of natural

resources; (vi) fisheries; (vii) animal production and health; and (viii) post-harvest technologies. These commodity reports formed the major input of the master plan To address current production and research constraints, the Master Plan highlights strategies that will improve technology generation and transfer for increased poroductivity. These include research funding strategies, reorganisation and management changes and research priorities.

FUNDING

Funding for research in Malawi has been unstable and inadequate. This has detrimental effects on the morale of scientists and quality of research. In most cases, funds from donors have been forthcoming but with little or no counterpart funding making the funding mechanism unsustainable. However, government now appears to recognise the crucial role research plays in promoting productivity of agriculture and natural resources for the country's socioeconomic growth, although this is not currently being translated into a budget priority. Since poverty alleviation is being regarded as high priority on its development agenda, it is hoped that the budget for agricultural and natural resources research will be increased as a worthwhile investment in relation to other demands on government funds. Currently, the recurrent budget allocation to research relative to Agricultural Gross Domestic Product (AGDP) is estimated at 0.78% which is much lower that the 2% level suggested by the World Bank. It has been proposed in the plan that this be increased gradually to at least 2% of AGDP; the levels of allocation being determined by sectoral or research priorities as outlined in Chapter V. The plan has also proposed mechanisms to diversify funding and to increase government funding for research.

ORGANISATIONAL AND MANAGEMENT CHANGES

The agriculture and natural resources research system is currently fragmented as outlined in Chapter III. Thus, scientists and equipment are dispersed over too many research institutions resulting in inefficient use of facilities and resources, duplication of efforts and consequently a considerable waste of public funds. The plan provides for strengthening of the present research system in order to address research priorities in a systematic and sustainable manner. It also puts forward proposals as to how the agricultural and natural resources research could be organised and how the available funds should be managed for improved impact during the next decade.

The plan, therefore, calls for management of research to adhere to farmers' priority problems and encourages a reward system that focuses on scientists who produce useful results in terms of impact rather than "successful" results as measured by experimental work. A weak linkage between researchers, extension staff and farmers has also been identified in the plan as contributing significantly to the low adoption rates of developed technologies besides other equally important and complex factors that affect technology uptake. As a way of improving the agricultural and natural resources research system, a restructuring strategy has been proposed to ensure a more effective and efficient organisation.

Globalisation of trade, information and research should be taken into account as these affect Malawi's interregional and international trade. Malawi must, therefore, take advantage of the global developments and make the best combination of farmers' skills, imported and locally generated

technologies to add value to its local and imported raw materials. The research master plan, therefore, advocates a ninefold purpose for the reorganisation of the research system as follows: (i) to make staff and physical resources of the research system more productive by operating in multi-disciplinary and multi-institutional teams; (ii) to make it more responsive to the needs of the farming and agro-industry community; (iii) to enable the Government and the donor community to get better value for money by managing its financial resources efficiently; (iv) to make it more proactive to changes in government policy as well as domestic and foreign market opportunities; (v) to ensure a close working relationship among the Ministry of Agriculture and Irrigation Development (MoAID), Ministry of Natural Resources and Environmental Affairs (MoNREA), the Universities in Malawi, the private sector, Non-Governmental Organisations (NGO's) and the donors; (vi) to ensure that personnel policies are conducive to motivation and good performance; (vii) to ensure that administrative procedures and financial control reflect the primary needs of a productive research system; (viii) to improve the dissemination of technologies through better research/extension/farmer linkages and transfer mechanisms; and (ix) enhance the capacity of end-users to adopt the technologies.

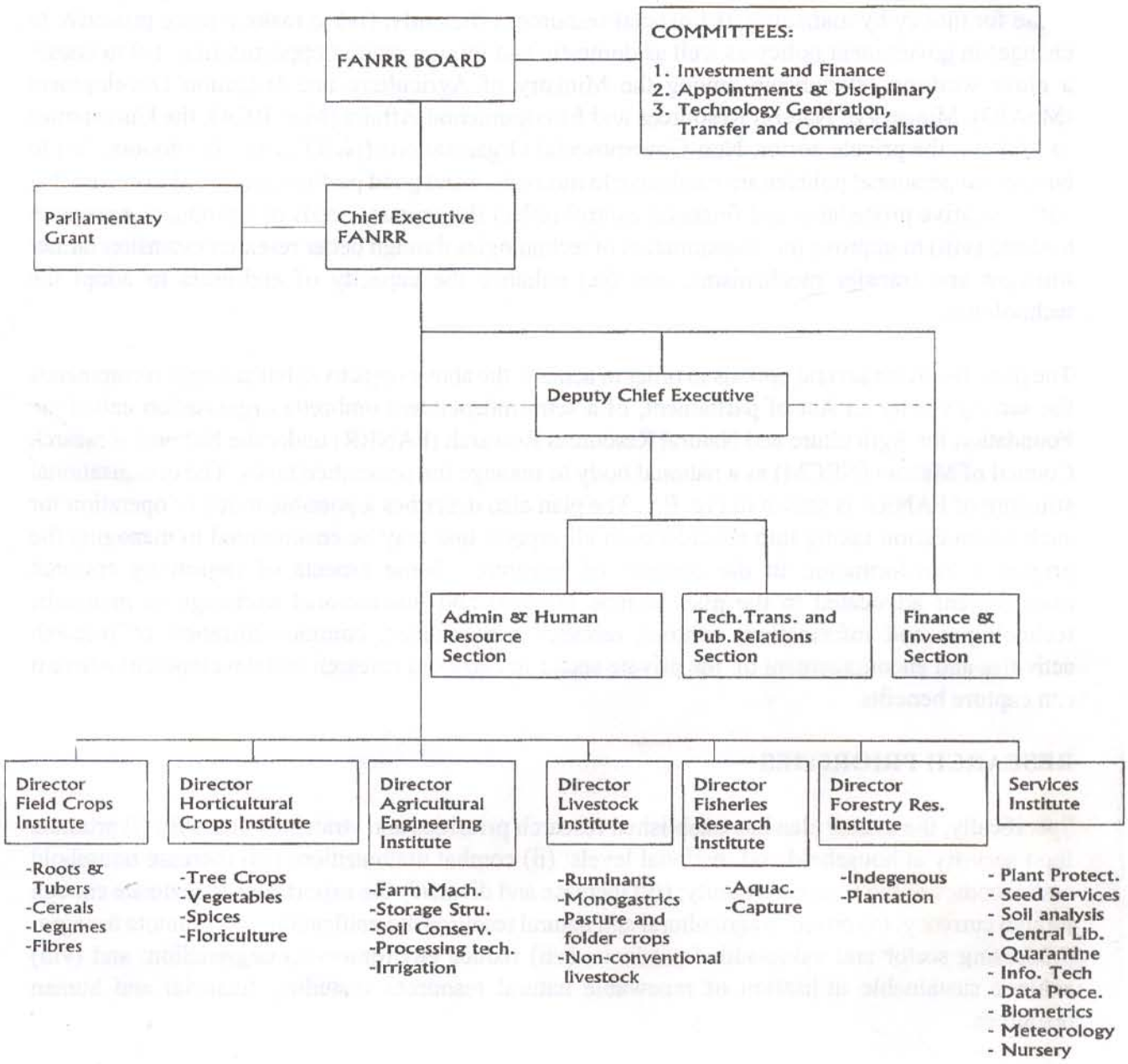
The plan dwells on several options in order to achieve the above objectives but strongly recommends the setting up, by an Act of parliament, of a semi-independent umbrella organisation called the Foundation for Agriculture and Natural Resources Research (FANRR) under the National Research Council of Malawi (NRCM) as a national body to manage the prescribed tasks. The organisational structure of FANRR is shown in Fig. E.1. The plan also describes a possible mode of operation for such a foundation taking into consideration all aspects that may be encountered in managing the proposed transformation in the conduct of research. Some aspects of improving research management advocated in the plan include regional and international exchange of materials, technologies and information, contract research programmes, commercialisation of research activities and encouragement of the private sector to carry out research and development where it can capture benefits.

RESEARCH PRIORITIES

Specifically, the master plan has established research priorities and strategies that will: (i) promote food security at household and national levels; (ii) combat malnutrition; (iii) increase household cash incomes of the rural community; (iv) increase and diversify the export base to generate enough foreign currency; (v) promote agricultural and natural resource diversification; (vi) promote the agro-processing sector and value-added products; (vii) reduce environmental degradation; and (viii) achieve sustainable utilisation of renewable natural resources including financial and human resources.

In setting out the priority research strategy, particular emphasis has been given to the need for an integrated approach to research in the agriculture and natural resources sector, realizing that crops and livestock production, irrigation, forestry, the environment and water are clearly interrelated at various levels of management. This will be complemented with a sustainable research structure designed to facilitate multi-disciplinary and inter-institutional approach which will include broadening and stabilizing financial support by commercializing some operations.

Fig E. 1 ORGANISATIONAL STRUCTURE OF THE FOUNDATION FOR AGRICULTURAL AND NATURAL RESOURCES RESEARCH (FANRR)



Research priority setting is a means of making efficient allocation and use of limited human, financial and physical resources in the implementation of research programmes to achieve desired government goals and objectives. The priority setting concept has been used to set research priorities among commodity groups, commodities, constraints to productivity, researchable areas and research focus in line with the current government goals and objectives which place poverty reduction as a central policy objective. The concept has been developed from a combination of four research planning methods: (i) congruency method; (ii) the weighted scoring method; (iii) comparative advantage method, measured by the domestic resource cost ratio; and (iv) intuition. The relative advantages and disadvantages of each method have been clearly outlined in the plan.

Levels of Priority

Research priorities for agriculture and natural resources have been established at five levels using various criteria as outlined in Chapter V. These are: (i) Level 1- among commodity groups, for example cereals, fruits, monogastric livestock, aquaculture and indigenous forests; (ii) Level 2 - among commodities within a commodity group, for example maize, groundnuts, cattle, chickens and chambo; (iii) Level 3 - among constraints to productivity, for example declining soil fertility, pests and diseases, labour shortage and lack of appropriate varieties; (iv) Level 4 - among researchable areas, for example crop improvement (breeding), crop management (agronomy), irrigation and farm mechanisation; and (v) Level 5 - research focus which outlines specific research projects, for example development of high yielding and early maturing flint maize varieties and improvement in compost manure making procedures. A summary of priorities among commodity groups and commodities is shown in Table E.1 while a summary of priority researchable areas in the agriculture and natural resources sector is presented in Table E.2.

TECHNOLOGY TRANSFER

The master plan has recognised deficiencies in the dissemination of developed technologies and yet the ultimate measure of success of any agricultural or natural resource technology is its uptake by end-users and impact on production. Several factors for this low adoption rates have been advanced and these include weak linkage between research and extension and little emphasis of research efforts on users' actual needs. The plan also recognises that technology transfer is a complex issue, since technology uptake rates are dependent on different factors. The document recommends that the existing mechanisms for technology transfer be improved by strengthening research-extension-farmer linkages and by creation of an effective two-way system of communication. This should be complemented by use of participatory approaches in defining research problems, utilisation of a wide range of dissemination mechanisms and the establishment of Research Extension Liaison units within FANRR and its institutes to facilitate technology transfer. The technology transfer strategy in the plan also advocates establishment of documentation centres at strategic locations such as ADD headquarters; strengthening and broadening outreach programmes; strengthening the technology clearing committee which will appraise and approve annually all technologies developed; identification of potential end-users who will act as early adopters, evaluators and trainers; identification of highly skilled communication personalities who can work with researchers and extension staff in re-packaging research results into messages and fact sheets for end-users; identification of end-users targeting those with the will and capacity to adopt the technologies;

Table E.1 Priority ranking of commodity groups showing commodities considered of high and medium priority

Priority rank	Commodity group	Commodities listed in order of priority
1	Cereals	Maize, rice, sorghum, millet
2	Industrial and cash crops	Tobacco, sugarcane, tea, cotton, cotton, coffee, rubber, macadamia, cashew
3	Roots and tubers	Cassava, sweet potato, potato
4	Vegetables	Tomato, cabbage, onion, pumpkin, amaranthus, carrot, mushroom
5	Legumes and oilseeds	Beans, groundnuts, pigeon peas, soyabeans, sunflower, cowpeas
6	Fisheries	Capture fisheries, aquaculture
7	Livestock	Cattle, chickens, goats, pigs, sheep
8	Fruits and flowers	Banana, mango, citrus, flowers, pineapple, guava, avocado pear, apple, peach
9	Spices	Chillies, paprika, ginger, tumeric
10	Forestry	Indigenous, plantation, trees on farm

Table E.2 Summary of priorities among researchable areas for crops, livestock, fisheries, forestry and environmental issues.

Priority researchable areas for crops	Priority researchable areas for livestock
1.0 Soil fertility and plant nutrition 2.0 Crop improvement 3.0 Crop management 4.0 Labour saving technologies 5.0 Post harvest technologies 6.0 Pests and diseases 7.0 Irrigation and water management	1.0 Feeds and nutrition 2.0 Livestock management 3.0 Rapid stock multiplication 4.0 Parasites and diseases 5.0 Breed improvement 6.0 Processing, storage and utilisation
Priority researchable areas for forestry	**Priority researchable areas for environment**
1.0 Seed production, storage and quality 2.0 Forest management 3.0 Species improvement 4.0 Fire prevention and control 5.0 Pests and diseases	1.0 Deforestation prevention and control 2.0 Land degradation, prevention and control 3.0 Sustainable utilisation of natural resources 4.0 Water pollution prevention and control 5.0 Biodiversity conservation 6.0 Climate variability management
Priority researchable areas for capture fisheries	**Priority researchable areas for aquaculture**
1.0 Managements strategies 2.0 Fishing methods and practices 3.0 Post harvest technologies 4.0 Fishing vessels and gear 5.0 Fish biology and ecology	1.0 Fingerling production and management 2.0 Feeds and fish nutrition 3.0 Production sytems 4.0 Genotype improvement 5.0 Pond management 6.0 Labour saving technologies 7.0 Predator control

improvement of collaboration with the agro-business institutions such as MIPA and MEPC with the aim of developing business ventures involving application and commercialisation of technologies.

IMPLEMENTATION

The main thrust of the implementation phase of this research master plan is the revitalisation of the research system by prudent use of the available human, physical and financial resources coupled with rationalisation of the research agenda through contract research mechanisms, commissioned research, commercialisation of some research activities and private sector involvement. The central feature of the plan is, therefore, the setting up of FANRR, a semi-independent parastatal organisation which is expected to prudently utilise the available human, financial and physical resources; focus more on stakeholder needs; review research priorities; and take advantage of globalisation developments in the agriculture and natural resources sector.

The implementation schedule for this plan has been established in Table 7.1 (chapter VII) in which specific research issues to be addressed have been outlined. Production strategies for various commodities have also been outlined in Table 7.3. Clearly, FANRR and its respective institutes will take a leading role in operationalising the stated research strategies to ensure the sustainable development of the sector. It is also hoped that the establishment of this foundation shall put in place a monitoring and evaluation system, financial management system, information system and research guidelines to ensure accountability by scientists and impact assessment of technologies for continued, justified support and funding from stakeholders.

CONCLUSION

Maximisation of the role of research in agricultural and natural resources productivity requires that: (i) research is appropriate for smallholder farmer needs; (ii) dissemination mechanisms for technology are broadened through utilisation of a wide range of technology dissemination mechanisms; (iii) technologies are realistic in terms of inputs and costs; and (iv) access to credit is made easy at affordable interest rates. The research system will, therefore, have to address this short fall in order to meet the challenges of increased productivity.

This master plan is a comprehensive guide aimed at assisting and directing researchers in the execution of a priority research programme in Malawi. The plan has clearly defined priority researchable areas of the sector and though it is not a rigid blue print, it is hoped that implementors of research will adhere to it as much as possible. The implementation of the plan will be in accordance with the current government goals and objectives. The successful implementation of this plan, as indicated in Chapter VII, will be measured by the impact it will have on increased productivity of the agricultural and natural resources sector which, it is hoped, will be translated into rural poverty reduction. The nation's desire to achieve sustainable socioeconomic development, as articulated in the Vision 2020 document, is dependent on the successful implementation of the plan.

CHAPTER ONE

NATURAL RESOURCES, LAND USE AND AGRICULTURE

1.1 INTRODUCTION

Malawi is a subtropical country situated between latitudes 9° and 18° S and longitudes 33° and 36°S in southeastern Africa with a total surface area of 11.8 million ha. The land area covers 9.4 million ha. The surface area of all water bodies, which comprises of Lake Malawi, Lake Chilwa, Lake Chiuta and numerous rivers, constitute about 2.4 million ha. The Malawian portion of Lake Malawi takes an area of about 2.1million ha, out of the total lake surface area of 3.1 million ha. Shire river is the only outlet of Lake Malawi and drains into the Zambezi river.

The country is endowed with a number of renewable natural resources such as land, water, fish, wildlife and forests which provide the basis for the country's sustainable socioeconomic development. Agriculture is the mainstay of the economy. It contributes 36% to the country's GDP and employs more than 80% of the total labour force. The agricultural sector accounts for 90% of export earnings, tobacco being the major export earner followed by tea and sugar. It is estimated that 64% of the population live below the poverty line. Hence, the primary objective of government policy, as expressed in Vision 2020, is to improve the livelihoods of the population through better household food security, improved nutrition and increased cash income.

This Chapter gives an overview of Malawi's renewable natural resources including land, water, fish, wildlife and forests that provide the basis for the sustainable socioeconomic development of the country. It also describes the main characteristics of population growth, environment, the climate and presents the agricultural and natural resource situation incorporating production levels of various commodities and their potential.

1.2 DEMOGRAPHY

The human population is currently estimated at 9.8 million, up from 3.9 million in 1965, of which 50% is under the age of 15, implying a high dependency ratio. The population growth rate is about 1.9% per annum (NSO, 1998). Women constitute about 52% of the population. The 1992 Malawi demographic and health survey (UNDP, 1997) reported infant, under-five and maternal mortality rates of 135 per 1,000 live births, 234 per 1,000 and 620 per 100,000 live births, respectively. Life expectancy at birth is estimated at 48 years, which is quite low by international standards.

1.3 CLIMATE

Malawi's climate is characterised by three main seasons: a cool and dry season (May to August); a warm and dry season (September - November) and a warm and wet season (November -April). In some areas, especially in the high plateaux, it is relatively cool from May to July and intermittent showers called "chiperoni" are common. Malawi's tropical continental climate is influenced mostly by the Indian Ocean. The main rain bearing system is the Inter Tropical Convergence Zone (ITCZ) a broad zone in the equatorial low pressure belt towards which the northeasterly and southeasterly

trade winds converge. The ITCZ produces widespread rains throughout Malawi beginning in the Southern region and progressing northwards. Annual rainfall ranges from 600 to over 3000mm, its distribution being influenced by topography and proximity to the Indian Ocean. Rain shadow areas such as the Shire valley, west of Shire highlands, Lake Chilwa, and northwest of Viphya and Nyika plateaux experience the lowest rainfall, whereas, highest rainfall is experienced in high altitude areas such as Mulanje, Nyika, Misuku and Viphya plateaux. On average, 70% of the country receives between 800 and 1,200mm of rain per year.

Temperatures range between 20 and 35^{0}C. Mean annual temperatures range from 12 to 15^{0}C, with the highest temperatures at the end of October or early November and the lowest in June and July. The highest mean temperatures are in the Lower Shire (25 to 26^{0}C) and along the lakeshore (23 to 25^{0}C). In these areas the mean maximum temperatures can reach 35 ^{0}C and the absolute maximum can exceed 42^{0}C. Lowest mean annual temperatures (13 to 15^{0}C) are recorded over the high Nyika plateaux, Dedza and Mulanje mountains and other high altitude areas. Relative humidity is highest from January to March at 60-80% and lowest in September and October at 40-60%.

1.4 LAND RESOURCES

The country occupies a total area of 11.8 million ha, of which 9.4 million ha is land and the remaining being water. Of the total land area, 28% is in the northern region, 38% in the central region and 34% in the southern region. Physiographically, Malawi can be divided into five zones as follows:

1.4.1 High Plateau

This consists of areas 1500 to 2400 metres above sea level (masl) with slopes ranging from 5% to 15% and includes the Nyika, Viphya, Zomba, Dedza and Mulanje. A large proportion of this zone is covered by forest reserves and national parks. The natural vegetation is *Brachystegia* woodlands with rainfall exceeding 2000mm per year.

1.4.2 Hill Country

This consists of areas 1400 to 2400 masl with moderate to steep slopes. The zone covers the dissected Nyika, Viphya, Zomba, Mulanje, Dowa, Misuku and Dedza hills. Most of the areas have been cleared and their deep soils and relatively high rainfall (up to 2000mm) make this zone suitable for agriculture.

1.4.3 The Plains

This zone consists of areas 600-1400 masl with slopes of 2%-5% and rainfall of 1000 to 1500 mm. The zone constitutes the Lilongwe - Kasungu plain and Phalombe plain. The natural vegetation consists of various forms of *Brachystegia, Combretum* and grassland. The plains constitute the largest proportion of arable land in the country.

1.4.4 Rift Valley Scarp

This consists of areas 500-600 masl, with steep slopes and rainfall of 800-1000 mm. The scarp includes most of the Thyolo and Livingstonia escarpments and has mostly woodland savanna vegetation. Although these areas are suitable for agriculture, their steep slopes make cultivation and soil conservation difficult.

1.4.5 Rift Valley Floor

This zone comprises mostly the shores of Lake Malawi through Bwanje valley and the Shire valley. The zone is 30-500 masl and has mostly flat terrain with rainfall ranging from 800 mm in the Shire Valley to 1500 mm on parts of the lakeshore. Although the zone is suitable for rainfed agriculture, the short duration rains and high temperatures necessitate the use of supplementary irrigation for sustainable crop production.

1.5 LAND USE AND TENURE

Of the total land area of 9.4 million ha, about 31% is suitable for rain-fed agriculture, 31% is marginal and 37% is unsuitable. The challenge facing agriculture, therefore, is to convert some of the presently marginal and unsuitable land for sustainable cultivation. The National Environmental Action Plan estimated that 49% of the country's land was under cultivation in 1990, an indication that 18% of the cultivation was being done on unsuitable or marginal land (NEAP, 1994). Movement away from traditional agriculture to improved management through improved soil fertility and effective, soil and water conservation could make most of the unsuitable and marginal land productive.

Table 1.1 presents the regional distribution of land in terms of suitability. It shows that under current rain-fed conditions and traditional management (using local varieties, manual labour, poor soil conservation, no fertiliser and poor extension services), the total suitable land is about 2.9 million ha. However, with improvements in management including use of improved cultivars, fertilisers, extension services and pesticides, the amount of suitable land could almost double to 5.7 million ha. This would be due to the conversion of some currently marginal and unsuitable lands for agricultural use.

Most of the customary land is cultivated by smallholder farmers using traditional farming systems. Due to increasing human population and density (87 persons/km^2), the land holdings under the smallholder system are becoming smaller. For example, some 1.6 million smallholder farm families cultivate 1.8 million ha of land, and approximately 72% of these cultivate less than 1.0 ha, and 41% less than 0.5 ha. The average area cultivated by individual households in the < 0.5 ha category is 0.28 ha. About 6% of the households cultivate more than 2.0 ha. Due to this pressure, fallow periods for restoring soil fertility have been reduced greatly in the smallholder farming systems, and crop production is expanding to marginal and less fertile areas. This is leading to severe deforestation, soil erosion hazards, and general degradation of the natural resource base. This problem is most serious in the southern Malawi as compared to central and northern Malawi.

Table 1.1: Present and potential land suitability by region (x1,000 ha)

Quality of land	Northern Region		Central Region		Southern Region		Total	
	Tradition	Improved	Tradition	Improved	Tradition	Improved	Tradition	Improved
Suitable	624	1515	1659	2650	672	1577	2955	5742
%	7	16	18	28	7	17	31	61
Marginal	800	508	956	399	1208	745	2963	1652
%	9	5	10	4	13	8	31	18
Unsuitable	1284	684	1058	623	1169	728	3511	2035
%	14	7	11	7	12	8	37	22
Total	2707	2707	3673	3673	3047	3049	9429	9429
% total land area	29	29	39	39	32	32	100	100

Source: NEAP 1994.

Human population pressure on land also has serious implications on livestock production. The declining natural grazing areas and resources have resulted in the keeping of fewer large ruminant animals. Farmers are forced to keep small stock, while exploring the possibilities of stall feeding, which is still not well developed in Malawi. Average yields of several important crops have either stagnated or declined over the last decade (World Bank, 1995b). Static food crop production indicates that many smallholder farmers devote most of the land and time on producing food crops to meet increasing food demands. Households usually with less than one ha only manage to produce 40-70% of the annual staple requirements which result in food shortages that lead to malnutrition and under nutrition, especially among children.

Land ownership in Malawi is currently in five distinct classes viz.:

1.5.1 Customary Land

This is land held in trust by the President, who in turn has delegated this authority to local chiefs. The chiefs distribute the land to people who gain recognised ownership of the land but cannot trade it. A coherent system in the distribution of the land exists in both the matrilineal and patrilineal societies and ensures that there is no undue interference with recognised ownership.

1.5.2 Leasehold Land

This is part of private land that is leased by individuals/organisations. The lease period varies with type of land and purposes for use, but most agricultural land falls into 21 year lease category.

1.5.3 Registered Land

This falls into customary land and adjudicated land. Customary registered land exists in Lilongwe

District only where land is registered in area leaders' names with all the families and land sizes registered. There is some freehold status in that each family can trade in its holding by leasing out or selling bits with the group's consent. The group can, therefore, use this land as collateral in obtaining loans though this has not been the case. The adjudicated land, which is basically a simplified leasehold system that allows for owners to have a certificate for a piece of land on the basis of a survey and registered number, is currently in place in the cities of Lilongwe and Blantyre.

1.5.4 Freehold/Certificate

This class embraces private land subdivided into: (i) Freehold land granted to persons in freehold with no rent and no government control over transactions on it, (ii) Certificate - an extinct colonial system of ownership which allowed settlers to obtain a certificate for land they were holding, and (iii) Public Lands - land for government use, for example for hospitals, schools, forest reserves and National Parks.

1.6 SOILS

The country has five major soil classes and these have been defined as follows:

1.6.1 Latosols

These are red-yellow soils with moderate to strong acidity (pH 4.0-6.0) and are among the best agricultural soils in the country. They include the ferruginous soils of the Lilongwe plain and some parts of the Southern region, and the weathered ferrallitic soils that cover large parts of the plains along the western border of the country. Those with a high ferrallitic content normally have low natural fertility and get exhausted easily. In high rainfall areas latosols get leached.

1.6.2 Lithosols

These soils occur mostly in areas of broken relief in the country and mostly include the shallow stony soils that are associated with steep slopes. The soils have limited agricultural potential, but are suitable for the growing of trees.

1.6.3 Calcimorphic Soils

This group includes the alluvial soils of riverine plains; the vertisols of the lower Shire valley and the Chilwa/Phalombe plain; and the mopanosols in the Liwonde and Balaka areas. Such soils have a pH of 6.5-8.5 and are gray to grayish brown in colour.

1.6.4 Hydromorphic Soils

These are grey soils found mostly in localised marshy area (dambos) and seasonally or permanently wet areas such as the Lake Chilwa plain and Lower Shire valley.

1.6.5 Vertisols

Vertisols are the dark brown to black soils mostly found in the Lower shire Valley around Ngabu. The soil pH ranges from 7.0 to 8.5 with a base saturation of 100%. The dominant clay minerals are the 2:1 lattice montmorillonitic clays which expand when wet and shrink upon drying. These soils are generally fertile, but crop production is constrained by an erratic and unevenly distributed rainfall pattern.

Most of the soils on the escarpment slope and plateaux are heavily leached and of medium fertility and therefore require good management and proper conservation practices for sustainable production. Soils in the hilly places are shallow and the areas are mostly used as catchment areas and for the protection of indigenous trees and vegetation. On the other hand, the soils of the rift valley are of alluvial origin and therefore rich in nutrients and ideal for agricultural production, although moisture becomes a limiting factor.

1.7 MINERAL RESOURCES

Information on Malawi's mineral resources is scanty. Identified resources include bauxite in Mulanje and rare earth elements such as monazite and strontianite. In addition, traces of gold have been found in the Lisungwi valley, although the levels have not been quantified. Some industrial chemicals have also been identified. These include deposits of limestone, coal, marble, vermiculite, kaolinitic clay, glass sands, and phosphates. Exploitation of these minerals, however, is still in its infancy. The Portland Cement Company has a quarry and clinker factory at Changalume in Zomba. There is also a coal mining facility at Kaziwiziwi in Rumphi and several small limestone plants around Balaka. The Optichem-Kynoch Fertiliser Company is currently looking at the feasibility of incorporating phosphate formulations from Tundulu rock in Mulanje.

1.8 WATER RESOURCES

The surface water resources of Malawi comprise a network of rivers and lakes, dominated by Lake Malawi. Other extensive water bodies include Lake Chilwa, Lake Chiuta, Lake Malombe, and the Shire River. Other important rivers include Songwe, North and South Rukuru, Dwambazi, Dwangwa, Bua, Linthipe, Lweya, Ruo and Mwanza. The surface water is totally dependent on rainfall, and most rivers, and some lakes, displays seasonal flow patterns. Although the ground water resources have not been quantified, two types of aquifers have been identified, the extensive but low yielding basement aquifer of the plateaux area and the high yielding aquifers of the Lakeshore Plain and in the Shire Valley.

Approximately 200,000 ha of Malawi's cultivable land can potentially be irrigated. It is estimated that 50% of this land is suitable for small scale irrigation. However, only 27,000 ha is currently under irrigation, of which about 16,000 ha are on two large sugar estates (Dwangwa and Nchalo). Neither the surface nor underground water resources are extensively used. The main potential for medium-sized and large scale irrigation development lies along the lakeshore, using water from the lake and from gravity fed canals. Malawi is also largely dependent on its water resources for the generation of hydroelectric power.

1.9 WILDLIFE RESOURCES

Malawi is endowed with diverse flora, fauna and microbiota ranging from low lying rift valley woodlands to montane forest grasslands and water bodies with at least 3,500 plant species, 4,000 animal species and 1,000 microorganisms that have been described so far. To protect the rich biodiversity, government has established five national parks and four wildlife reserves covering 1.3 million ha of land. The Lake Malawi National Park, which was set up in 1980, is the first freshwater and underwater national park in Africa and is now a United Nations World Heritage Site. The current contribution of wildlife to the economy is small largely due to the unexploited tourism potential.

1.10 FISH RESOURCES

Malawi's water ecosystem has diversified fish resources consisting between 500 and 1,000 species. Almost all the fish species, except six, are endemic to Malawi. Fish production in Malawi rose dramatically from 20,000 tonnes in 1965 to 88,000 tonnes in the 1987 but has since declined to about 50,000 tonnes in 1995 (Table 1.2). The anticipated potential is well in excess of 150,000 tonnes/year. There are about 11,000 traditional fishermen and 33,000 assistants country-wide with a capacity of 12,000 fishing crafts using gill nets, seine nets, long lines, hand lines and traps. In addition, there are about 20 licensed commercial fishing companies that own 25 fishing units (18 demersal pair trawlers, three stern trawlers, and four pair ring netters).

Officially, fisheries are known to contribute only 4% of the Gross National Product (GNP) through fishing, ecotourism and trading. Of this GNP share, Lake Malawi contributes 40%, Lake Chilwa 10-12 %, Lake Malombe 10%, Lake Chiuta 6% and Lower Shire 3%. The rest is contributed by rivers and other water bodies.

1.10.1 Lake Malawi

Fishing on the lake is mostly confined to the shallow waters inshore and around islands. The major groups of fish netted being chambo (*Oreochromis* spp) and utaka (*copadichromis* spp). Large untapped stocks of pelagic species have been identified in deeper waters that are inaccessible to the small scale fishermen using the currently available fishing methods. Lake Malawi is much more productive in the shallow southern part. The contribution of Lake Malawi in relation to other water bodies is shown by the total catches in Table 1.3.

1.10.2 Riverine Fisheries

Malawi's rivers and streams have around 30 fish species. The riverine fisheries can be classified into two groups. Those fish species that are permanently riverine and so reside in rivers throughout their life cycle, and those that migrate up rivers (anadromous) for spawning and breeding purposes only.

The species that can entirely depend on rivers for their life cycle include *Oreochromis mossambicus*

(Makakano) and *Oreochromis placidus* among many other species. Species that migrate into rivers for spawning purposes only, include a diversity of cyprinid species, the most important of which are *Opsaridium microlepis* (Mpasa) and *Opsaridium microcephalus* (Sanjika). The lesser fisheries of the cyprinids which exploit the larger *Barbus* spp comprise *Barbus johnstoni* (Nkumbwa), *Barbus eurystomus* (Kadyakalo), *Barbus litamba*; and *Llabeo* spp. notably *Labeo mesops* (Ntchira) and *Labeo cylindricus* (Ningwi). All of these fisheries are in the decline as a result of destruction of spawning and nursery areas and over-fishing at river mouths.

1.10.3 Aquarium Fisheries

There are more than 140 species of aquarium fish in Lake Malawi and about half are cichlids of the rock dwelling mbuna. The aquarium traders harvest about 300 fishes of each species every year giving about 150,000 tonnes of fishes at an export value of US$350,000.

1.10.4 Aquaculture

Aquaculture has boomed in places where there are perennial streams, in dambo and other wet low-lying areas. There are more than 2,000 fish farmers owning more than 4,000 ponds scattered in all the three regions of the country. The common species are *Oreochromis* and *Bathyclarias*. The annual aquaculture production is about 300 tonnes. In addition to ponds, there are about 800 small water bodies. The overall production from shallow water bodies amounts to 36.4 tonnes/year (24 tonnes for the north; 10 tonnes for the centre and 2.4 tonnes for the south). Fish is also commercially farmed within the two sugar plantations, which produce some 50 tonnes in Nchalo, and nearly 63.3 tonnes in Dwangwa annually. Some estates also produce fish though less intensively with production levels of less than 10 tonnes/year.

Table 1.2: Total fish landing (tonnes) by species and year

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Chambo	16828	13,486	9360	10,757	7,461	7597	8231	7054	6417	3400
Utaka	7,581	9,714	33,777	23,736	9,275	12,631	12,179	8,807	13,566	14,698
Kambuzi	3,220	10,388	9,418	9,312	7,816	11,969	7,698	9,920	8,451	6,011
Kampango	1,480	3,675	2,362	1,984	1,796	2,048	3,183	1,540	1,916	1,645
Mlamba	3,588	2,195	5,238	5,526	5,366	4,939	7,478	5,598	6,541	4,488
Chisawasawa	3,377	5,605	4,302	2,406	2,676	2,718	3,449	2,184	2,482	2,432
Usipa	3,047	6,077	5,771	6,386	11,694	2,026	5,049	11,743	10,225	7,321
Mphende	4,144	4,433	3,932	4,044	4,250	3,442	3,789	950	1,111	6,18
Makumba	5,060	3,622	4,680	863	3,051	4,263	4,170	6,417	463	266
Matemba	8,998	6,498	2,747	3,297	8,498	15,456	2,365	3,662	2,725	2,635
Chikano	870	1,109	842	1,073	1,068	666	1,124	416	6,121	6,687
Others	3,863	5,897	6,070	6,416	7,812	6,339	5,011	11,190	8,191	6,509
Total	**62,056**	**72,699**	**88,499**	**75,800**	**70,763**	**74,094**	**63,726**	**69,481**	**68,209**	**56,710**

Source: Fisheries Department, 1995

Table 1.3 Fish catch trends (tonnes) by water body (1986-1996)

Year	Lake Malawi Artisanal	Lake Malawi (Commercial)	Lake Malawi Total	Lake Chilwa	Lake Malombe	Lake Chiuta	Lower and Middle Shire	Total
1986	-	-	36,400	12,700	13,800	700	9,200	72,800
1987	41,800	8,200	50,000	13,000	14,000	4,000	7,500	138,500
1988	40,400	6,700	47,100	10,900	10,800	1,800	8,200	125,900
1989	33,800	4,900	38,700	7,000	11,900	910	12,200	109,410
1990	31,600	6,200	37,800	12,200	14,200	2,400	7,500	111,900
1991	30,000	5,700	35,700	9,900	7,400	1,700	9,000	99,400
1992	35,500	4,900	40,000	8,000	14,500	3,600	3,000	109,500
1993	38,155	5,931	44,086	6,709	11,079	3,433	2,892	112,285
1994	33,162	3,196	36,358	4,310	9,973	3,472	1,751	92,222
1995	41,390	3,408	44,798	5,304	0	1,888	1,900	98,688
1996	50,875	2,988	53,863	3,899	0	4,023	1,848	117,496
TOTAL	**376,682**	**52,123**	**464,805**	**93,922**	**107,652**	**27,926**	**64,991**	**1,188,101**

Source: Department of Fisheries, 1997

1.11 FOREST RESOURCES

Malawi's total forest resource covers 3.6 million ha, of the total land area. This has remained static from 1988 although the forest resource was estimated at six million ha at the turn of the century, implying that by 1988 the resource had reduced by 42%. There is a striking regional variation in the distribution of forest resources. The northern region with only 11% of the human population has 40% of forest resources while the centre with 38% and the south with 50% of the population has 30% of the forest resources each.

The importance of forests and forest products in improving the welfare of the people is increasingly gaining recognition throughout the world. Both natural and plantation forests play an important role in providing fuel, food, fodder, poles, timber and pharmaceuticals and provide shelter to wildlife, are a source of genetic resources and biodiversity, regulate soil degradation and protect watersheds. In Malawi, the forestry industry contributes 0.2% to the GDP. It employs some 22,000 people, and generates cash income; thereby contributing greatly to socioeconomic development of the country. In 1993, the per capita fuel wood consumption for urban dwellers was estimated at two solid cubic metres while that for rural dwellers was 1.1 solid cubic metres. This translates into retail values of MK370 million for wood fuels and MK16 million for charcoal. With the current population growth rate of 1.9% per annum, there is increasing pressure to open more land for cultivation, grazing livestock and meeting the growing energy needs. Malawi's forest systems can be subdivided into three distinct types: indigenous forests, woodlot and plantation forests. Table 1.4 gives forest distribution by region.

1.11.1 Indigenous Forests

Indigenous forests cover 96% of the total national forestry resource with more than 6,000 tre species. About 3.4 million ha are Miombo woodlands with significant species such as (Mlombwa *P. angolensis*, (Tsanya) *C. mopane* and (Mbawa) *Khaya anthotheca* which are valued for timbe However, there is a distinct variation in regional distribution, in relation to population density. C the 71 gazetted forest reserves, 17 are in the north, 25 in the centre and 29 in the south.

Table 1.4 Forest cover by region (x 1,000 ha)

Region	Indigenous	Plantations	Total	Forest cover as % of Total land	
				Regional Area	National Area
Northern	1,375 (39%)	76 (68%)	1,451 (40%)	54	15
Central	1,074 (31%)	25 (22%)	1,099 (30%)	36	12
Southern	1,065 (30%)	11 (10%)	1,075 (30)	35	11
Malawi	3,514	112	3,626	100	38

Source: **NEAP (1994)**

1.11.2 Woodlot and Trees on Farm

The area under woodlots and trees on farm is difficult to quantify because these are generally smal in size. However, trees on farm constitute a major effort towards sustainable forestry production a rural level. Woodlots vary greatly in size but mostly comprise a combination of species grown fo poles, domestic fuel wood, fertility improvement, tobacco curing, brick making, shade, and aesthetic beauty. Important species grown under this category include *Leaucaena, Sesbania, Glircidia Acacia and Senna.* A major component of this has been the organisation of Village Fores Committees that plant woodlots for village use. The committees manage their own nurseries an raise 10,000 to 12,000 seedlings per annum in addition to managing existing forest areas around th villages.

1.11.3 Plantation Forests

Plantation forests constitute trees or plantations that have been planted for commercial exploitation About 68% of the plantations are composed of softwoods, such as *Pinus patula* while 32% consis of hardwood, such as *Eucalyptus* and *Gmelina* species. The specific purposes for establishing thes plantation forests are varied. The Viphya plantation was established for pulp paper, timber an charcoal production. Dedza, Mulanje and Zomba mountain plantations were established for timbe while the Kasungu Flue Cured Tobacco Authority and Press Agriculture plantations in Kasung were established to provide fuel wood for tobacco curing.

1.12 LIVESTOCK PRODUCTION

The livestock industry contributes about 7% to Malawi's GDP (NLDMP, 1998). The main livestock types include monogastrics which comprise of chickens and pigs and ruminants such as cattle, sheep and goats. Apart from meeting subsistence needs, they provide regular cash earning for approximately 15% of farm families classified as commercial producers. Animals provide a way of transforming crop residues (e.g. straws, stover) and crop by-products (e.g. maize bran, cotton seed) into food or cash. They are also capable of using areas unsuitable for arable farming for grazing, and making profitable use of resting land within a crop rotation. Poultry, eggs and other small stock provide cash and food on special occasions, even in food-deficit households. In some areas cattle are also used as a source of draught power and transport. Livestock products provide raw material for the production of footwear and leather goods and are sometimes exported in the form of hides and skins for that purpose. Livestock constitute an integral part of the food and social security system. In a harsh and uncertain environment, livestock provide a significant nutritional supplement to vulnerable groups, increase the stability of smallholder households in the face of food crisis and help maintain traditional social safety nets for which the government cannot usually provide an alternative. However, livestock constitute only a limited part of most people's diet in Malawi, and account for less than 10% of average household expenditures and only an estimated 1.3% of the total energy intake.

1.12.1 Livestock Population

Livestock population figures (Table 1.5) indicate a steady rise in cattle numbers up to 1985. However, there has been a decrease in cattle population since 1985. The main impact of this fall has been due to the fact that the central region, which held around half of the national cattle population for several decades now holds only around 35%. The rate of decrease for cattle seems to have accelerated since 1992 largely due to the effect of severe droughts in the 1991/92 and 1993/94 cropping seasons combined with an increased incidence of stock theft. The main areas affected have been the central and southern regions of the country. This has strongly discouraged ownership of cattle. The figures indicate a steady increase in goat population largely because they are very prolific even under low management systems, are less affected by drought and that most stock theft has targeted cattle.

1.12.2 Monogastrics

1.12.2.1 Chickens: In 1998 the Malawi chicken population was estimated at 10,365,700 and egg production at 8,000 tonnes. These are not adequate to satisfy local demand. For example, Malawi had to import an extra 900 tonnes of poultry meat and 28.6 million eggs to meet 1997 demand. During the same year, Malawi imported 910,000 day-old broiler chicks and 80,000 day-old layer chicks to bridge the demand gap in the broiler and layer industry, respectively.

Table 1.5 Annual livestock population (1983-1998)

Year	Cattle	Sheep	Goats	Pigs
1983	907,959	155,607	631,071	211,704
1984	948,519	149,854	738,547	186,031
1985	1,019,959	184,711	799,094	322,413
1986	1,010,959	165,483	789,300	281,538
1987	838,471	88,476	586,562	238,302
1988	823,064	79,552	764,313	238,283
1989	826,788	82,939	841,467	239,900
1990	835,552	85,167	853,324	233,108
1991	807,613	101,796	848,716	254,394
1992	814,100	100,100	942,300	299,800
1995	833,136	85,722	802717	235,158
1996	775,776	101,511	968,019	312,925
1997	775,776	101,511	968,019	312,925
1998	618,800	102,700	1,597,500	428,000
Chickens*	10,365,700			
Ducks*	358,800			
Turkeys*	17,400			
Guineafowl*	15,600			
Doves*	1,024,700			
Rabbits*	140,900			

* **Figures are for 1998**

1.12.2.2 Pigs: Pig population (Table 1.5) was estimated at about 428,000 in 1998 while total production of pork (including offal) for the same year was about 14,000 tonnes derived from both planned and salvage slaughter. Currently, Malawi imports an average of 382,955 kg of pig products to meet local demand for pig and pig by-products. The domestic supply of pork is derived from three different types of production systems namely: (i) smallholder extensive production which accounts for almost 87% of the total pig production and 61% of pork production; (ii) smallholder and urban backyard intensive production accounts for about 34% of the total output, and (iii) large-scale intensive commercial units produce about 5% national supplies of pork.

1.12.3 Ruminants

1.12.3.1 Cattle: Almost all total domestic beef supply originates from herds in the smallholder sector, which supports 99% of the total cattle population and national beef output. The commonest cattle breeds in Malawi are the indigenous Malawi Zebu, Brahmans and Friesian-holsteins for beef and dairy production. Other less common ones are Jersey and Sahiwal. The Malawi Zebu is the predominant breed kept by 98% of the smallholder farmers. The traditional beef production system in Malawi is the extensive communal grazing system with little input to boost production. However, the Malawi Zebu performs reasonably well under this low input system and has an added advantage in that it is fairly resistant to tick and tick-borne diseases compared to exotic beef breeds. Domestic production of red meat from cattle was estimated at about 20,000 tonnes including both planned and salvage slaughter. The major proportion of planned beef supply is derived from the slaughter of young males (54.5%) with culled cows contributing a further 38% and the rest by culled breeding bulls (NLDMP, 1998). Salvage slaughter contributes almost 21% of total beef production.

The dairy industry has three milk-shed areas and processing plants in Blantyre, Lilongwe and Mzuzu. Cattle are virtually the major source of fresh milk in Malawi. There is a very insignificant contribution to milk production from dairy goats. Almost 63% of milk available for human consumption originates from the formal dairy sector. Of the total milk obtained from the formal national dairy herd, 88% is used for human consumption and the rest for calf feeding. The Zebu herd, which constitute 99% of the national herd, contributes a modest 7,772 tonnes of milk for human consumption (37%). Zebu cows give an average of only 340 litres of milk per lactation as compared to 2,000 litres by crossbred cows and 3,300 litres by purebred Friesians kept under commercial management. It is also estimated that only 35% of lactating Zebu cows are actually milked and 60% of that milk is fed directly to calves.

Total dairy domestic production was estimated at 21,120 tonnes of milk against a consumption demand of 34,120 tonnes. This implies that the demand gap has to be covered by importation of about 13,000 tonnes of milk. It should be noted that Malawi is currently importing 1.1% of its total red meat, and 38.1% of its milk and milk product requirements.

1.12.3.2 Goats: Malawi goats are hardy, prolific, small and slow growing and usually perform well under the low input extensive management system. Currently, 97% the goat population is owned by rural farmers, while the rest are on private and government farms. The goat breeds include the East African Local, Boer, Saanen and Damascus. However, the East African Local which is small and hardy is the most popular breed. Traditionally, goats are on free range, especially during the dry season, and are tethered during the rainy season when crops are in the field. There is a lot of room for improvement in goat production in Malawi. Land shortage, resulting from rapid human population growth, should stimulate the improvement of goat production which has a total off-take rate for planned slaughter of 38%.

1.12.3.3 Sheep: The majority of sheep in Malawi are found in the central and southern regions. The commonest sheep breed in Malawi is the local sheep, but a few Dorper sheep and their crosses also exist. Almost all sheep are on the extensive grazing system. About 5% of the red meat produced in

Malawi is mutton from sheep reared exclusively under smallholder conditions. About 50 of the planned production is derived mainly from weaned males with a further 24% provided from surplus weaned females. Culled breeding females produce 22% of mutton output while culled breeding males contribute only 4% of the total mutton. The total off-take rate for planned slaughter is 25%. Total mutton production comprises around 24% salvage slaughter.

1.12.4 Consumption Levels of Livestock Products

Livestock consumption levels are extremely low and are considered to be totally inadequate on nutritional grounds. The per capita consumption of all types of meat, including offal and savage slaughter in Malawi is around 5.26 kg. This compares unfavourably with estimates for the Sub-Saharan Africa of around 12 kg while Food and Agricultural Organisation (FAO) estimate an average consumption of 27.8 kg/capita for developing countries as a whole. Annual milk consumption of more than three litres/person is also very low, as is egg consumption (0.87kg/person). Table 1.6 summarises per capita consumption based on a population of 9.8 million people.

Table 1.6 Consumption of livestock products for 1997

Product type	National total (tonnes)	Consumption (kg/person)
Red Meat	45,416	4.63
Poultry Meat	12,385	1.26
Milk	34,120	3.48
Eggs	9,613	0.98

With widespread poverty, the low consumption levels are not expected to rise in the foreseeable future. Public interventions will best be targeted only to influence consumption levels within the poorest groups of the population or in the case of disaster relief. Future growth in demand will, therefore, be driven by market forces.

1.13 CROP PRODUCTION

A variety of crops are grown in Malawi for food or cash. The major crop groups include cereals, legumes and oilseeds, plantation crops, treenuts, vegetables, spices and ornamentals. The smallholder area under crops and production levels from 1986 to 1997 are shown in Tables 1.7 and 1.8, respectively. All these crops are, however, characterised by low productivity with demand outstripping supply in most cases.

Table 1.9 provides estimates of yield gaps between smallholder farmers and research stations for hybrid maize, pulses, groundnuts, rice, tobacco and cotton. The 'yield gap' represents the percentage shortfall in yields that can be achieved through adoption of productivity-enhancing technologies and management. There are many factors influencing yield including ecological factors, soil fertility and management. The application of technology, therefore, becomes a very important factor in reducing yield gaps. The yield gap can, to a large extent, be explained by types and levels of technologies. In

the case of maize, most farmers apply inadequate quantities of fertiliser or none at all, and this limits the production potential. Tobacco and pulses have the largest yield gaps followed by groundnuts, hybrid maize, rice and cotton. Yield gaps can also be explained by the purpose of growing the crop, for example crops such as rice and cotton are grown basically as cash crops and farmers apply higher levels of management and technologies resulting in lower yield gaps.

1.13.1 Cereals

Maize, rice, millet and sorghum are the major cereal crops which are important sources of carbohydrates for the majority of Malawians.

1.13.1.1Maize (*Zea mays L.*): Maize is the staple food for most Malawians. It contributes about 80% of the daily food calories and occupies approximately 76% of the total cultivable land. Smallholder farmers produce most of the crop whereas estate production is very low. The country needs to produce 2.25 million tonnes of maize to attain household self-sufficiency; hence production has to be doubled if the nation is to have sufficient food. With a population of 9.8 million, and per capita maize consumption of 230kg, the present total maize production of 1.79 million tonnes is inadequate. Estimates indicate that with the current population growth rate of 1.9%, food production may have to increase by up to 4% annually to feed the increasing human population. Table 1.7 shows that production has fluctuated between 0.65 and 1.79 million tonnes between 1992 and 1996. However, due to population growth and other uses of maize, the maize requirements are far above the production levels (Fig. 1.1)

Maize yields under smallholder farm conditions are very low. Local landraces produce an average of 0.9 tonnes/ha, composites 1.4 tonnes/ha and hybrids 2.5 to 3 tonnes/ha. However, yields obtained at research demonstration plots and estates are as high as 6 tonnes/ha, indicating a remarkable yield gap. The difference is largely due to varieties, declining soil fertility, and crop management.

1.13.1.2 Rice (*Oryza sativa L.):* Among the major cereals, rice ranks second to maize. It serves as a food crop for Malawians especially along parts of the Lakeshore Plain and in the urban centres. It is also a major cash crop for smallholder farmers in irrigation schemes located in the wetter parts of the country. The crop is grown on some 3,586 ha of irrigated land and 30,000 ha of rain-fed land, mostly in the Shire Valley, Machinga, Salima, Mzuzu and Karonga ADDs.

Rice yields vary considerably between irrigated and rain-fed crops with the former producing higher yields. Yields under smallholder farm conditions average between 4 and 1.5 tonnes/ha for irrigated and rain-fed crops, respectively. Research demonstrations produce 6 to 4 tonnes/ha for irrigated and rain-fed conditions, respectively. This indicates the great potential for increased rice yields.

1.13.1.3 Sorghum and Millet: Sorghum and millet are the two most important drought tolerant cereal crops for approximately one million people living in the Shire Valley. These crops are also grown in drier parts of Blantyre ADD (Phalombe Plain), Salima ADD (Bwanje Valley), Machinga ADD (Liwonde), and Karonga ADD (Lupembe and Baka). The current national demand for both crops is estimated at 270,000 tonnes. There is high demand for home consumption and the local

brewery industry. This means that there is need for concerted effort to achieve high production levels to attain self sufficiency in sorghum and millets.

Current average yields for sorghum and millet under smallholder farm conditions are estimated at only 0.7 and 0.6 tonnes/ha, respectively while yields from research demonstration plots in the main growing areas are between 2 tonnes and 3 tonnes/ha for sorghum and millets, respectively. The major factor contributing to low yield under smallholder farm conditions is the use of local unimproved varieties that are tall and late maturing. Research has, however, developed improved varieties that are high yielding, short and early maturing.

1.13.2 Grain Legumes and Oilseeds

Grain legume crops, such as groundnuts, phaseolus beans, pigeonpeas and soyabeans are important sources of vegetable protein. They are also used to improve the nutritional value of cereal or cassava-based diets for the majority of Malawians. Grain legumes also improve soil fertility through atmospheric nitrogen fixation. However, current production of these crops is very low.

1.13.2.1 Phaseolus beans: The common bean is the most important grain legume crop in Malawi. It is a valuable source of vegetable protein for the rural and urban populations, as well as various institutions, such as schools, prisons and hospitals. Beans are predominantly a smallholder crop grown as an intercrop or as a relay crop with maize, or in pure stands in upland fields during the rainy season and in dimbas during the dry season. Recently there has been a dramatic increase in national production levels of beans, largely due to the development of new bean varieties, increased availability of seed, and improved pests and disease control measures. Yields under smallholder farmer management are generally low, averaging 0.2 tonnes/ha in intercropping systems and 0.6 tonnes/ha in pure stands. The potential is much higher and yields of 3 tonnes/ha in pure stands have been recorded under research station management conditions.

1.13.2.2 Groundnuts: Groundnut is the second most important legume crop in Malawi. It is a food, cash and export crop that provides substantial income for smallholder farmers. Groundnuts are grown mostly in the plateaux areas of the country largely by smallholders in pure stands and as an intercrop with maize. National production has declined since 1988/89 due to low producer prices, drought, disease epidemics and lack of seed for improved varieties. However, recent studies have shown that Malawi enjoys a stronger comparative advantage in the production of confectionery groundnuts, such as Chalimbana, hence, production should increase over the current annual production levels. Over the past few years, there has been an increase in the production of groundnuts as a winter crop under residual moisture in irrigation schemes in Karonga and Mzuzu ADDs. Farmers' yields are generally low, averaging 250 kg/ha. With the adoption of improved varieties, yields should increase to about three tonnes/ha for pure stands as has been demonstrated in experimental fields in most parts of the country.

Table 1.7 National smallholder crop production estimates (tonnes) for 1986-1997

Commodity	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97
Cereals												
Maize	1294564	1201757	1423848	1509513	1342809	1589377	657000	2033957	818999	1327865	1793461	1226478
Wheat	1287	1669	1869	1481	1639	877	613	1014	208	1572	2315	1339
Millet	9526	8666	11841	11183	10113	7766	3418	15228	9711	13259	20262	16424
Sorghum	20761	14542	21776	20050	15452	18557	3957	21591	16667	19290	54710	39514
Rice	37407	28432	32311	45690	43280	63175	23798	65357	41132	39073	72629	65690
Legumes & oilseeds												
Beans	22545	28725	28071	27522	27638	38755	30341	45257	25134	30895	49574	52803
Groundnuts	716	2056	1825	69	5	-	12060	31785	30654	1390	40327	68718
Pigeon Peas	14933	26311	27237	19762	42814	28808	15772	24484	43311	52601	87880	72672
Sesame	27	34	139	154	143	215	7	75	11	59	291	46
Sunflower	1705	1182	1456	2192	1703	5211	4961	9339	6673	50353	17832	4580
Soya beans	-	-	311	836	3284	13020	10965	13660	8176	15011	42374	28425
Cash Crops												
*Tobacco	63539	72507	75023	86327	101028	118518	136163	133248	97575	130180	141660	-
*Tea	38976	31908	40157	39476	39059	40530	28136	39497	35140	34526	38312	43930
*Sugar	172498	173838	182305	171337	197919	199486	253974	126123	193249	9972	212005	
Coffee	3692	4967	4532	6909	7200	7720	4803	3434	5811	4514	4797	4552
Macadamia	-	-	-	4	-	3	4	4	5	5	5	-
Cotton	36235	20957	29286	35106	33026	42780	13632	45339	17014	25197	82591	-
Cashew	58	67	107	89	7465	11723	2501	148	154	150	148	-
Root & Tubers												
Sweet Potato	80003	121195	101974	177424	94911	176999	43074	210572	165322	317714	596469	858129
Irish Potato	-	13180	11400	11979	34200	39969	49144	47975	42495	79500	106422	116884
Spices												
Chillies	-	278	331	615	1020	834	353	633	829	797	882	4132

*Combined figures for smallholder and estate, Source: FEWS 1999

Table 1.8 National smallholder crop hectarage (ha) estimates for 1986-1998

Commodity	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	AVERAGE
Cereals														
Maize	1193275	1182415	1215087	1270822	1343784	1391878	1368093	1327038	1129327	1225580	1242588	1233538	1292669	1244015
Wheat	1513	2525	2593	2211	2119	1494	1446	1608	912	2290	2686	2271	2483	1961
Millet	17424	18163	19439	17916	19583	14979	14767	24169	23958	27953	34994	38634	35165	21923
Sorghum	32059	30626	30099	29828	30814	31035	27668	43873	54482	61633	76029	83859	67938	42289
Rice	22874	19076	22658	25573	29042	32841	18241	38824	27087	33308	41223	40368	41854	28500
Legumes & oilseeds														
Beans	71329	86626	91345	93506	96499	116268	126969	132879	106238	112208	128317	172197	171663	115850
Groundnuts	176293	209938	175819	139691	48185	69978	64386	61040	95309	89373	71586	100140	140747	116856
Pigeon Peas	37977	60612	62256	48380	113941	69814	67838	62756	135915	155132	172982	113035	79368	41227
Sesame	61	93	387	420	465	545	136	262	97	599	709	122	219	97
Sunflower	4078	2551	3000	4726	3757	7990	9649	10776	15460	26783	32146	10766	1818	4567
Soya beans	-	-	760	1671	5901	16255	22163	15842	18433	23274	53611	39604	28482	14959
Cash Crops														
*Tea	18790	18786	18831	18507	18204	18300	18587	18705	18801	18963	18986	18966	-	
*Sugar	14685	15200	15208	15197	15608	15595	15692	12736	17585	17612	17612	17612	-	
Coffee	4562	5294	5957	6174	6694	6902	6058	3705	3532	3971	3687	3890	858	115
Macadamia	-	-	-	1188	-	1188	1188	1288	1288	13	1293	13768	13821	2920
Cotton	51910	34504	43642	47741	48516	58691	58281	53691	37593	52237	79073	70734	45023	51632
Cashew	6546	24031	27302	32951	41349	54820	53683	53956	53646	43963	42887	53493	44104	33301
Roots & tubers														
Cassava	72904	64875	61780	72823	61506	71619	63965	75050	72149	94731	116523	125813	151941	82924
Sweet Potato	22447	28977	28517	43823	29839	48384	19886	34466	37151	60701	68804	91700	1432383	31143
Irish Potato	-	3200	3080	3437	4460	5565	5855	6217	3844	7782	9042	10113	120338	56124
Spices														
Chillies	-	246	292	746	1988	2053	1551	1229	2596	2160	2177	6656	1825	1044

*Combined figures for smallholder and estates
Source: FEWS, 1999

Fig 1.1 Trends in national maize production, demand for consumption and human population growth.

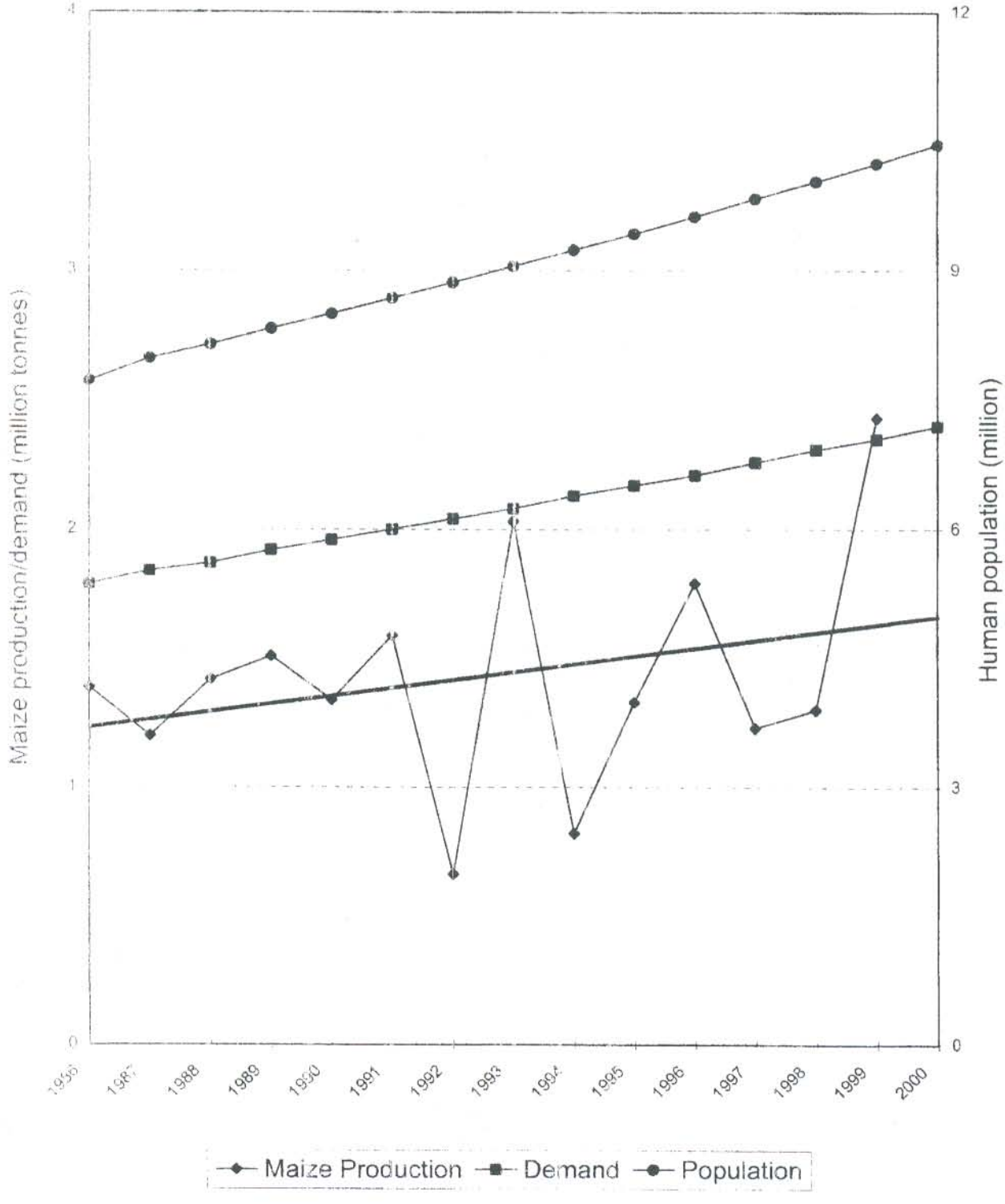


Table 1.9 Estimate of yield gaps between smallholder farmers and research on selected crops

Crops	Average smallholder yields (kg/ha)	Research yields (kg/ha)	Yield gaps (%)
Hybrid maize	2450	8000	69
Pulses	509	2000	75
Groundnuts	563	2000	72
Rice	1762	4500	61
Tobacco	874	3500	75
Cotton	1044	2000	48

1.13.2.3 Pigeon peas: Pigeon peas are an important pulse that account for 53% of the total pulse production in Malawi. These are grown for both local consumption and export. The traditional tall and long duration pigeon pea cultivars are grown as an inter-crop with maize, sorghum, cassava, cotton and other crops. The introduction of the high yielding short-duration cultivars has opened up possibilities for the cultivation of pure stands of pigeon peas by both estate and smallholder farmers. These varieties have also reduced the incidence of the *Fusarium* wilt disease from a level of 36.3% in 1980 to 4% in 1991. However, current yields are very low with a national yield average of 0.5 tonnes/ha which is well below the potential yield of three tonnes/ha. The potential can be realised with improved varieties and improved production technologies including insect pest management practices.

1.13.2.4 Soyabeans: Soyabeans are an important source of high quality protein for both humans and livestock, vegetable oil, and as a source of cash income. Soyabeans are grown either in pure stands or inter-cropped with maize. Yields of soyabeans are presently at 0.5 tonnes/ha but can be increased to three tonnes/ha with improved varieties and production techniques.

1.13.3 Industrial and Cash Crops

This group comprises crops that are produced primarily for their commercial value and have to be processed in some form before use. They make an enormous contribution to the country's GDP and as such play an important role in the economic status of Malawi. The important cash crops include tobacco, tea, sugarcane, macadamia and cotton. In general, these crops are grown in an organised manner by medium to large scale estates and progressive smallholder farmers. The removal of production restrictions and repeal of the "Special Crops Act" has diversified production of some cash crops by smallholder farmers.

1.13.3.1 Tobacco: Tobacco is the most dominant cash crop in Malawi, accounting for 71% of the export earnings. In 1992, tobacco occupied about 6% of the country's arable land. The types

grown include flue cured, burley, western and oriental tobaccos. Burley tobacco accounted for 72% of all the tobacco production in 1992. The country has a strong comparative advantage in the production of this crop as it is produced on large and medium size estates, and under smallholder farm conditions. Flue cured tobacco accounts for 19% of the total tobacco output and is mostly produced by estates due to its requirement for high investment and infrastructure. It also requires the use of fuel wood, an aspect with wide environmental implications. This has resulted in a decline in production from about 30 million tonnes in 1993 to about 19 million tonnes in 1996. Western and oriental tobaccos account for the remaining 9% of the total output and are mostly grown by smallholder farmers.

1.13.3.2 Tea: The tea industry in Malawi is of major economic importance as a foreign exchange earner and as a large employer and provider of many social services. It is second to tobacco as the largest contributor to foreign exchange earnings. There are 18,300 ha devoted to tea with estates accounting for 87% of the total area, whereas the remaining 13% is grown by smallholders under Smallholder Tea Authority. Production is concentrated in the Thyolo and Mulanje districts in the south, and Nkhatabay in the north. Total production increased by 9% between 1995 and 1996 largely due to favourable weather conditions. Overall production increased steadily until the mid 1980s when adverse conditions on the world market, coupled with increased input costs, led to stagnation in production.

1.13.3.3 Sugarcane: Sugarcane production for processing into sugar is confined to Dwangwa and Nchalo Sugar Estates, and the Smallholder Sugar Authority with a total production in excess of 129,000 tonnes/year. This is adequate for local needs while leaving some for export.

1.13.3.4 Cotton: Cotton is a valuable annual cash crop grown by more than 60,000 farm families, especially in the Shire Valley and along the Salima Lakeshore Plain and Bwanje Valley. It is an important raw material for the textile industry. The seed is pressed into edible oils and the seed cake is feed for livestock. Currently, the textile industry is importing cotton lint because the country cannot satisfy local demand. The excess demand implies that production of cotton has a lot of potential for expansion in all the cotton growing areas.

1.13.3.5 Macadamia: Macadamia is one of the cash crops that is quickly gaining importance in Malawi. Its production is concentrated in areas ranging from 600 to 1700 masl. There are currently 3,000 ha of macadamia grown mostly by the estate sector. There are two processing plants in Malawi: one in the south and the other in the north. Almost all processed macadamia nuts are exported to Europe and the USA, earning Malawi valuable foreign exchange. Kernel production has increased from 4 tonnes in 1983 to more than 500 tonnes in 1997. Smallholder interest in the crop is presently still low due to marketing problems. Potential sites have, however, been identified in Mwanza and the Shire Highlands in the south and the Viphya Plateau and Misuku Hills in the north.

1.13.4 Vegetables

Vegetables are a major source of vitamins and minerals in addition to supplying some proteins and carbohydrates. They are grown throughout the country, mostly by smallholder farmers under rainfed and residual moisture conditions. The most important ones are tomato, cabbage, onions

and pumpkins. Although Malawi has suitable environmental conditions for the production of all these vegetables, current production is far below demand forcing importations of tomato and onions from South Africa and Zimbabwe.

1.13.4.1 Tomato: Tomato is one of the fruit vegetables that is widely grown in the country. It is a source of Vitamin C and mineral salts especially calcium. The yield of tomatoes ranges from 18-50 tonnes/ha under research station conditions and below 10 tonnes/ha under smallholder farm conditions.

1.13.4.2 Cabbage: Cabbage is grown in many parts of the country. Most of the varieties grown are introduced from other countries. The country has a potential to expand cabbage production to meet the increasing demand for these considering that smallholder farmer yields are on average 10 tonnes/ha while yields at research stations are about 50-86 tonnes/ha.

1.13.4.3 Pumpkins: Pumpkin leaves are a major source of relish, especially during the rainy season. The pumpkin fruit is also very important to the Malawian diet as a source of carbohydrates for most of the rural population, especially before maize is harvested. Pumpkins are adapted to most parts of Malawi and require minimum inputs with low cost of production.

1.13.4.4 Onions: Onion is the most common flavouring vegetable in Malawi. Onions are grown throughout the country under rain-fed and residual moisture conditions. Farmers yields are often below 10 tonnes/ha, while research yields average 24 tonnes/ha, indicating great potential for improvement for this crop under smallholder farm conditions.

1.13.5 Fruits

The Malawi fruit industry is not fully developed. The importance of fruits in Malawi is underplayed by low scales of production, consumption and export. This is despite the fact that Malawi has ideal conditions for the production of various fruits for both the local and export markets. Current production is largely by smallholder farmers who are growing seedling trees of unimproved varieties. The trees receive little or no attention at all, and the fruit yield is very low and of poor quality. The major fruit crops are bananas, mango, citrus and pineapples. Their production is very low relative to demand and this has led to an increase in the importation of fresh fruit, especially apples, citrus, and mango. Hence, improvements in the production of high quality tropical and deciduous fruits could potentially earn Malawi the much needed foreign exchange earnings. Statistics on the production of fruits in Malawi are not readily available because of its unorganised marketing system. Nevertheless, fruits form a very important part of agricultural production in Malawi, with a value of some MK 20.4 million in 1991 and estimated to reach MK40 million by year 2000. Smallholder form the bulk of fruit producers.

1.13.5.1 Bananas and plantains: The banana is the major tropical fruit in Malawi and plays a very important role in supplying carbohydrates, vitamins, and minerals to the local people. Bananas serve as an important source of income for smallholders. Bananas are grown throughout the country, although most of these mainly come from Thyolo and Mulanje in the south, and Nkhatabay and Karonga in the north. In some parts of Karonga and Nkhatabay, plantains constitute a major food supplement. In recent times, the production of bananas and plantains has

been severely affected by the outbreak of diseases, such as black sigatoka, bunchy top, and Panama. Black sigatoka was first noticed in 1985 in Nkhatabay district and has since spread rapidly to most parts of the country, affecting more than 25, 000 ha of bananas and plantains. There are also incidences of pests such as the banana weevil.

1.13.5.2 Mango: The Mango is the most common fruit in Malawi after banana. It is grown virtually everywhere with trees scattered throughout the smallholder farms. Mango provides a rich source of vitamins A, B, C, and K, and minerals, iron and calcium. It is also an important source of income for the local population with most of it being sold fresh along roadsides and in urban centres. The production is mainly from local seedling trees which produce fibrous fruits. Improved fibre-less cultivars have a high potential for export during the off-season. There is, therefore, big potential for the intensification of mango production using the available improved varieties for high yields and quality.

1.13.5.3 Citrus fruits: The most common citrus fruits in Malawi include the orange, lemon, tangerine and the grapefruit. These fruits are rich in vitamin C which gives resistance to the body against diseases. Oranges and tangerines also have a high cash value on the domestic market. Currently, Malawi imports citrus juices, jams, marmalades and fresh orange, mostly from Zimbabwe and South Africa. However, the climatic conditions in most parts of Malawi are ideal for the production of all types of citrus fruit, the main factors being the availability of water and occurrence of high temperatures. For high quality orange, the hot areas of Chikwawa, Mangochi, Salima, Nkhatabay and Karonga are highly suitable for production, especially where water is available during fruiting time. Tangerines are mostly grown on the Kirk Range in Mwanza and Ntcheu, and Mwera Hills in Ntchisi. However, these can also do well in some parts of Shire Valley ADD and the Lakeshore Plain, provided supplementary irrigation water is applied. Hence, there is great potential in Malawi for the production of citrus fruits, which can also stimulate the creation of cottage processing industries that can generate rural employment.

1.13.5.4 Pineapples: Pineapples are an important source of vitamins and minerals. Available information on pineapples shows that 141,000 tonnes were produced in 1997 from a total land area of 6,000 ha. However, production appears to have drastically declined from the early 1980s due to various reasons, among which is loss of valuable export markets and the closure of the canning factory in Mulanje. Pineapples are produced mostly in Mulanje, Thyolo, Nkhatabay, Rumphi and Karonga. The production is geared towards fresh use although few are used for juice extraction and canning. The major markets are the urban centres, and very little is exported outside the country.

1.13.6 Spices

Spices are high value cash crops with great export potential. Spices are good candidates for crop diversification and for broadening the income base for smallholders. The spice industry is fairly well developed in terms of marketing. There is a lot of commercial interest from processors as well as exporters. The Malawi Association of Spices and Herbs coordinates production and marketing activities for smallholder farmers. The domestic market is capable of absorbing a significant quantity of the spices. Export demand is high, especially in the Far East and Europe. In 1989, foreign exchange earnings from spices amounted to MK1.8 million. The most important

spices are chilies and paprika while ginger and turmeric have a high potential for production.

1.13.6.1 Chilies: This is the most common spice and is grown throughout the country. Currently, farmers' yields range from 200 to 500 kg/ha while research yields are as high as 2,000 kg/ha. The yield gap is quite distinct.

1.13.6.2 Paprika: Paprika is relatively a new export crop with a ready market within and outside Malawi. The potential to grow the crop is high, especially in traditional tobacco growing areas where conditions are suitable for its production. Presently, more than 2,925 ha are grown to paprika by both private and smallholder farmers. Most smallholders are also contracted to grow paprika by commercial companies such as Cheetah Limited.

1.13.7 Ornamental Plants

A wide range of both exotic and indigenous ornamental plants, including flowers, shrubs, trees, ground covers and lawn grasses, are grown in the country. The main producers are the city parks and recreation departments in Blantyre, Lilongwe, Mzuzu and Zomba. Limited ornamental plants are produced by district centres and private companies. There has also been a recent upsurge of interest by the commercial sector to produce for the export market in South Africa and Europe. Ornamental plants are mainly sold locally, although some are exported. The potential for ornamental plants, especially cut flowers, is high in view of the large unexploited local and export markets.

1.13.7.1 Cut Flowers: Cut flowers have been identified as one of the high value products with excellent export potentials. There are two main producers of this commodity in Malawi, namely Malavi and Tropex, in Dedza and Mangochi, respectively. However, a number of producers continue entering the market. According to 1999 estimates the current area under production is estimated at 20 ha. Current production is estimated at MK3 to MK4 million in foreign exchange. If this estimate is realistic, Malawi would drastically reduce dependence on tobacco as the major source of foreign exchange by a slight increase in hecterage of cut-flowers. The major outlet for the country's cut-flowers is the Netherlands and other importers include the United Kingdom, France, Germany, Canada and Switzerland.

1.13.8 Root and Tubers Crops

Cassava, sweet potatoes and potatoes are the major root and tuber crops which are an important source of food and cash income. More than 25% of the population depends on these crops as a staple food. One of Malawi's agricultural policies is to achieve food security. Therefore, cassava and sweet potatoes have a high potential to contribute to achieving this policy. These crops are drought resistant and the government has taken measures to encourage smallholder farmers to grow these crops to avert hunger.

1.13.8.1 Cassava: Cassava (*Manihot esculenta)* is a fairly drought-tolerant crop that is mainly grown by smallholder farmers. Apart from the root, cassava leaves are a source of vegetables while the stems are used as the planting materials. Due to the current government policy to promote the growing of cassava, the total land area grown to this crop has gone up by 23%.

1.13.8.2 Sweet potato: Sweet potato **(*Ipomoea batatus*)** is a fairly drought-tolerant crop once it has been established. The leaves are also served as a vegetable and the vines are used as planting materials. The area planted to sweet potato increased by 13% in 1997 and due to favourable weather conditions, output of the crop was expected to increase over the 1996 figures.

1.13.8.3 Potato: Potatoes (*Solanum tuberosum*) are grown in high altitude areas in the southern, central and northern Malawi, mainly by smallholder farmers. The crop is important as a cash and a food crop for both urban and rural households. Total Irish potato production has increased from 43 tonnes in 1993/94, to 117 tonnes in 1996/97. This indicates high potential for the crop in the country.

CHAPTER TWO

GOVERNMENT POLICIES AND GOALS

2.1 INTRODUCTION

Realization of the production potential in the agriculture and natural resources requires that sectoral policies such as those for research must be in line with overall government development strategies. Since 64% of the population live below the poverty line and are dependent on agriculture and the natural resource base, the government's central policy objective is poverty alleviation. The government intends to achieve this policy objective through the promotion of broad-based and rapid agricultural development while ensuring sustainable use of the natural resources.

Within the broad framework of poverty alleviation, policies on agriculture, livestock, fisheries, forestry, water, environment and other natural resources are geared towards improving food security, nutritional status and sustainable livelihoods of the population by: (i) encouraging self-reliance through increased broad-based small agro-industries and businesses; (ii) expanding and diversifying exports of crops and livestock products; (iii) raising production per unit, and promoting economic growth while conserving natural resources; and (iv) encouraging sustainable use of the renewable natural resources. It is envisaged that these policy objectives will be achieved by: (i) reducing the disproportionate distribution of crops and livestock; (ii) reducing over-dependence on volatile external trade flows; and (iii) empowering local communities in sustainable natural resource management.

In the post-independence era, Malawi experimented with a variety of policies and strategies designed to improve the economy and the living standards of the people. In the past, food self-sufficiency guided sectoral strategies, programmes and plans of action. The policy on food self-sufficiency emphasized maize production even in unsuitable areas and regions where maize is not traditionally a staple food crop. However, poverty indicators demonstrate that these policies have had a limited impact on food self-sufficiency and the welfare of the majority of the people. Such policies affected technology development and transfer which in turn help explain the limited impact of agriculture and natural resources technologies.

The dualistic agricultural system, similar to that of the colonial period, was characterised by the development of capital intensive large estates under the estate sub-sector, in addition to small fields characteristic of the smallholder sub-sector. The smallholder and estate sub-sectors were distinguished by legal and institutional arrangements as regards crop production, marketing, and pricing, and the land tenure systems. The legal and institutional arrangements were biased towards the estate sub-sector making their farming activities more profitable than those of the smallholder sub-sector.

2.2 THE DEVELOPMENT OF SMALLHOLDER AGRICULTURE

2.2.1 Integrated Rural Development Projects

Government's commitment to agrarian reform in the late 1960s and early 1970s was manifested through the establishment of Integrated Rural Development Projects (IRDP). Implementation of the first five-year development plan (1965-1969) was economically impressive. Coincidentally, between 1964 and 1970, GDP increased by 6.6% per year in real terms and fixed investment grew from 16 to 23% of the GDP. The emphasis on agricultural development was explicit. The objectives were to: (i) increase agricultural productivity and improve the living standards of the rural people; (ii) increase employment opportunities to attain better balance in regional development; (iii) achieve food self-sufficiency and balance the recurrent government budget; (iv) reduce the rural-urban income gap; and (v) expand private enterprises, especially among Malawians.

These objectives were to be attained through a trickle down strategy based on high levels of investment in IRDP and the development of a transportation infrastructure in strategic sites throughout the country. In 1968, the World Bank financed the Lilongwe Land Development Programme, the first major IRDP launched since the attainment of independence. Emphasis was on areas with a high rate of direct return on capital. It was perceived that the strategy would have a catalytic effect on smallholders in the surrounding areas. This also marked the beginning of a dual strategy with emphasis on the preparation of donor-funded projects, while the government maintained basic support services and facilities for smallholders outside designated development project areas.

The advantage of IRDPs was that they were conceptualised and implemented in a multifaceted approach, bringing basic facilities and services such as boreholes, clinics, markets, feeder roads and land conservation works in an area. However, the approach was costly and the conceptual framework on which the programme was based *"the trickle down theory"* lacked the necessary elements that would ensure its sustainability. Apart from cost, the design, implementation, monitoring and evaluation of project activities did not involve consultations with smallholder farmers who were the potential stakeholders.

2.2.2 The National Rural Development Programme

Although the major projects were perceived as successful in the early stages by both the government and the donor community, the high cost of expanding beyond the original project areas necessitated a reorientation of the rural development strategy. In 1978, the government initiated the National Rural Development Programme (NRDP) which, unlike the IRDPs, focused on the needs of the resource-poor farmers throughout the country whilst maintaining its support for the better endowed farmers. The aim of NRDP was to shift the emphasis from major capital intensive projects concentrated in areas of high development potential which would, over a period of years, modernise the agricultural economy of the whole country. This programme was implemented with the following objectives: (i) to increase smallholder production of cash crops for export and to feed the growing urban population; (ii) to provide inputs and services to enable smallholders to increase production per unit area; (iii) to conserve natural resources by

encouraging good cultivation practices and soil conservation and by conserving key watersheds especially in areas with fishing potential; and (iv) to maintain forests by afforestation in reserves on customary and estate land.

To implement this strategy, the country was divided into eight ADDs and, for the first time, the agricultural strategy embraced issues of environment and sustainable use of natural resources and broadened the base of target beneficiaries. Redesigning the agricultural development strategy using agro-ecological zones provided both extension and research personnel an opportunity to identify area-specific problems and to provide appropriate solutions. The implementation of NRDP also initiated a multi-disciplinary research approach through the incorporation of adaptive research personnel in national research centres who were later moved to the ADDs although there was little inter-sectoral coordination.

2.2.3 Performance of the Smallholder Sub-Sector

The poor performance of the smallholder sub-sector, relative to the estate sub-sector, can be attributed to several factors. In particular, declining producer incomes resulting from ADMARC's exploitative pricing system appeared to have eroded farmers' incentive to engage in cash crop production. Apart from contributing to low growth rates of smallholder-marketed output during the 1970s, reduced producer incentives accelerated the rate of migration of farm labourers in search of remunerative off-farm employment.

Declining soil fertility has been a major factor in the poor performance of the smallholder sub-sector. In this context, the high cost of fertilisers, following the removal of subsidies, has compounded the soil fertility problem especially among the rural resource-poor farmers. The premise for subsidy removal was that an increase in fertilizer prices would not affect production since demand for fertilizer was presumed inelastic. Although it appears that demand for fertilizer rose following removal of subsidies in the 1980s, this increase may not have contributed to smallholder growth due to leakage of fertilisers to the estate sub-sector resulting from the price difference between the two sectors. A comparison of Value Cost Ratios (VCR) in table 2.1 indicates that the removal of subsidies reduced the profitability of maize using the standard fertiliser application recommendations. VCR estimates of less than 1.0 have been recorded for some local maize (0.46) and hybrid maize plots (0.31), further supporting the negative effects of subsidy removal.

Table 2.1 Effect of removal of fertiliser subsidies on maize production

Fertiliser type	Level of subsidies by year			
	1993/94		1994/95	
	Actual	Unsubsidized	Actual	Unsubsidized
DAP (Mk/kg)	1.82	2.02	2.08	2.08
Urea (Mk/kg)	2.27	1.42	1.72	1.93
VCR Local maize	2.00	1.80	2.70	2.50
VCRHybrid maize	2.30	2.10	3.10	2.90

Source: World Bank, 1995

An increase in the cost of fertilizer following the removal of subsidies necessitated improvement in the credit delivery system. However, it is estimated that no more than 16% to 20% of all smallholder farmers in Malawi have access to credit. Related to the credit constraint is extension education. For a long time, extension education has been linked to credit for improved farm inputs, such as hybrid maize and fertilizer. Extension workers perceived their role as primarily one of promoting hybrid seed varieties, neglecting other important crops and skills training, thus bypassing those smallholder farmers who could not access credit, especially the poorest and female-headed households.

This misguided extension strategy, coupled with the distorted pricing system and low productivity has been a major reason for smallholders allocating more than 75% of cultivable customary land to food crops, especially local maize. Contrary to expectations, allocating more land to maize has not solved the household and national food security problems. Although the latter have been accorded high priority, research on food crops, such as cassava, sweet potato, millet and sorghum has received very little attention. In order to cope with the rising demand for food, most smallholders have been compelled to expand the area under food crop cultivation, which has contributed to deforestation, soil erosion, loss of biodiversity and degradation of the natural resource base. With limited land and a rapidly growing population, increasing the area under cultivation alone cannot satisfy the increasing demand for food and cash crops.

2.2.4 Performance of the Estate Sub-Sector

The estate sub-sector expansion in Malawi has involved the alienation of land from the smallholder farmers, and the acquisition of capital inputs from commercial banks. The surplus from smallholder sub-sector, through commodity price control, constituted another important source of financing for the estate sub-sector. The government established ADMARC to sell farm inputs and purchase all smallholder produce. The prices paid to smallholder farmers were fixed far below the export parity prices to enable ADMARC to generate substantial profits. For example, an average farmer received 24% and 38% of the export parity price for rice and cotton, respectively between 1980 and 1992 (Table 2.2).

Table 2.2 Nominal protection coefficients on smallholder export crop production

Year	Rice	Tobacco	Groundnuts	Beans	Cotton
1980/81	0.21	0.16	0.32	0.31	0.47
1981/85	0.40	0.78	0.74	0.73	0.27
1987/88	0.20	0.26	0.87	0.68	0.50
1991/92	0.13	0.45	0.44	0.71	0.27
Average	0.24	0.41	0.59	0.61	0.38

Source: World Bank, 1995b.

Although the marketing mechanism was exploitative, it had some positive features. Since the country's physical infrastructure was underdeveloped, ADMARC provided market services for inputs and outputs in remote areas. Fixing prices reduced the risk of price fluctuations originating from world markets. However, the surplus money from farmers' produce could have accelerated growth if it had been reinvested in the development of facilities and services supporting smallholder agriculture. Instead, ADMARC's profits were invested in the estate sub-sector and other such enterprises such as commercial banks and processing industries.

The major reason justifying government's bias towards the estate sub-sector was skepticism of the smallholders' ability to generate sufficient and sustainable growth. Factors contributing to the skepticism included smallholders vulnerability to weather fluctuations and the pressure to generate revenue for the government to reduce dependence on foreign aid. As in the colonial era, the smallholder sub-sector was regarded as a source of food and a potential source of capital for industrial development. Establishment of estates increased rapidly in the 1980s (Table 2.3). Unlike in the earlier period, these new estates were relatively small. The rapid growth of the estate sub-sector throughout the 1970s and 1980s was a result of land expansion in the estate sub-sector, particularly the area under tobacco, rather than an increase in productivity. Nevertheless, the productivity of the estate sub-sector grew at an average annual rate of 5.6% between 1973 and 1994, while the smallholder sub-sector grew at 0.67% during the same period.

Table 2.3 Leasehold expansion in Malawi (1970-1993)

Year	Number of new leasehold estates	Area leased (ha)	Mean size (ha)	Total Number of leasehold area	Leasehold estates (ha)	Mean size (ha)
to 1970	229	79000	345	229	79000	345
1970-79	876	176800	202	1105	255800	231
1980-89	13250	503600	38	14355	759400	53
1990-93	8645	388600	45	23000	1148000	50

Source: World Bank, 1995

2.3 STRUCTURAL ADJUSTMENT PROGRAMMES

The introduction of the Structural Adjustment Programme (SAP) in 1981 under the International Monetary Fund (IMF) and the World Bank was in response to the economic structural problems. The primary objectives of the programme included: (i) stabilising the economy, (ii) accelerating agricultural growth, (iii) diversifying the export base, (iv) increasing efficiency of import substituting enterprises and parastatals, and (v) improving the mobilization and management of public resources.

The implementation of the SAP was supported by Structural Adjustment Loans (SALs), each of which addressed a specific objective. In the first SAL, the IMF and World Bank stipulated an

increase in the prices of smallholder produce. The government responded by substantially increasing the relative price of maize, resulting in a phenomenal increase in maize production, instead of a balanced increase in all cash crops. The second SAL reemphasised agricultural price incentives and improved financial and operational efficiency of ADMARC. Production of export crops, relative to maize production, increased considerably in response to higher producer prices in the 1986/87 crop season. The third SAL stipulated the elimination of subsidies on fertilizer for smallholders and the establishment of estate sector management, training and extension service to complement the estate sub-sector credit facility.

Apart from encouraging increased production and diversification of the export base through price incentives, the agreement accommodated Malawi's long standing policy of food self-sufficiency. In spite of the SAP, Malawi's exports are still dominated by the estate sector (>70%), and the country still faces balance of payments deficits. Although the implementation of SAP was necessary, it has several weaknesses including lack of information on its impact on the economy, food security and poverty reduction, especially with respect to vulnerable groups in rural and urban areas. The reform programs began while the major components of the economy, such as the exchange rate and trading in smallholder commodities, were still controlled by government or dominated by the public sector. In addition, underdeveloped markets and infrastructure posed a threat to the successful implementation of SAP. Fear of repercussions forced the government to delay implementation of some policies which were preconditions for SAP such as floatation of the exchange rate, removal of quantitative restrictions on foreign currency transactions, repeal of restrictive practices on growing and trading in certain crops, subsidy removal, reduction in public expenditure and rationalization of parastatal organizations. Under the Agriculture General Purposes Act of 1987, private traders were permitted to compete with ADMARC in the pricing and marketing of a broad range of smallholder produce. In 1990 smallholders were granted a quota for growing burley tobacco without leasing land. Improving farmers' income was the major objective for the repeal of the restrictive tobacco growing policy.

In 1994, the government liberalized the marketing of all types of tobacco, thus providing farmers with alternative marketing channels which included intermediate buyers and selling at the auction floors. In line with this change in marketing policy, the pricing of most commodities, except maize was deregulated. Government continues to regulate maize pricing through a band that stipulates the floor and ceiling prices, especially in ADMARC depots. Since maize is the major food crop in Malawi, the government's desire to influence accessibility and distribution through price control is sensible, although this impacts negatively on overall production. Although liberalisation has encouraged private trading in agricultural inputs and commodities, ADMARC and a few other firms still dominate the business. Poor infrastructure and capital constraints are major factors limiting the proliferation of private traders.

2.4 CURRENT SECTORAL POLICIES AND STRATEGIES

Malawi's effort to bring the economy to a sustainable path through reform has been underway for almost two decades now. However, in spite of undertaking a series of major institutional, micro-economic and macro-economic reforms, the concerns registered in the 1980s, such as the country's vulnerability to external shocks due to deep-rooted structural weaknesses, still exist. Tobacco, tea and sugar are still the main cash crops supporting the economy. The export commodities are bulky and

sold predominantly in raw form. In the smallholder sub-sector, maize is the major commodity, contributing about 60% of the total output. Although the commodity constitutes a large proportion of the smallholder agricultural output, the country is becoming increasingly dependent on foreign imports because of low productivity and inadequate incentives for increased productivity. New policies are required to stimulate growth in Malawi. These include: fiscal policy, foreign trade policy, monetary policy, and policies on food security, agriculture, livestock, water development, forestry, fishing, park and wildlife, the environment, land use, and land tenure.

2.4.1 Fiscal Policy

The current fiscal policy in Malawi is designed to reestablish and sustain macro-economic balance by increasing domestic savings. This means a reduction in budgetary allocations to many sectors and departments, including research. Unless research is accorded high priority, the implication of reduced budgetary allocation will result in the scaling down of technology development and transfer. Decisions on which public projects or programmes to finance depend on the assessment of the likely benefits and impact that these will have on the economy and people's welfare. However, such information is often not available to the extent that allocation of funds may be out of line with national priorities. The impact of research on the economy is likely to be high, but there has been no empirical assessment to determine its priority relative to competing sectors when decisions to finance projects or programmes are made. Non-recognition of the value of information can explain the low priority accorded to the generation and dissemination of technology and why research continues to be inadequately financed by government.

2.4.2 Foreign Trade

The foreign trade policy in Malawi revolves around promotion and maintenance of external competitiveness and attainment of a medium-term balance of payments through market economy instruments. Most of the restrictive foreign trade practices have been abolished but the foreign exchange market is not operating efficiently. This is partly because only a few firms, including the Reserve Bank of Malawi, provide the service and thus the price of foreign currency does not really reflect the forces of supply and demand. Hence, there is shortage of foreign exchange, and exchange rates are escalating all the time. Since the country depends on imported fertiliser and raw materials, the high cost of foreign exchange raises the cost of inputs causing a reduction in agricultural and industrial output as well as in the growth of the GDP. Considering these factors, devaluation of the Malawi Kwacha currently has negative impact to the country which is solely dependent on agriculture whose inputs are mostly imported.

2.4.3 Monetary Policy

The country's monetary policy aims at achieving and sustaining a low rate of inflation consistent with the overall balance of payment objectives. Major changes instituted by the monetary authorities to date include deregulation of interest rates, promoting the development of financial markets, introduction of re-discount and re-purchase facilities at the Reserve Bank of Malawi and abolition of credit ceilings. However, the financial market is dominated by a few major institutions and there is lack of competition which means that prices of services, such as credit and insurance, are determined by suppliers. Inefficiencies and conditionalities associated with certain services have cost and

delivery time implications to the disadvantage of the consumers. Due to unstable exchange rates, the cost of technologies has increased rapidly, while the repayment period is fixed. Farmers' incomes have not increased in proportion with product prices. Custom duty and other levies charged on imported raw materials and finished products result in increased prices. Conditions for credit are unfavourable for smallholder farmers, who in most cases cannot meet these conditions and thus fail to access commercial credit from these institutions. In the absence of alternative sources of credit, the resource-poor farmers cannot afford inputs to improve their productivity, thereby negating their ability to adopt technologies that would increase productivity.

2.4.4 Food Security

Prior to the early 1980s, national food security was equated to the quantity of maize produced at national level. Associating food security with national maize output failed to recognize the problems of inter and intra-household distribution over time and the lack of effective purchasing power of some households. Emphasis on maize production also ignored the importance of other crops, such as cassava, sweet potatoes, rice, sorghum and millets in meeting food requirements of both the rural and urban households, particularly during drought years. However, a number of studies in the 1980s that addressed the extent of food insecurity at household level coupled with persistent droughts and increased demand for food, compelled the government to develop a consistent policy on food security. The overall objective is to improve the food security and nutrition of all households in Malawi. In order to achieve this objective, the Food Security and Nutrition Policy is envisaged to be implemented through an approach of "a growth through poverty reduction". Specific objectives to improve the food security and nutrition of the poorer segments of the population, and the country as a whole, include: (i) increased agricultural productivity with special emphasis on holdings with less than one hectare; (ii) increased employment opportunities to enhance income; (iii) improved human resource development; and (iv) increased income transfers to vulnerable segments of society in the short-term until the longer term objectives are achieved.

One of the major problems in food security that has not been adequately addressed by the policy, is agricultural mechanisation. The mechanization policy aims at: (i) encouraging mechanisation in all parts of Malawi, (ii) encouraging individual ownership of mechanization technologies, in contrast to joint ownership, (iii) popularising mechanisation technologies among smallholder farmers, and (iv) encouraging mechanisation technologies for irrigated agriculture, crop protection, post harvest handling, processing and utilisation, storage and rural transportation.

However, mechanisation has not been fully integrated into the Malawian farming systems, and even where this has been done, it has been fraught with lack of spare parts, appropriate equipment, draught power or lack of proper implementation of the policy. Poor storage and lack of protection against pests and diseases also reduce the available stocks of grains, roots and tubers. Processing and proper storage of food will not only increase the period of availability but will also add value to the commodity, thus improving both household income and food security. Factors influencing consumption behaviour, such as associating food shortage with inadequate supply of maize, while ignoring the fact that roots and tubers and other grains, such as sorghum, millet and pulses, constitute important sources of nutrition, are important.

2.4.5 Crop Production

The Malawi government places the highest priority on poverty alleviation and with the overwhelming importance of agriculture to the economy the major policy objectives are: (i) improving food self sufficiency and nutritional status of the population; (ii) expanding and diversifying exports in agricultural and livestock products; and (iii) raising farm incomes and promoting economic growth while conserving the natural resource base.

The current policy differs from the past in several ways: (i) the change in the political and economic environment has created an opportunity for all stakeholders to contribute to the identification and prioritisation of problems and solutions, as well as the development of policies, strategies and plans of action, (ii) for the first time, the policy has acknowledged the problems of deforestation and land degradation, and has provided for corrective policy guidelines within the context of improving food security, foreign exchange earnings and household incomes and (iii) the policies are also being implemented at a time when other sectoral policies, such as those on environment, forestry, fisheries, land, national parks and wild life have either been developed or are in the process of development.

Achieving these policy objectives depends on the quality of the proposed strategies and the process of their implementation. While the analysis of the problems in the agricultural policy development is clear, the strategies for solving them are too general, not available, or inadequate. For example, the objective of growing high value crops by smallholders to improve income and food security is not clear. Based on comparative advantage, smallholders are being encouraged to grow burley tobacco even though the government recognises the need for agricultural diversification in the medium to long-term. Although recommended tobacco growing strategies require good agronomic and crop husbandry practices, such as crop rotation and the planting of trees to 10% of the farm land, many smallholders are not implementing these. This can mostly be attributed to poverty and the small nature of the land holdings. This results in insect pest and disease build up in the nurseries and in the fields. On the other hand, the cost of ensuring that smallholder farmers follow recommended crop husbandry practices and are planting 10% of their land holdings to trees is expensive and prohibitive at the present moment.

While the agricultural policy addresses multi-sectoral issues including environment and natural resources, it does not adequately address the process of institutional coordination, community empowerment, and monitoring and evaluation. The lack of consultation and participation of stakeholders in the development, implementation, monitoring and evaluation of programmes limits the effectiveness of the policy. The information provided by monitoring and evaluation teams at ADD level to Programme Managers and the Ministry of Agriculture and Irrigation Development headquarters, appears to be used inadequately in decision making. Poor utilisation of these reports shows lack of appreciation of the role of monitoring and evaluation process in programme development. The problems of land utilisation and environmental protection involve many stakeholders including the Ministry of Natural Resources and Environmental Affairs, Ministry of Lands, Housing, Physical Planning and Surveys; NGO's; local communities; and the private sector. Hence, the need for the coordination of programmed activities in these institutions. The problems of coordination also extend to donor agencies who have different and sometimes conflicting strategies for agricultural development.

2.4.6 Livestock Production

Production and research activities in the livestock industry have for a long time been regarded as secondary to those of crops. Livestock production and research have mostly concentrated on animal nutrition, with little on animal health, breeding and animal husbandry. The country is increasingly dependent on imported livestock and livestock products. The current government policy for livestock development is to improve the productivity of the livestock sub-sector by facilitating sustainable animal health and production in order to satisfy demand for animal protein on the domestic market and improve the well-being of Malawians. It intends to achieve this by involving the pharmaceutical industry, the feed manufacturers, NGOs and other neglected stakeholders, such as women, who have so far been seriously under-represented in livestock development programmes. Livestock production should contribute to poverty alleviation through improvement of the nutritional base and provision of income generating activities to farmers.

One of the major tasks to be undertaken in livestock development is to determine the land carrying capacity in order to ascertain what types of animals and how many can constitute a viable industry. Intensive management offers an opportunity to farmers with limited land holding capacity to undertake livestock production. Land shortage, diseases, lack of improved breeds, and inadequate and poor quality feeds are some of the constraints that affect livestock production. The country also has inadequate marketing, processing and storage infrastructure to support a viable dairy and meat industry. Opportunities for growth in the livestock industry in the era of market liberalisation are favourable but unless crop productivity improves, competition for land between crop and animal production will continue to be the major constraint to the development of the industry.

2.4.7 Water and Irrigation

Periodic droughts and increasing human population are exerting tremendous pressure on the food supplies and the limited water resource base. Irrigation provides an opportunity for increased agricultural production. The water policy objective emphasises efficient management of resources and conservation of water in sufficient quantity and acceptable qualities. This includes conservation by small dams and diversion of rivers. The Irrigation Development Policy of 1996 aims at improving agricultural production and achieving national food sufficiency by targeting small-scale irrigation development. The policy emphasizes the identification, design, construction, ownership and management of small-scale irrigation schemes while the government serves as a facilitator in the development process. Many estates have established dams to provide water for irrigation and for household use. However, dams constructed for use by rural communities are inadequate and poorly managed. Improvement and enforcement of community-based rules and regulations could help to address the problems of water scarcity and quality.

2.4.8 Forestry

The goal of the Forestry Policy is to sustain the contribution trees and forest resources make to the quality of life in the country through conservation of the natural resources base. The general objective is to satisfy the people's many diverse and changing needs, particularly those in the rural areas, who are the most disadvantaged.

Several strategies to ensure that the goals and objectives can be accomplished have been identified. These include development of community-based programmes, skill training in the utilisation of forest products, development of rules and regulations with partner institutions to control unsustainable use of resources, promoting the development of income generating activities and alternative sources of energy to reduce over dependence on biomass. In dealing with cross-sectoral issues, provisions have been made for regular consultations and policy review meetings. Although the forestry policy and its strategies address issues of national interest and multi-sectoral concerns, financial constraints will limit its implementation. Prioritisation of problems and development of joint action plans with other stakeholders will be essential. Nevertheless, policies and action plans provide a basis for consultations and negotiations with other stakeholders for joint funding and implementation of programmes.

2.4.9 Fisheries

Past policies on fisheries aimed at "maximising the safe sustainable yields that could be economically exploited from national waters without destroying the stocks" whilst improving the efficiency of exploitation, processing, marketing and investment, with special attention to the protection of the endemic fish fauna. Realising that government has no resources to continue managing the fish resources without involving stakeholders, the practice of co-management being advocated worldwide has now been adopted as a way forward. The objective of the current policy is to manage fish resources for sustainable utilisation and protect and conserve the aquatic biodiversity. Articles governing the management and utilisation of the fisheries resources are contained in the 1997 Fisheries Conservation and Management Act. The Act stipulates the institutional framework, including community participation in fisheries conservation and management systems for dealing with violators of regulations governing the fisheries conservation and management.

2.4.10 National Parks and Wildlife Reserves

The goal of the draft policy for the National Parks and Wildlife Reserves is to ensure proper conservation and management of wildlife resources in order to provide for suitable utilisation and equitable access to the resources and fair sharing of the benefits for both present and future generations. The implementation of this policy, while ensuring adequate protection of representative ecosystems and their biological diversity through the promotion and adoption of appropriate land management practices, will depend on satisfying future demands for land by farmers. Other aspects of the policy include legislation to manage and protect land and wildlife.

2.4.11 The Environment

The performance and sustainability of Malawi's economy depend on the proper management of the environment and its natural resources. The rapid increase in population over the last three decades has exerted tremendous pressure on the natural resource base leading to severe land degradation problems. Natural resource and environmental degradation translate into economic and aesthetic losses. Thus, apart from considerations of sustainability, the question of inter-generational equity demands a concerted effort to prevent further damage. Pursuant to the NEAP and in an effort to provide a coherent environmental framework for development policies, a National Environmental Policy was developed in 1994. The policy provides an overall umbrella structure under which relevant sectoral environmental policies can be reviewed to ensure that they are consistent with the

principles of sustainable development. The overall goal of the policy is to promote sustainable social and economic development through sound management of the environment.

2.4.12 Land Use and Tenure

Within the overall environmental policy framework, the land use management policy is designed to promote the long-term sustainable use of Malawi's natural resources for agricultural and other uses. This will have to operate under increasing rapid rural population pressure and declining land productivity. Allocation of large tracts of land for estates, which has been accompanied by underutilisation of land in some cases, has reduced available land for smallholder. The major thrust of the land use policy is to create incentives to encourage the efficient use of land and equity. The current land tenure system does not provide security and incentives to improve productivity in some rural communities.

Smallholders on some customary lands have the right to use the land, but do not own it. On the other hand, the increasing subdivision of land in rural communities is reducing farm sizes to the extent that farming is no longer a viable source of livelihoods for many people. However, it should also be clearly borne in mind that farming is "a way of life" and "a source of life" for subsistence farmers, to the extent that they will grow any type of food crop whether it is economical or not. In 1996, the Government set up a commission of enquiry on Land Policy Reform to investigate land problems and make necessary recommendations as a basis for policy reform. Three studies on customary land, estate lands and public land were commissioned to support the activities of the Land Policy Reform Commission. Preliminary findings of the study have shown that there is some land that is underutilised in some districts, but negligible in others. The study has further shown that alternative sources of income for smallholders could ease the pressure on land.

2.5 RESEARCH POLICIES IN AGRICULTURE AND NATURAL RESOURCES

Malawi's growth in agricultural output is increasingly becoming dependent on the development of scientific and technical capacity to develop new mechanical, chemical, and biological technologies. As such, growth in agricultural output, based on increases in cultivable land, is no longer possible. Farm inputs, including implements, fertilisers and pesticides have become increasingly expensive; hence, relatively inaccessible to the majority of the agriculturally-dependent resource poor smallholders.

2.5.1. Crops Research

Prior to 1985, research was organised on a project basis by crop, livestock or discipline. As part of Phase V of the NRDP, agricultural research operated under the National Agricultural Research Project. Its objectives were: (i) to generate appropriate technologies for increased yields; (ii) to obtain higher rates of return to land, labour and investment in agricultural production with special emphasis on traditional crops, such as maize; (iii) to identify crops and livestock for diversifying smallholder production to provide higher income employment levels and increasing foreign exchange; and (iv) to develop an institutional framework for human resource development.

The project led to the creation of the Agricultural Research Council (ARC) charged with the function of formulating research priorities and advising MoAID. It planned to rationalise the Department of Agriculture Research and Technical Services (DARTS) research stations network with a view to improving management and infrastructure and reduce administrative costs by reorganising its staff into multi-disciplinary research teams, including task planning and budgeting. The project also involved training to improve DARTS's technical capacity, increased collaboration with international research centres, regional research institutes and introduction of contract research programmes with NGO's in Malawi, especially the University of Malawi and private research institutions. Improved linkages between research and extension were to be achieved through the creation of adaptive research teams. These were established in such a way that they conducted on-farm research and other linkage activities from the ADD headquarters.

Research policy has been strongly associated with food self sufficiency rather than food security even though the latter is consistent with a liberalised economic system. The element of food self-sufficiency characteristic of a subsistence economy, is apparent in policy statements which are based on the assumption that Malawi is predominantly a producer of primary raw materials. The low priority accorded to mechanization and processing technologies in research is evidence of the flawed sustainable development strategy. The failure to incorporate the value-added component in policy statements and action plans reduces the scope for improving the welfare of the people through increased revenue from exports of high value commodities and the creation of alternative employment opportunities. This is an aspect of policy change which has been addressed in the Strategy and Action Plan for Agriculture and Natural Resources Research.

2.5.2 Livestock Research

The National Livestock Development Master Plan (NLDMP), states that there has been poor problem analysis at the farmer level and that past research has lacked attention to the needs of livestock owners (NLDMP, 1998). Improving disease control and improved husbandry at the farm level and increasing the feed supply are given high priority whereas improvement through breeding is given low priority for all stock. Research for animal production by the estate sector is needed and better collaboration among DARTS, Department of Animal Health and Industry, (DAHI), Department of Agricultural Extension Services (DAES), NGOs and University Colleges is imperative. Overall, there is little research in livestock primarily due to inadequate human and financial resources.

2.5.3 Fisheries Research

Before independence, a fisheries research unit was established in Nkhata Bay. During that time fishing pressure was still low, and the research work was descriptive, mainly focussing on morphometry, limnology, inshore fisheries and some plankton. This period was also associated with very little work on fish biology. In the post independence period, fisheries research was brought in line with national development policies. Most of the work centred on increasing fish production. This period registered many successes, such as the introduction of synthetic fibres, motorised fishing boats, and the establishment of the commercial fishing industry sub-sector. Fishing activities expanded considerably to many parts of the lake during this period. At the same time, the total catch increased and research focussed on investigating the possibilities of utilising some of the unused stocks found in the country.

Undertaking relevant problem-related research aimed at generating usable information and technologies required for the management, conservation and sustainable utilisation of fisheries resource is a major policy objective. Fisheries research focuses on two main areas of aquaculture and capture fisheries. The research objective of aquaculture is to increase commercial fish farming among smallholders to improve household income and food security. This emphasises on the improvement of productivity through selection and breeding for fast growth and high feed conversion, and the management of fish ponds, dams and water reservoirs.

The major objective of capture fisheries research is to increase sustainable levels of fish landings through the improvement of fishery technology, management of large water bodies and harvesting techniques. In this respect, research focuses on: (i) the development of appropriate fishing equipment and harvesting methods for deep water fishing; (ii) taxonomy; (iii) monitoring both deep and shallow water fishes; (iv) development of community-based fish management practices; (v) environmental monitoring; (vi) aquatic ecology on vulnerable habitats; (vii) processing,; (viii) storage; and (ix) inventory of fish stocks.

2.5.4 Forestry Research

Forestry resources are declining at a rapid rate due to a number of factors including: (i) increased demand for firewood for home consumption and agricultural uses; (ii) timber for home and industrial uses; (iii) lack of improved technology to enhance utilisation; and (iv) land for agricultural use. The supply of forest resources is also constrained by low productivity resulting from poor genetic performance of current species, poor management and lack of incentive to invest in forestry production. The overall objective of forestry research is to optimise tree productivity on farm, woodlots, plantations and woodlands in order to enhance the contribution of trees and forests to the economy of Malawi. Specifically, forestry research aims at: (i) providing technical and social forestry solutions to problems communities encounter in daily lives; (ii) establishing methods and generating knowledge for advancing forestry science; (iii) providing leadership in forestry sector development, and (iv) contributing towards a scientific culture. These objectives will be achieved by undertaking well designed and relevant research, whenever necessary, jointly with other national and international institutions in areas such as:- (i) plantations; (ii) trees on the farm; (iii) indigenous woodlands; and (iv) seed development.

CHAPTER THREE

RESOURCES AND INFRASTRUCTURE OF EXISTING AGRICULTURE AND NATURAL RESOURCES RESEARCH SYSTEMS

3.1 INTRODUCTION

Research in agriculture and natural resources in Malawi is conducted by several public, parastatal and private research institutions. The public institutions include: the Departments of Agricultural Research and Technical Services (DARTS), and Animal Health and Industry (DAHI) in the Ministry of Agriculture and Irrigation Development (MoAID); Fisheries Department (DoF) and the Forest Research Institute of Malawi (FRIM) in the Ministry of Natural Resources and Environmental Affairs, and; National Parks and Wildlife in the Ministry of Tourism, Parks and Wildlife. Parastatal institutes include Bunda College of Agriculture, Chancellor College, The Polytechnic, Centre for Social Research and Agricultural Policy Research Unit (APRU) in the University of Malawi; the National Herbarium and Botanic Gardens (NHBG) of Malawi and; the Malawi Industrial Research and Technology Development Centre (MIRTDC). Private institutions include the Tea Research Foundation (TRF); the Agricultural Research and Extension Trust (ARET) and ILLOVO Sugar Company. The locations of these institutions are shown in Fig 3.1.

Public institutions are funded from recurrent and development budgets while private research institutions obtain funding from their stakeholders. Funding from recurrent budget has drastically declined over the years and it seems public institutions largely depend on development funding. Overall, the recurrent research, relative to AGDP, is much lower than the 2% level suggested by the World Bank. On the other hand, human resources have tremendously improved since independence and most institutions have very qualified personnel due to an intensive post graduate training program initiated in the last decade but have since slowed down in favour of in-country short term courses.

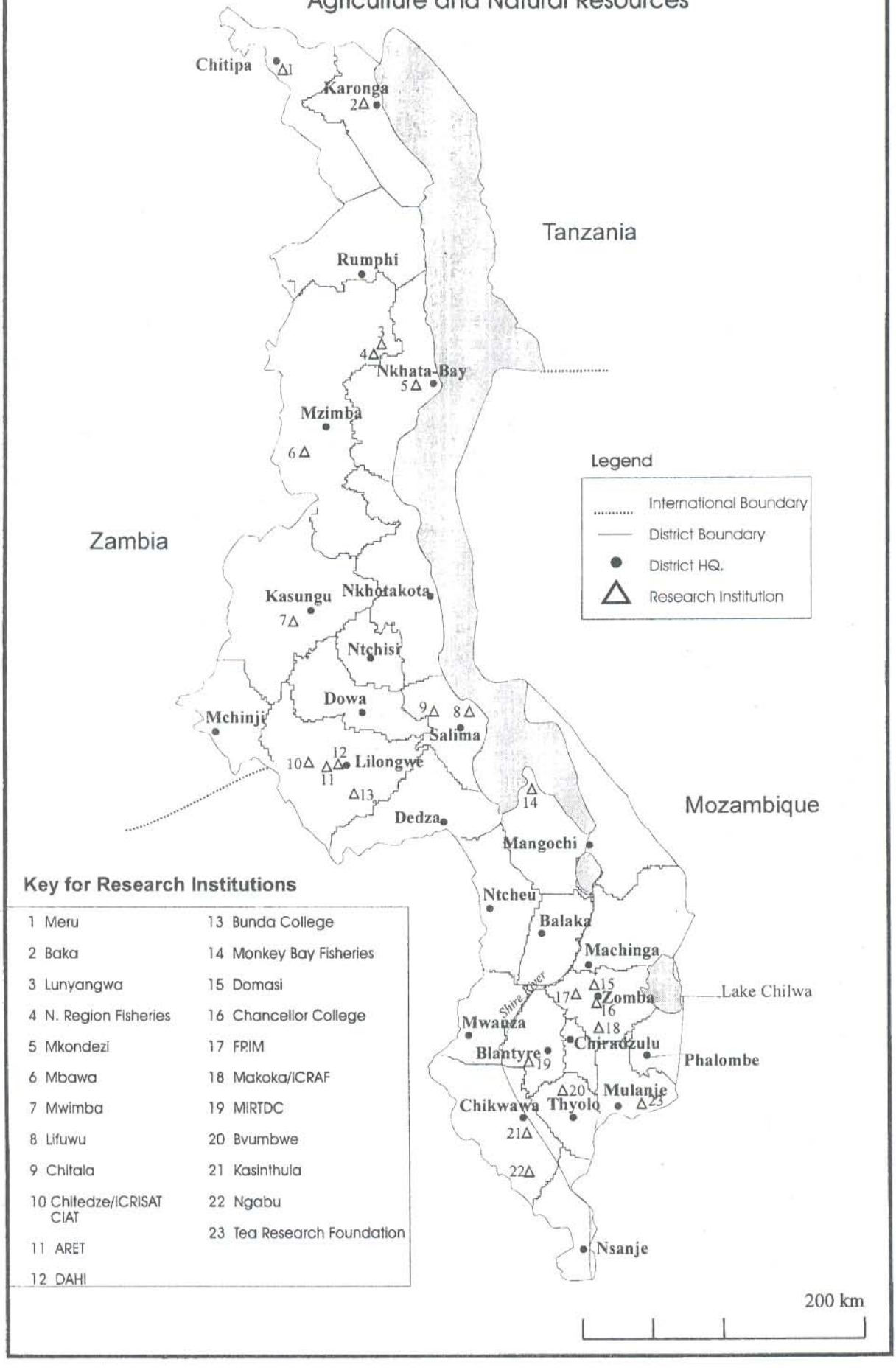
3.2 RESEARCH INSTITUTIONS

3.2.1 Department of Agricultural Research and Technical Services (DARTS).

The policy of DARTS in the MoAID is to carry out applied agricultural research, provide technical and advisory services and make available information and technologies to the smallholder sub-sector. DARTS has three major research stations at Chitedze, Bvumbwe and Lunyangwa; four experimental research stations at Makoka, Mkondezi, Lifuwu and Kasinthula; and nine substations at Baka, Bembeke, Bolero, Chitala, Mbawa, Meru, Nchenachena, Ngabu and Tsangano.

Research under DARTS is organised into seven research commodity groups namely: (i) cereals; (ii) horticulture; (iii) livestock and pastures; (iv) legumes, fibres and oilseeds; (v) soils and agricultural engineering; (vi) technical services; and (vii) plant protection. Each group is led by a National Research Coordinator (NRC). Within a commodity group, there are several commodity teams headed by a Commodity Team Leader (CTL). The CTL is responsible to NRC who reports to the Director at the Ministry headquarters through Deputy Directors of Research Programmes and Technical Services and Administration. All scientists and staff are employed under terms of the civil service.

Fig 3.1 Map of Malawi showing the locations of Research Institutions for Agriculture and Natural Resources



Goals, objectives and research priorities for each commodity team are defined by DARTS while the identification of research projects is the responsibility of individual team members. Identified projects are discussed by the commodity team and at DARTS annual research meetings before submission to the Agricultural Research Council for approval.

DARTS is funded through the Government's recurrent and development budgets. Research scientists prepare budget estimates for each project. These are consolidated into a departmental budget for submission to Treasury as part of the Ministry's budget. The recurrent budgeting process is based on an incremental basis and does not reflect priority areas, while development budgets are prepared on the likely availability of donor funds. Hence, research programmes are approved without matching funds resulting in *ad hoc* cut-backs for planned and approved projects. The "Medium Term Expenditure Framework" (MTEF) discussed in Chapter VI, is designed to introduce a rational approach to resource allocation by identifying priority activities that would receive adequate funding. In addition, individual scientists can get research funds from donors and are able to administer these on their own using standard government procedures or donor requirements.

Technologies developed by DARTS are approved by a Technology Clearing Committee prior to dissemination to end-users through the Department of Agricultural Extension Services (DAES) which has the mandate to provide extension services to farmers. The Technology Clearing Committee is mandated to approve technologies before release. In addition, DARTS organises annual field days for the public at the major research stations. Research liaison personnel link DARTS with the DAES to provide feedback mechanisms. However, there is little direct research-beneficiary contact.

The major research thrusts for DARTS include: (i) development of high yielding early maturing varieties that are tolerant to drought, pests and diseases, and evaluation of animal breeds suitable for various production systems; (ii) development of integrated pest management strategies for crops and, diseases and parasite control measures for livestock; (iii) development of appropriate technologies that support agriculture and natural resource diversification; (iv) development of feed and evaluation of feeding technologies for increased livestock production; (v) development of improved soil fertility techniques, appropriate land husbandry and soil and water conservation practices; (vi) development of agroforestry technologies that address low soil fertility, rapid deforestation and land degradation; and (vii) development of appropriate farm machinery, irrigation, storage, processing and post harvest technologies.

3.2.1.1 Cereals research: Cereals research is conducted on maize, rice, sorghum, millets and wheat and the programme is coordinated from Chitedze Agricultural Research Station (CARS). Research on maize and wheat is based at CARS, rice at Lifuwu, and sorghum and millet at Kasinthula. The group collaborates with the International Center for Research in Maize and Wheat (CIMMYT) on maize and wheat variety testing, adaptation and soil fertility; the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) on Sorghum and Millet Improvement Program (SMIP) based at Matopos in Zimbabwe, and the International Rice Research Institute (IRRI) on rice germplasm evaluation and exchange programme.

3.2.1.2 Horticulture research: The Horticulture research programme focusses on vegetables, roots and tubers, tropical and deciduous fruits, tree nuts, spices and coffee. The programme is coordinated from Bvumbwe Agricultural Research Station (BARS) but with experiments at Chitedze, Lunyangwa

and Mkondezi Research Stations which have greenhouse facilities and nurseries. There are also tissue culture laboratory facilities for propagating planting materials of cassava, indigenous fruits and bananas at Bvumbwe and Bunda College. The group collaborates with the International Potato Center (CIP) on potato (*Solanum*) research and with the Asian Vegetable Research and Development Centre (AVRDC) and Collaborative Network for Vegetable Research and Development in Southern Africa (CONVERDS) on vegetables. Roots and tubers' research is conducted in collaboration with International Institute of Tropical Agriculture/Southern Africa Root Crops Research Network (IITA/SARNET), while banana research is conducted in collaboration with the International Institute for Bananas and Plantains (INIBAP). Coffee research is conducted in collaboration with the Tea Research Foundation. In addition, the group collaborates with the Tree Nut Authority on research in macadamia and cashew.

3.2.1.3 Livestock and pastures research: Livestock research covers husbandry for large and small ruminants, monogastrics and pastures. The research activities are coordinated from Chitedze although most breeding work is done at Mbawa Research Substation. Livestock research also covers dairy especially for the milk shed areas of Mzuzu, Lilongwe and Blantyre. On monogastric animals, research activities emphasize the development of feed and feeding technologies, whereas identification of forages and feeding systems is the major focus for pasture research. The group collaborates closely with the International Livestock Research Institute (ILRI)

3.2.1.4 Legumes, fibres and oilseeds research: Research on legumes, fibres and oil seeds covers cotton, groundnut, bean, sunflower, sesame, pigeon pea, soyabean and cowpea and is coordinated from CARS. The CTLs for all these are stationed at CARS except for cotton whose CTL is based at Makoka Agricultural Research Station. Researchers on this commodity group work in collaboration with SADC/ICRISAT on groundnut and pigeon peas and with International Center for Tropical Agriculture (CIAT) and Department For International Development (DFID) on beans.

3.2.1.5 Soils and agricultural engineering research: Research on soils and agriculture engineering is coordinated from CARS where the group has equipped laboratories for plant and soil analysis, and soil microbiology research. The station also has a fairly well equipped farm machinery unit. In addition, there is an operational laboratory for soils analysis at Bvumbwe. This group is supposed to conduct research on irrigation at Kasinthula but the irrigation research commodity team has no staff at the present moment.

3.2.1.7 Plant protection services: Under plant protection, research is conducted on plant pathology, entomology, nematology, weed control, quarantine/inspection and crop storage and is coordinated from Bvumbwe. Research is on the control of pests and diseases for all crops with the overall goal of developing integrated pest management (IPM) systems for all major crops. Advisory services on pests and disease control are provided at no cost. Research programmes on IPM are conducted in collaboration with the Malawi-Germany Plant Protection Project and the DFID Farming Systems Project.

The plant protection group provides advisory services on nematodes, insect pests and diseases, inspection and certification of produce for exports and imports; monitoring, forecasting and control services on migrant pests; development of insect reference collections and the development of pesticide registration and control measures.

3.2.1.6 Technical services: The overall mandate of technical services is to conduct research and provide advisory services in seed production, design of experiments and analysis of experimental data, socioeconomic evaluation of production technologies, conservation of plant genetic resources and provision of scientific information to researchers. The main library for DARTS is located at Chitedze with branches at all the main research stations. The library at Chitedze serves as a focal point for acquiring, processing and distributing books, journals and information to libraries in the network. It is a member of the Malawi Library Association and the National Information Systems Network.

The Seed Services Unit located at Chitedze comprises the seed inspectorate division and a seed testing laboratory. Satellite seed testing laboratories are located at Baka, Lifuwu and Bvumbwe Research Stations. It provides technical supervision for the production of all seed classes beyond breeder seed for seed companies, small scale seed growers in one of the action groups of the Maize Productivity Taskforce and non-governmental organisations that multiply seed. The unit assists in developing appropriate seed regulations for seed quality control and collaborates with the International Seed Testing Association (ISTA) through an ISTA-accredited laboratory at Chitedze.

The Agricultural Economics, Statistics and Data Processing unit provides advice on statistical designs and socioeconomic analysis of data to researchers and serves as a data bank for DARTS. The Gene Bank, located at Chitedze, is responsible for collection, documentation and conservation of the country's genetic resources and collaborates closely with the SADC Plant Genetic Resources Centre (SPGRC) and International Plant Genetic Resources Institute (IPGRI).

3.2.2 Department of Animal Health and Industry (DAHI)

DAHI in the MoAID is mandated to conduct research on animal health from the Central Veterinary Laboratory (CVL) in Lilongwe. It conducts basic and applied research, in order to generate technologies or new information for farmers and consumers of livestock products; generates epidemiological data on livestock diseases and guides the MoAID in updating or reformulating its policies on animal health. The CVL also carries out diagnostic services in various disciplines such as pathology, microbiology, toxicology and parasitology.

The current activities include production of vaccines against east coast fever and other tick-borne diseases, monitoring of acaricide resistance in ticks, investigating the relationship between bovine and human tuberculosis, establishing the role of recovered pigs in the epidemiology of African swine fever and breeding of dairy cattle using oestrus synchronisation. The mechanism for determination and approval of research projects is not well defined but the department has completed drafting a National Livestock Development Master Plan. At national level, DAHI collaborates with DARTS, DAES, Parks and Wildlife and Bunda College of Agriculture on livestock research. In addition, DAHI collaborates with ILRI, Southern Africa Centre for Cooperation in Agricultural Research (SACCAR), GTZ, Iceland International Development Agency (ICEIDA), International Centre for Research in Agroforestry (ICRAF) and Food and Agricultural Organisation/International Atomic Energy Agency (FAO/IAEA) on breeding, disease control and nutrition. Funding for DAHI comes from the government revenue budget and the donor community. The budgeting process is similar to that of DARTS where projects are often approved without matching funds, hence planned programmes face *ad-hoc* financial cutbacks.

3.2.3 Department of Fisheries

The mission of the Department of Fisheries in MoNREA is to promote increased fish production through the sustainable use and management of resources to meet increasing demands of an increasing human population. Malawi is currently coordinating the SADC Inland Fisheries Sector. Fisheries' research is organised into two areas of aquaculture and capture fisheries. Funding for research is mainly from donors and cooperating partners on specific programmes. Government revenue budget is mostly used for personal emoluments and operational costs. Research areas are determined at annual technical meetings involving scientists, extension staff and the end users. The department has fisheries assistants in appropriately targeted areas to facilitate technology transfer.

At national level, the department collaborates closely with the Salima based SADC/GEF Lake Malawi/Nyasa Biodiversity Conservation Project, Bunda College of Agriculture and Chancellor College. On the international front, the department works in collaboration with the Universities of East Anglia and Southampton and J.L.B. Smith Institute of Rhodes University in South Africa.

3.2.3.1 Aquaculture research: The aquaculture research programme is based at the National Aquaculture Centre in Zomba which is also the regional centre for the International Centre for Living Aquatic Resources Management (ICLARM). The main areas of emphasis include breeding of indigenous fish species and development of pond management technologies. Support for the programme is from the FAO, ICLARM, and more recently the Japanese Government through JICA.

3.2.3.2 Capture fisheries research: The Fisheries Research Unit at Monkey Bay in Mangochi is the headquarters for research on capture fisheries. The unit has two main research centres based at Nkhata Bay and Senga Bay. In addition, the unit has substations in Zomba and in the Shire Valley. Research emphasis is on stock assessment for inshore, demersal and pelagic stocks for all water body species. Limnology is also a major component as a means of monitoring environment and assessing the bases for fish production. The unit also examines the relationship among limnological, ecological and fishing gears on fish catches from the major water bodies. Another area of major concern in capture fisheries research is on socioeconomic factors especially involving children, women and men in the management of fisheries and environmental effects on fish catches and spawning habitats.

3.2.4 The Forestry Research Institute of Malawi (FRIM)

FRIM in MoNREA is mandated to develop appropriate technologies for forestry management. FRIM whose headquarters is located in Zomba is responsible for research on sustained wood production, reduced risk in losses from timber, tree pests and diseases, and advising on the optimum use of forest products. It has substations at Chikangawa and Viphya Plateau in the north and Dedza in the centre. It also has satellite research sites at Kasungu, Karonga, Rumphi, Mangochi and Nsanje.

Forest research is organised into a programme-based structure consisting of four strategy areas: (i) industrial plantations; (ii) trees on-farm; (iii) indigenous wood management; and (iv) tree seed. FRIM also undertakes one non research strategy area on technical and information services that covers management of the National Tree Seed Centre, dissemination of research findings and management of research information data bases. Programmes in each strategy area are revisited every three years at a meeting of the National Forestry Research Committee, which is attended by invited interest

groups and FRIM staff. The committee is assisted by Strategy Area Coordinating Committees. Each strategy area consists of a number of programmes and a team leader who coordinates activities of the research team within the programme. The programmes provide information on planned activities and how to achieve set objectives, the target audience and the means by which research outputs will be disseminated. A three-year planning cycle allows flexibility for priorities to be reviewed from time to time. The budgeting and funding processes are similar to those of DARTS.

It collaborates locally with other research institutions including DARTS, University of Malawi, NHBG, ARET, TRF and the SADC/ICRAF Agroforestry Project. Internationally, FRIM has links with Oxford University in the United Kingdom and collaborates with the International Union of Forestry Organisation (IUFRO), DFID, International Development Research Centre (IDRC), International Foundation for Science (IFS), FAO, the Norwegian Agency for International Development (NORAD), the Centre for International Forestry Research (CIFOR), Commonwealth Agricultural Bureau International (CABI), and Universities of Aberdeen and Bangor.

3.2.4.1 Plantations strategy area: The main emphasis here is on tree improvement programmes. Most pine species and provenance trials are scattered inside old timber plantations in Viphya, Chongoni, Zomba and Chigumula forests. Some trials of multipurpose and indigenous trees have been established in Liwonde and Chisasira (Chintheche) forest reserves. Most nursery research is done in Zomba while establishment and regeneration experiments are scattered throughout the timber and fuel wood plantations, including some tobacco and tea estates.

3.2.4.2 Trees on-farm strategy area: The programme concentrates on propagation, establishment and regeneration programmes with most propagation work done in Zomba. Establishment and regeneration are done at Liwonde Forest Reserve, Blantyre City Fuelwood Project Area and selected smallholder farms. Other programmes include species identification and evaluation, tree management and productivity and to some extent, protection.

3.2.4.3 Indigenous woodland management strategy area: The research is on productivity and use of indigenous woodlands. Experiments and surveys are conducted in the Chimaliro Forest Reserve in Kasungu, Liwonde Forest Reserve in Machinga and Phuyu woodlands in Blantyre. These will be extended to Dzalanyama Forest Reserve in Lilongwe, Kongwe in Dowa, Ntchisi Forest Reserves, Kaning'ina Forest Reserve in Nkhata Bay and Matandwe Forest Reserve. Ecology and status trials cover all tree species in the forest. Regeneration and establishment research trials are conducted in Kasungu, Dedza and Phuyu.

3.2.4.4 Seed strategy area: The programme is handled by the National Seed Centre which undertakes research on seed production. Seed stands and orchards of more than 20 tree species have been established in all silvicultural and agroecological zones. Some stands are on farmers fields while others are in forest reserves and plantations. Management of the stands is done by farmers, plantation managers and research staff. Seed pretreatment, germination enhancement, storage and pest control is also conducted at the Centre in Zomba.

3.2.5 National Parks and Wildlife

The Department of National Parks and Wildlife in the Ministry of Tourism, Parks and Wildlife has a small section which conducts research in four areas: (i) factors controlling community structure in the park reserve ecosystems; (ii) management activities involving inventories of plants that are important to large herbivores; (iii) animal population dynamics, seasonal movements and distribution; and (iv) introducing and managing co-management strategies. The studies are conducted at Nyika and Lifupa National Parks and Lake Malawi. Funding for the Department of National Parks and Wildlife is from government and the donor community.

3.2.6 University of Malawi

Considerable research in agriculture and renewable natural resources is conducted by the constituent colleges of the University of Malawi. Research in the University is coordinated by the Research and Publications Committee (RPC) whose secretary is the University Research Coordinator. Each college has in turn a college RPC that oversees its research projects. Funding for university research is mostly from the private, international institutions and the donor community. Projects are mainly researcher or donor-driven and the university staff are allowed to use 25% of their time for research.

3.2.6.1 Bunda College of Agriculture: The college was established in 1966 and has seven departments as follows: (i) Agriculture Engineering, deals with teaching and research in farm structures, postharvest storage and processing, soil and water conservation, farm machinery, and irrigation engineering; (ii) Animal Sciences, handles livestock nutrition, production, breeding and management; (iii) Crop Sciences, deals with soil fertility, domestication and selection of indigenous fruits and vegetables, crop pests and diseases, agroforestry, community forestry, and management of field crops; (iv) Home Economics/Human Nutrition, is responsible for food processing/utilisation, nutritional status, vitamin content of local foods and family science; (v) Rural Development, is responsible for marketing, extension, agribusiness, poverty indicators; (vi) Language and Development Communication, deals with technical writing and communication; and (vii) Aquaculture and Fisheries, which is responsible for research in Aquaculture. The college has projects in agroforestry, fisheries, soil fertility, small ruminants and human nutrition. Bunda collaborates with government departments and local institutions which conduct research in agriculture and natural resources. It has a strong working relationship with the Rockefeller Foundation through the Small grants programmes. The college also has joint research programmes with other institutions such as Lincoln and Minnesota Universities, ILRI, SADC/GTZ, SACCAR and SADC/ICRISAT.

3.2.6.2 Agricultural Policy Research Unit (APRU): The unit, based at Bunda College of Agriculture started its activities in 1994 with financial support from United States Agency for International Development (USAID) through the Agricultural Sector Assistance Project (ASAP). Its main functions include research, information retrieval, documentation, dissemination, and training. The unit has successfully launched a consultancy research programme in agricultural policies. APRU's current activities include research on liberalisation of agricultural input and output markets; impact of smallholder burley tobacco production on household income and food security; agricultural diversification; opportunities and constraints; land tenure reforms; enterprise cost studies; small scale irrigation; soil erosion, land degradation and the environment; integrated pest management; and human resource development in the agricultural sector.

3.2.8 Agricultural Research and Extension Trust (ARET)

Originally called the Tobacco Research Institute of Malawi (TRIM), it was established in 1989 to conduct research on tobacco. Later, an Estate Extension Service Trust (EEST) was created to undertake tobacco extension services. In 1995 the two were merged to form ARET, an independent private organisation to undertake research and provide extension services on tobacco. A levy on tobacco sold on the auction floors provides the Trust's total funding. The Director is responsible to the board, comprising representatives from the tobacco industry, farmers, government and the Tobacco Association of Malawi (TAMA). Research programmes are largely defined by scientists and discussed at planning meetings before presentation to a technical committee for funding. Approved programmes are matched with financial resources and the programmes are monitored through monthly meetings. Research is conducted at Kandiya near Lilongwe and at Mwimba, a substation located in Kasungu and on farmers' fields.

ARET has a flexible employment policy whereby scientists can be promoted on the basis of performance rather than seniority. Research results are presented at annual planning meetings attended by scientists and interested groups and at numerous field days held throughout the country. ARET has had long running collaboration with Kutsaga Tobacco Research Station in Zimbabwe in the areas of training, varietal exchange programmes and information sharing. The Trust is a unique example of an institution that has both research and extension divisions under one roof. The major research thrusts of ARET include: (i) breeding tobacco varieties which are high yielding, disease resistant and of good quality; (ii) developing efficient and energy saving curing technologies to minimise wastage; (iii) developing appropriate agronomic technologies; (iv) controlling pests and diseases in tobacco; and (v) developing technologies for the sustainable use of environmental resources including soil and trees.

3.2.9 Tea Research Foundation (TRF)

The TRF located in Mulanje, and established in 1966, undertakes research and provides extension services on tea. Currently, the Foundation serves the tea industries of Malawi, Tanzania, Zimbabwe and South Africa. In addition, the Coffee Growers Association of Malawi with funding from the World Bank and the European Union (EU), contracted coffee research to the TRF. Funding for TRF is from a levy on the tea industry in all member states and revenue from sales of planting materials. TRF is governed by a Board of Directors representing member industries and the governments of Malawi and Zimbabwe.

The Director and Assistant Director are responsible for the management of research programmes assisted by a technical committee from the tea industry which meets annually to decide on research projects, budgets and scrutinise research progress. TRF scientists are responsible for the dissemination of their technologies to the industry. The main research thrusts include: (i) breeding for vegetatively propagated clonal tea with a high yield and quality potential and drought tolerant root stocks; (ii) agronomy programmes on the management of clonal tea including pruning, mechanical harvesting and fertiliser responses; (iii) plant protection through screening of clonal teas against pests and diseases; (iv) engineering research which includes automated irrigation systems and the development of data logging systems for factory monitoring; and (v) research on biochemical composition of tea.

3.2.10 The Malawi Sugar Industry

Research for the sugar industry is mostly conducted by the Mt. Edgecombe Research Station in South Africa, the Zimbabwe Sugar Experiment Station and the Mauritius Sugar Research Institute. However, limited research in agronomy is done by ILLOVO at Nchalo and Dwangwa. Introduced varieties are evaluated for adaptability, disease tolerance, sugar content and quality. The industry has its own extension services especially for small holder sugar production.

3.2.11 Malawi Industrial Research and Technology Development Centre (MIRTDC)

The MIRTDC based in Blantyre, was established as a trust in 1991. In addition to the major research facility in Blantyre, it has technology dissemination satellite centres in Nsanje, Mangochi, Mchinji and Nkhata Bay. The mandate of the centre is to conduct industrial research and develop technologies for sustainable utilisation of natural resources. Programmes of the centre include the development of irrigation and farm machinery equipment, egg incubators, fruit juice extraction machines, vermiculture, industrial information, food science and entrepreneurial technologies. A technical committee approves all projects that are proposed by individual scientists.

The centre collaborates with researchers in DARTS and the University of Malawi on farm machinery and human nutrition research. In addition, the centre works hand in hand with the Malawi Chamber of Commerce and Industry in carrying out industrial audits. The centre's funding is through annual government allocation, the private sector and the donor community.

3.2.12 National Research Council of Malawi (NRCM)

The NRCM was established in 1974 by a Presidential Decree and placed in the Office of the President and Cabinet (OPC) to coordinate and promote research and development (R&D) activities in the country. The Council oversees the development of sectoral R&D plans and priorities, monitors implementation and provides feedback to all R&D institutions. The Council is also mandated to coordinate the country's national information system that links all scientific and technological information providers in Malawi and undertakes inventories of scientific activities at national level. The NRCM collaborates with all R&D institutions in the country and some regional and international institutions including the Commonwealth Science Council (CSC), International Foundation for Science (IFS), African Regional Centre for Technology (ARCT), African Centre for Technology Studies (ACTS), United National Educational, Scientific and Cultural Organisation (UNESCO) and the United Nations Environmental Programme (UNEP). As a government department, NRCM gets its funding from government, the private sector and the donor community. The NRCM, through the Agricultural Sciences Committee (ASC) with funding from the World Bank, administers a contract research programme for scientists in agriculture and the natural resources sectors. Under this programme, funding is provided on a competitive basis for beneficiary demand-driven research. The ASC has put in place a monitoring and evaluation system and is planning to implement a technology dissemination mechanism for the technologies developed under its auspices.

3.2.13 International Organisations Involved in Research

A large number of international organisations are involved in research in collaboration with national research institutions as indicated in Table 3.1. Examples of successful collaborative research programmes from the table include:- (i) maize breeding at Chitedze using germplasm from CIMMYT with funding from the Rockefeller Foundation; (ii) groundnut research with the SADC/ICRISAT Groundnut Project; and (iii) bean improvement with CIAT and funding from DFID. In addition to conducting on-farm research and funding specific programmes, the institutions have provided training in research techniques and management.

Donor support for the research system is in various commodities and focuses on specific activities, hence it is difficult to synchronise government and research policies with priority research areas. For example, the Rockefeller Foundation has supported maize research in agronomy, breeding and soil fertility at Chitedze for the past seven years. GTZ is involved in integrated pest management in cabbage and tomatoes at Bvumbwe and biological control studies on cassava mealy bug and green spider mites at Chitedze. DFID supports farming systems and IPM programme on maize, pigeon peas and beans at Bvumbwe Research Station.

One of the major problems with bilateral programmes is the lack of proper coordination between the donor, on one hand and implementation agencies on the other. This has often led to duplication and repetitive research. There is, therefore, need for proper coordination to achieve greater benefits and impact.

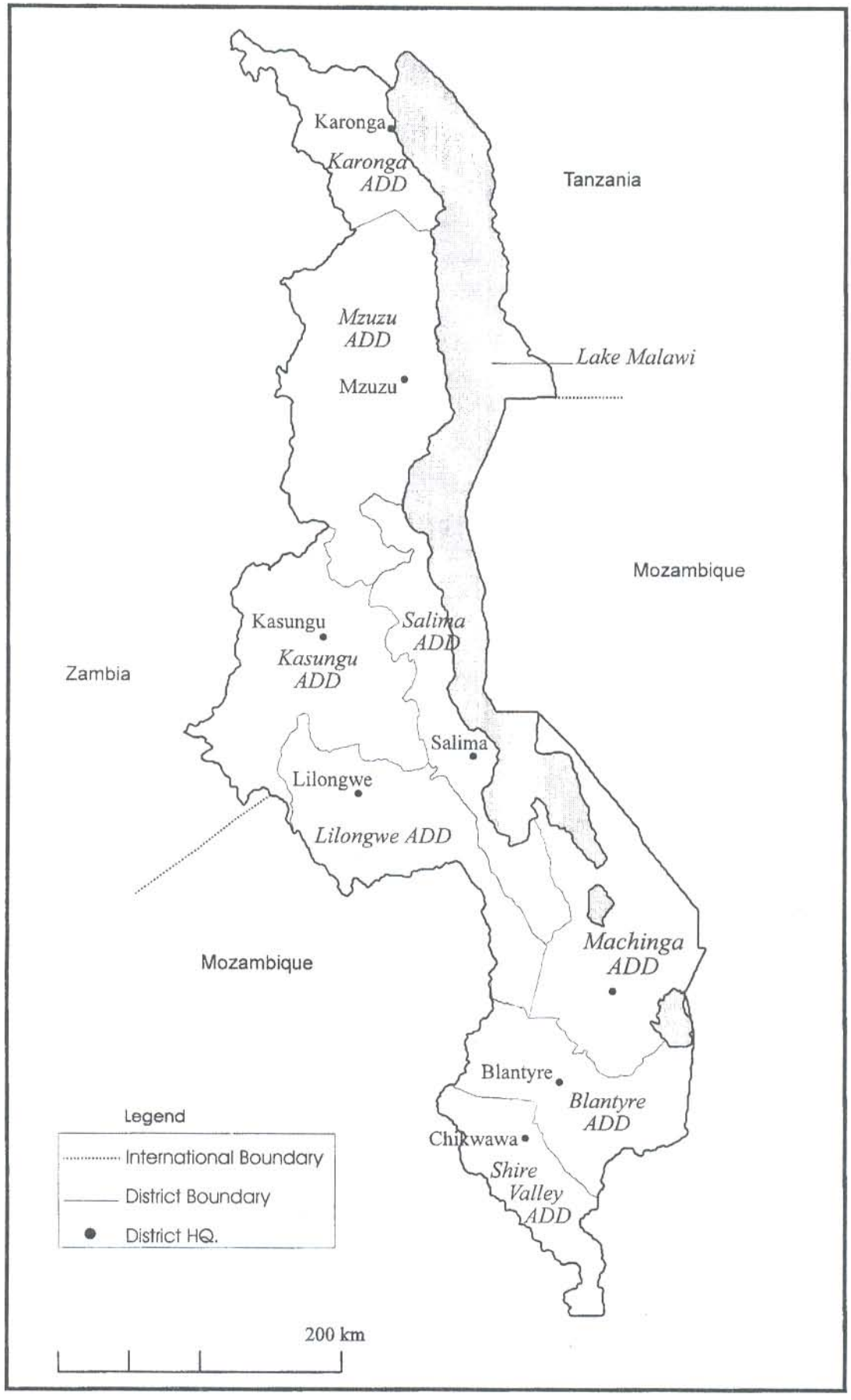
3.2.14 Department of Agricultural Extension Services (DAES)

The DAES is a large institution in the MoAID which is responsible for the transfer of agricultural technologies and the training of farmers. It performs its functions in the eight Agricultural Development Divisions (ADDs) of Blantyre, Shire Valley, Machinga, Lilongwe, Salima, Kasungu, Mzuzu and Karonga which cover the whole country (Fig. 3.2). The ADDs basically group areas of similar agroecological characteristics. They are subdivided into project areas, development areas and extension planning areas in a system that has extension agents at grassroots level. The extension agents are responsible for organising farmers for purposes of access to inputs and technologies. They also provide a link between research and farmers.

Table 3.1 **International organisations involved in collaborative agricultural and natural resources research in Malawi.**

Organisation	Institutional affiliation	Commodity involved	Research activity/focus
CIMMYT	DARTS	Maize, Wheat	a) Variety introductions b) Testing and adaptation c) Genetic enhancement
IITA (SARRNET)	DARTS	Cassava and sweet potato cowpeas	a) Variety selection b) Genetic enhancement
ICRISAT	DARTS	Pigeon pea, groundnut sorghum and millet	a) Genetic enhancement b) Control of pests and diseases c) Socioeconomic studies
IRRI	DARTS	Rice	a) Genetic enhancement b) Variety trials
CIP	DARTS	Potatoes	a) Exchange of germplasm b) Training in potato production
AVRDC/CONVERDS	DARTS	Vegetables	Exchange of germplasm
ICRAF	DARTS, FRIM and Bunda	Indigenous fruits	a) Agro-forestry b) Soil fertility
SADC Maize & Wheat network	DARTS	Wheat, Maize	a)Variety testing and adaptation
DFID	FRIM	Tree seeds	a) Seed b) Biological control of pests
DFID/CIAT	DARTS	Beans	a) Variety screening b) Soil fertility c) Pest and disease control
DFID	Chancellor College		Soil pests
DFID	DARTS	Plant protection	a) Farming systems b) IPM
GTZ	Bunda	Livestock	Nutrition
GTZ (MAPPP)	DARTS	Plant protection	a) Bio-control b) IPM
World Bank	DARTS	All commodities	Various
World Bank/UNEP	Fisheries Dept National Parks	Capture Fisheries	a) Fish ecology b) Fish conservation
JICA	Fisheries Dept Bunda	Aquaculture	a) Fish breeding b) Indigenous fish
ROCKEFELLER (Soil Fertility network)	DARTS	Maize	a) Inorganic and organic fertiliser trials
ROCKEFELLER	DARTS		Maize pathology
ROCKEFELLER	Bunda		Farming systems, weeds
ROCKEFELLER	FRIM	Agroforestry	Tree provenances
USAID	Bunda		Agricultural policy
USAID (UDLP)	Bunda	Goats	Milk production
USAID (CRSP)	Bunda	Bean	a) Pest and disease control b) Drought tolerance c) Processing and use d) Seed multiplication e) Socioeconomic f) Genetic enhancement
USAID (CRSP)	DARTS	Groundnuts	Breeding
SPGRC	DARTS	Genebank	a)Conservation b)Biodiversity c)Documentation

Fig. 3.2 Map of Malawi showing Agric. Dev. Divisions (ADDs)



3.3 RESOURCES FOR RESEARCH

3.3.1 Financial Resources

Financial resources are of major concern for both researchers and research managers and, therefore, need to be given due attention. Public research institutions in Malawi are largely funded from the government recurrent and developing budgets. Institutions submit separate annual budgets through their respective ministries to the Treasury and Parliament for approval and allocation of funds. Approved budgets cover capital and operating expenditures, staff training and personal emoluments. Emoluments are covered by the recurrent budgets only.

Expenditures under the two budgets are audited at the end of each financial year. In some institutions, scientists are able to obtain direct funding from donors or NGOs for work in specific areas. Budgets and expenditures on direct funding prove difficult to obtain largely due to the poor coordination of these projects. Private research institutions, on the other hand, obtain funding from a cess/levy charged from their respective stakeholders. TRF for example gets US$12.5 per tonne made tea, while ARET gets 1% levy on all tobacco sold at the Auction Floors. The University of Malawi receives little government funding for research and the bulk of the budget is from donor-funded projects that are negotiated directly by scientists but implemented through the constituent colleges to ensure accountability.

Table 3.2 gives levels of funding for research in DARTS, DAHI, Fisheries, FRIM, Bunda College of Agriculture, ARET and TRF between 1992/93 and 1996/97. The figures do not include expenditure on bilateral donor-funded projects and funding that goes direct to scientists and are actual disbursements for 1992/93 through 1995/96, while those for 1996/97 are the approved ones. The figures provide a good picture of the changing circumstances of agriculture and natural resources research over the five-year period. There has been a substantial decrease in the MoAID and Ministry of Natural Resources and Environmental Affairs (MoNREA) revenue budgets as a percentage of the total GOM budget, from 4.54% to 2.80 % for MoAID and from 2.43% to 1.62 % for MoNREA.

Overall, the level of recurrent funding to publicly funded research institutions off the total government budget decreased from 0.82% in 1992 to 0.32% in 1996. In real terms, expressed in US$ at exchange rates for the year in question, funding under recurrent budget has dropped by 53% over the five-year period.

More importantly, the proportion of allocations to research relative to Ministry allocations were reduced tremendously, probably reflecting the reduced importance ministries attach to research. For example, allocations to DARTS decreased from about 15% to 8% whereas those from FRIM decreased from about 2.7% to 1.9%. Revenue budgets for DAHI, fisheries and forestry research also show substantial fluctuations over the same period.

Since numbers of staff have remained about the same, an increasing percentage of the budgets have been spent on personal emoluments. Between 1992 and 1996 personal emoluments increased from 56% to 77% in DARTS, from 48% to 90% in DAHI, from 47% to 78% in the Department of Fisheries, and from 52% to 65% for FRIM. Since these are drawn from the overall recurrent allocation, the increase has brought about related reductions in operational funds.

Table 3.2 Levels of recurrent and development budget (MK'000) for research institutions in agriculture and natural resources (1992/93 to 1996/97)

RECURRENT ALLOCATIONS	1992/93	1993/94	1994/95	1995/96	1996/97
Government Budget	1,800,237	2,152,736	3,745,095	6,266,782	7,848,948
Agricultural GDP		2,302,400	3,182,500	4,298,100	3,361,000
Min. of Agriculture & Irrigation Development (MoAID)					
Revenue Allocation	81,796	92,068	146,904	151,269	219,661
As % of Govt. Budget	4.54	4.28	3.92	2.41	2.80
As % of AGDP		4.00	4.62	3.52	6.54
(i) DARTS					
Revenue Allocation	12,072	13,744	18,722	19,393	17,325
As % of MAI Allocation	14.76	14.93	12.74	12.82	7.89
As % of AGDP		0.60	0.59	0.45	0.52
Personal Emoluments (As % of Allocation)	56.00	63.00	73.00	77.00	81.00
(iii) DAHI					
Revenue Allocation	1,005	944	1,808	1,704	2,756
As % of MAI Allocation	1.23	1.03	1.23	1.13	1.25
As % of AGDP		0.04	0.06	0.04	0.08
Personal Emoluments (As % of Allocation)	48.00	53.00	63.00	90.00	52.00
Min of Natural Resources and Environmental Affairs (MoNREA)					
Revenue Allocation	43,797	48,077	74,159	83,853	127,102
As % of Govt. Budget	2.43	2.23	1.98	1.34	1.62
(i) Fisheries Research					
Revenue Allocation	432	694	455	763	1,348
As % of MoNREA Allocation	0.99	1.44	0.61	0.91	1.06
As % of Allocation		0.03	0.01	0.02	0.04
Personal Emoluments	47.00	70.00	68.00	78.00	52.00
(ii) FRIM					
Revenue Allocation	1,177	1,169	1,409	1,374	2,408
As % of MoNREA Allocation	2.69	2.43	1.90	1.64	1.89
As % of AGDP		0.05	0.04	0.03	0.07
Personal Emoluments (As % of Allocation)	52.00	68.00	64.00	65.00	65.00
Total Allocation Under Recurrent Budget in MK	14,686	16,551	22,394	23,234	23,837
" in US$	3,338	3,646	1,904	1,555	1,556
As % of AGDP		0.72	0.70	0.54	0.7

Table 3.2 cont...

DEVELOPMENT ALLOCATIONS	1992/93	1993/94	1994/95	1995'96	1996/97
A. Public Institutions					
(i) DARTS					
Development Allocation	3,695	8,492	10,289	32,177	21,060
Donors	3,278	8,492	10,014	31,345	20,438
Government	417		275	832	622
(ii) ASC					
Development Allocation			2,269	5,541	6,507
(iii) DAHI					
Development Allocation	662	405	1,311	10,416	6,578
Donors	249	273	1,280	8,916	6,013
Government	413	132	31	1,500	565
(iv) Fisheries					
Development Allocation	4,952	2,513	977	1,627	299
Donors	4,631	2,390	957	1,597	0
Government	321	123	20	30	299
(v) FRIM					
Development Allocation	107	370	1,551	1,126	2,390
Donors	100	330	1,492	1,083	1,945
Government	7	40	59	43	445
(vi) Bunda College of Agriculture					
Total Allocation		1,926	5,009	8,852	9,124
Donors		1,900	4,979	8,820	9,093
Government		26	30	32	31
Total Development Allocations	9,416	13,706	19,137	54,198	39,451
Total Recurrent & Development Allocations (MK)	24,102	30,257	41,531	77,432	65,2847
Total Recurrent & Development Allocations (US$)	5,478	6,665	3,532	5,183	4,261
B. Private Institutions					
(vii) ARET				8,420	15,801
Personal Emoluments (As % of Allocation)				42	39
(viii) TRF		6,407	5,655	12,160	28,718
Personal Emoluments (As % of Allocation)			47	45	
Total Private Institutions (MK)	0	6,407	5,655	20,580	44,519
Total Private Institutions (US$)				1,346	2,906
Grand Total of Research Funds for Agric. and Natural Resources	24,102	36,664	47,186	98,012	109,803
Revenue Funds as a promotion of Funding	60.9	45.1	47.5	23.7	21.7

The decline in recurrent funding for research resulted in the development budget bearing an increasing part of the costs for research. In general, the level of development funds as a proportion of public funding to research increased from 39% to 75% between 1992/93 and 1995/96. For example, development budget allocation to DARTS has increased eightfold, DAHI fifteen-fold, FRIM tenfold and that of Bunda College of Agriculture fourfold over the five-year period. Although in real terms this does not represent significant annual increases in funding, it is nevertheless true that most of the public institutions largely depend on development funding for their activities. This is not a sustainable situation as donor funding is attached to projects that only operate within a set time-frame and their termination often results in huge funding gaps. A case in point is that of fisheries research which has faced a large reduction of about 94% in development budget allocations over the five-year period. Sustainable research programmes, therefore, will have to continue depending on revenue funding.

An emerging factor in research funding is the apparent recognition of the importance of research in specific commodities by the private sector. This is signified by the increase in funding of around 100% for tea (from 1995/96 to 1996/97) and tobacco research (from 1994/95 to 1995/96). This is a good example of how parts of the national research system can be delinked and still get substantial funding from private investors. It should be noted that the two institutions share 41% of all research funding for agriculture and natural resources. Considering their size, this level should be conducive for good research programmes. Another significant factor has been the increased involvement of Bunda College of Agriculture in research. While public funding for research at Bunda College of Agriculture is almost nonexistent, donor funding has increased fourfold between 1993/94 and 1996/97. The College receives by far the highest proportion (99.6%) of its research funding from donor funds, a sign of the growing realisation by the donor community that manpower resources and facilities at Bunda College of Agriculture can play an important and active role in ANR research.

Public research expenditure as a proportion of Agricultural GDP, termed the Agricultural Research Intensity Ratio, has been used as a measure of support to agricultural research. The World Bank proposed a target of 2% of the GDP for government support but this is rarely reached, and many developing countries have remained in the 0.2 to 1.0% range. The total recurrent allocations to research relative to AGDP in Malawi between 1993/94 and 1996/97 have remained relatively static at around 0.7%, which is consistently lower than the 2% suggested by the World Bank.

Pardey *et al* (1995) have shown that agricultural research expenditure as a share of the AGDP in Malawi is 1.68%. This total is made up of 0.78% from the recurrent budget and 0.90% from development budget (Table 3.3). This shows that donors are contributing more to the research budget. However, the total contribution is still falling short of the minimum 2% required. The latest data in Table 3.2 shows that the contribution of government to the research budget is now only 0.7% of the AGDP thus indicating decreasing contribution of government to the research budget. The 1995 report also showed that in Southern Africa only Botswana and the Republic of South Africa (RSA) contributed at least 2% of the research budget using their recurrent budget. Furthermore only Botswana, Swaziland, RSA and Zambia are able to contribute to the research budget.

The Malawi government therefore needs to increase its contribution to the research budget to reach at least the 2% level. Furthermore, managers of the national research system for agriculture and natural resources need to improve the management system to create an enabling environment for

increased productivity. This involves improved management of financial, human and physical resources, prioritisation of the research programmes, and allocation of resources to priority research programmes, that will generate high impact technologies.

Table 3.3 Agricultural research expenditure as a share of agricultural GDP in Southern Africa, 1991

Country	Total expenditure	National expenditure	Donor expenditure
Lesotho	1.49	1.18	0.31
Zimbabwe	1.52	1.18	0.34
Malawi	1.68	0.78	0.90
Swaziland	2.05	1.62	0.43
Zambia	2.52	0.56	1.96
South Africa	2.55	2.25	0
Botswana	3.58	3.08	0.50

Source: Adapted from a graph by a 2020 Vision for Southern Africa: Pardey, Roseboom and Beintema, 1995.

3.3.2 Human Resources and Time Allocation

Upon realising that the key to national development is human resource development, the government expanded the educational system including the establishment of the University of Malawi and overseas training of staff in most sectors of the economy using donor assistance. This is reflected in the scientific manpower of the institutions involved in research in agriculture and natural resources. Most staff are recruited from the University of Malawi after completing a B.Sc degree and sent abroad for advanced training under donor-funded projects. Currently, some researchers receive advanced training from the University of Malawi through programmes supported by donors such as the Rockefeller Foundation and GTZ. The national research institutions have made great progress since independence in 1964, in localising research positions. For instance, DARTS had one Malawian researcher at professional level in 1964 compared with 23 expatriates; FRIM, TRF and Fisheries were fully staffed by expatriates. Currently, most of the institutions, including DARTS, DAHI, ARET and FRIM are staffed by nationals with a few expatriates in donor-funded projects.

The current status of researchers involved in the agricultural and natural resources research system in the country is summarised in Table 3.4. These show numbers of staff in various sectors and institutions. Of the 275 researchers with post graduate academic qualifications, 57 hold B.Scs, 139 M.Scs and 79 Ph.Ds. The largest concentration of Ph.Ds is in DARTS and the University of Malawi. Among the institutions, DARTS has 29% of the total staff while, Bunda College of Agriculture has 26% of the total staff. Among the sectors, agriculture accounts for 68% of the total staff, livestock has 15% while fisheries and forestry have 8% each. These numbers are a great improvement over

the past three decades when the research system was staffed mainly with B.Sc degree holders.

Despite the good progress in localisation, the researchers are predominantly male with less than 7% female in the whole national research system. The low number of females is largely due to few female students graduating from the University of Malawi. In addition, there has generally not been much interest in science among women students although the attitude is now changing. Considering that women are the *de facto* natural resource conservationists and form the majority of farmers, there is need to recruit qualified female graduates to work in research.

An appropriate indicator for current priorities in the research system is the allocation of scientists' time to programmes and projects. This gives an indication of the effective time each scientist allocates to specific activities including research and non-research tasks in their respective commodities and disciplines. The analyses provide a valuable overview on the use of human resources and, even more importantly, how these will need to be redeployed to cater for the priorities outlined in Chapter V. The tables 3.5 to 3.8 summarise the time allocation by scientists to various commodities in different research themes based on a survey conducted by the ASC in the various research institutions in 1998.

Table 3.4 Numbers and qualifications of scientists involved in agricultural and natural resources research

Institution	Academic Qualification			
	Ph.D	**M.Sc**	**B.Sc**	**Totals**
ARET	5	5	1	11
Bunda College	34	33	2	69
Centre for Social Research	2	8	1	11
Chancellor College	6	1	0	7
Polytechnic	0	3	2	5
DAHI	0	4	2	6
DARTS	23	44	13	80
Fisheries	1	18	22	41
FRIM	2	6	4	12
MIRTDC	0	7	2	9
Parks & Wildlife	1	2	1	4
NHBG	1	3	5	9
TRF	4	5	2	11
Total	**79**	**139**	**57**	**275**

3.3.2.1 Crops research: In general, research on industrial crops takes up most of the scientific time (Table 3.5). This is largely because of a concentrated focus through private sector funding of research on these crops. This is followed by research on cereals, legumes and root and tuber crops in that order. Among the crops, the least scientific time is spent on vegetables (12%) and fruits (7%). This is compounded by the fact that more than 50% of scientific time spent on these crops is on disease and pest control research.

Among research areas in crops, pests and diseases have the highest overall allocation of scientific time, (32%). This is followed by research on crop improvement (15%) and crop management (14%). There is substantial scientific time spent on biodiversity although the efforts and outputs are masked by the fragmentation of the work in different institutions. Likewise, there is variation in research efforts within the various crop commodities. For example, in cereals, crop improvement and soil fertility research take up 44% of the total scientist time. In fruits, legumes and vegetable crops, scientific time on pests and diseases take between 30% and 60% of the total time. In roots and tubers, and legumes and oilseeds, pests and diseases and crop improvement together account for 61% and 65% of the total scientific time respectively. Generally, the data shows that crops research on storage, processing and utilisation, irrigation and post harvest handling receive very little attention. The data also shows that soil fertility research is not given much attention in the individual commodity groups apart from the cereals group. Even at cross commodity level the scientist time spent is insignificant, despite the fact that this is the single most important factor that lowers crop production in Malawi.

Table 3.5 Total scientist-years spent on crops research

Research Theme	Cereals	Tubers	Fruits & ornamental	Industrial crops	Legumes & oil seeds	Vegetables & spices	Total scientific time	As % of total time
1. Soil fertility	1.9	0.04	0.12	1.17	0.61	0.25	3.12	8.23
2. Crop management	1.28	0.8	0.45	2.36	1.13	0.91	5.22	13.94
3. Crop improvement	2.05	2.11	0.32	1.2	1.25	0.74	6.47	15.43
4. On-farm storage	0.05	0.08	0	0.05	0.02	0	0.15	0.40
5. Pests & diseases	1.3	1.84	2.09	5.7	2.34	2.47	12.97	31.66
6. Processing & utilization	0.05	0.1	0	0.85	0.11	0	0.26	2.23
7. Irrigation	0	0.1	0.11	0	0.03	0	0.24	0.48
8. Seed production	0.25	0.38	0.22	0.8	0.6	1.14	2.59	6.82
9. Labour	0	0	0	0.08		0	0	0.16
10. Post harvest	0.05	0.08	0	0.07	0.18	0.14	0.45	1.05
11. Administration	1.61	0.71	0.03	4.41	0.77	0.27	4.21	15.69
12. Advisory	0.17	0.18	0.03	0.89	0.21	0.18	0.81	3.34
13. Teaching & superv.	0.1	0.01	0	0.11	0.01	0.05	0.17	0.56
14. Economics				0.95				
Totals	8.81	6.43	3.37	18.64	7.26	6.15	49.71	
As % Total Time	17.72	12.94	6.78	37.50	14.60	12.37		

Note: Out of 275 scientists in Agriculture and Natural Resources Research, 50% responded to the questionnaire on scientific time utilisation.

3.3.2.1 Forestry research: In forestry, all strategy areas receive more or less equal scientific time. However there are variations in time spent on specific research areas. Most time is spent on the management (31%) followed by pests and diseases (15%) (Table 3.6).

Table 3.6. Total scientist-years spent on forestry research

Research Theme	Plantation & woodlot forests	Indigenous forests	Total scientific time	As % of total time
1. Soil fertility	0.6	0	0.6	5.93
2. Crop management	1.33	1.82	3.15	31.16
3. Crop improvement	0.25	0.05	0.3	2.97
4. On-farm storage	0	0.05	0.05	0.49
5. Pests & diseases	1.18	0.33	1.51	14.94
6. Processing & utilization	0.06	0.03	0.09	0.89
7. Irrigation	0	0	0	0.00
8. Seed production	0.6	0.35	0.95	9.40
9. Labour	0	0	0	0.00
10. Post harvest	0	0	0	0.00
11. Administration	1.11	1.28	2.39	23.64
12. Advisory	0.35	0.4	0.75	7.42
13. Teaching and supervision	0.15	0.17	0.32	3.17
Totals	5.63	4.48	10.11	
As % Total Time	55.69	44.31		

3.3.2.3 Livestock research: Research on livestock receives much less scientific time than most crops. Among the livestock types, research on ruminants takes 75% of total scientific time, dominating that of monogastrics (Table 3.7). Among the research areas, most scientific time is spent on nutrition (17%) and management (15%). Little time is spent on breeding (1%) and pests and disease control (8%). The data indicates that most livestock research areas are fairly weak and scientific effort is spread thinly across many research themes. Virtually no time is allocated to animal traction and breed improvement because of lack of scientists in the area.

Table 3.7 Total scientist-years spent on livestock research

Research Area	Ruminant livestock	Monogastric livestock	Total scientific time	As % of total time
1. Breed improvement	0.02	0.05	0.07	1.75
2. Livestock management	0.32	0.31	0.63	15.75
3. Feeds & nutrition	0.44	0.24	0.68	17.00
4. Diseases & parasites	0.25	0.10	0.35	8.75
5. Storage/processing /utilization	0.10	0.12	0.22	5.50
6. Animal traction	0.00	0.00	0.00	0.00
7. Management & administration	1.01	0.13	1.14	28.50
8. Advisory	0.12	0.03	0.15	3.75
9. Teaching	0.76	0.00	0.76	19.00
Total	**3.02**	**0.98**	**4.00**	
As % of Total Time	**75.50**	**24.50**		

3.3.2.4: Fisheries research: In fisheries, research is mostly concentrated in capture fisheries where among its research areas emphasis is on ecology, fish biology and taxonomy. In aquaculture emphasis is on fish management and feeds and nutrition (Table 3.8).

Table 3.8 Total scientist-years spent on fisheries research

Research Area	Aquaculture fisheries	Research Area	Capture Fisheries
1. Breed improvement	0.53	1. Ecology/Limnology	1.67
2. Fish management	1.81	2. Fish Biology	1.69
3. Feeds & nutrition	1.06	3. Taxonomy	1.94
4. Diseases & parasites		4.Pop. Dynamics	0.79
5.Storage/processing /utilization	0.44	5.Gear technology	0.00
6. Animal traction		6. Boat Engineering	0.00
7. Management & administration	0.81	7. Processing/handling	0.01
8. Advisory	0.10	8. Socioeconomics	0.04
9. Teaching	0.13	9. Mgt./admin	1.33
		10. Consultancy	0.17
		11. Workshops	0.57
		12. Teaching & advisory	0.35
Total	**4.88**		**9.01**
As % of Total Time			**75.50**

In general, the data on human resources and time allocation shows that significant scientific time (48%) is spent on administration, perhaps an indication of the many subdivisions and sections that characterise the research system. These often carry with them bureaucratic and management duties. Contrary to popular view, consultancies and workshops do not take up much of the scientists time. Perhaps, scientists should be encouraged to take up consultancies to enhance their knowledge, contribute to technology dissemination and raise revenue for their institutions. The data shows that time spent on advisory services is quite negligible i.e 3.% in crops and livestock, and 7% in forestry. This indicates that scientists are not actively involved in disseminating developed technologies, an area that merits special attention if the technologies will have to be taken up by end-users. It is also very clear that scientists spread their time thinly over a wide range of research areas in most programmes. The much vaunted for concept of "concentration into specific areas" is lacking and this has led to dilution of effort.

CHAPTER FOUR

THE OUTPUTS AND IMPACT OF AGRICULTURE AND NATURAL RESOURCES RESEARCH

4.1 INTRODUCTION

Agriculture and natural resources research in Malawi is fragmented and has weak intra and inter-sectoral linkages and collaborative mechanisms. Hence, resources are spread so thinly to several institutions, activities and programmes resulting in low research outputs. Considering the degree of dependence of the economy on agriculture and the natural resource base, there is need for a vibrant research system that is able to produce new knowledge and improved technologies for sustainable agriculture and natural resource productivity.

To have an impact on the sectors' productivity and exploit the production potential, the research outputs must be adopted and utilised to the fullest extent by potential end-users. To achieve this, the end-users must have access to the new knowledge and technologies that are cost effective. Weaknesses in any linkages in the communication chain will negate the value of the research system. This chapter has described the outputs, uptake and impact of technologies generated. It analyses the reasons for success or failures of research programmes and draws lessons from past programmes for incorporation in similar programmes in future.

Historically, the main emphasis of agricultural research has been on the development of yield increasing technologies, such as improved crops, livestock breeds and associated production technologies. An examination of the Malawi Agriculture and Natural Resources Research System shows evidence of programmes that have proved successful and also those that have had little impact.

4.2 THE AGRICULTURAL RESEARCH COUNCIL OF MALAWI

The Agriculture Research Council of Malawi (ARC) was established by an Act of Parliament in July 1967 to reinforce existing government research and technical services. The United Kingdom government strongly supported the formation of the ARC and provided 80% of the capital costs, with the Malawi government and ADMARC, then Farmers Marketing Board, contributing the remaining 20%. During 1967-1975, the Council developed three research units: (i) a cotton research and a biometrics unit located at Makoka Agricultural Research Station; (ii) a grain legumes unit located at Chitedze Agricultural Research Station; and (iii) a soil fertility research unit located at Bvumbwe Agricultural Research Station. The ARC was dissolved in 1975 and its activities amalgamated with those of the Department of Agricultural Research and Technical Services.

4.2.1 Outputs of the ARC Programmes

Several cotton varieties, including Makoka 72 and Albar 51, were released. Crop protection and agronomic practices were part of the package for these varieties. The programme also developed and released several groundnut varieties, including Chalimbana, Mani pintar, Mwitunde, Malimba and

RG1. Additional recommendations included agronomic practices, pest and disease control measures, and *Rhizobia* inoculations on soybeans to increase yields and reduce the need for fertiliser application.

4.2.2 Factors That Contributed to the Success of the ARC Programmes

4.2.2.1 Government commitment and funding: There was strong government support for research and the will to make it succeed. The ARCs internal and external donor agencies provided funds for staff emoluments and procurement of equipment for the programme. Both the Malawi and British Governments provided substantial capital funds for the establishment of the Council and its operational costs. The British Cotton Growers Association and the Tropical Products Institute supported the project financially and conducted studies on sex pheromone programmes. Because of its interest in cotton and grain legumes, ADMARC contributed additional operational funds for cotton and grain legumes. Other local commercial companies supplied spraying equipment and chemicals such as insecticides, fungicides, herbicides and fertilizers for experimental purposes. In addition, the Shell Chemicals company donated three green houses to Makoka Research Station, and provided operational funds.

Staff were on two year contracts with emoluments and working conditions better than those in government. The ARC staff got gratuities after working for two years and this provided an incentive to work harder. There was very good cooperation and collaboration with staff of the DARTS, TRF and international institutions such as the Cotton Research Corporation which provided technical assistance.

4.2.2.2 Organizational structure: The ARC worked through a Board based at the research station. Research plans were discussed and adequate funds disbursed on a timely basis. Monitoring and evaluation of research programmes was under the strict control of the Board. The ARC concentrated on few crops and research was done on all aspects of the crops such as breeding, physiology, agronomy, soil fertility and crop protection.

4.3 THE DEPARTMENT OF AGRICULTURAL RESEARCH AND TECHNICAL SERVICES (DARTS)

The mission of the DARTS is to conduct applied research to generate information for farmers. The research was originally station-based. However, under NARP, the research system was reorganised into commodity groups in mid-1980s. To improve research-extension-farmer linkages, a farming systems research component, later named Adaptive Research was included. Adaptive Research Teams were established in Shire Valley, Blantyre, Machinga, Lilongwe, Kasungu, Mzuzu and Karonga ADDs. Experiments conducted by the Adaptive Research Teams were directed at developing site-specific recommendations for field crops. However, this component was abandoned in the early 1990s due to several reasons including lack of funding and lack of a proper definition of the role of the scientists and staff in the component.

4.3.1 Outputs of Agricultural Research

4.3.1.1 Crops research: Research on crops has led to the development of several technologies that can be used to increase productivity. These include improved crop varieties, agronomic practices, soil fertility improving practices, farm machinery and irrigation technologies.

(i) Improved varieties: Concerted short and long term efforts by scientists in DARTS, Bunda and International Agricultural Research Centres have led to the development and release of a large number of varieties. These varieties, for both field and horticultural crops are high yielding, tolerant to diseases and pests and are adaptable to local conditions. Research on maize has led to the release of several maize hybrids and composites that yield between six and ten tonnes per hectare compared to yields of less than one tonne for local varieties. Work on legumes and oilseeds has also led to the release of a large number of groundnut, pigeon peas, soybeans and bean varieties. Work on horticultural crops has led to the release of high yielding and disease tolerant varieties of bananas, mango, tomato, cabbage, sweet potato, cassava and potato, among many others. Research by ARET and TRF has led to the release of numerous tobacco and tea varieties. The two private institutions have been able to multiply adequate quantities of basic seed of tobacco and tea and this has accelerated the transfer of new varieties quicker to farmers. On the other hand, the public and parastatal institutions have had to rely on commercial seed companies and NGO seed programmes for multiplication of basic seed, hence slowing down the spread of some varieties.

The improved crop varieties have high potential yields over local varieties and the yield gap between smallholder farms and research plots ranges between 60-85%. Most varieties have been developed from both local and introduced germplasm through normal crossing and selection programmes. Where such programmes do not exist, as in vegetables and fruits, varieties have been introduced and selected for adaptability to local conditions subsequent to release. A comprehensive list of crop varieties released in Malawi is contained in "A handbook of crop varieties", DARTS (1995).

(ii) Improved agronomic practices: Research has developed a lot of improved agronomic practices for various crops. These include recommendations for plant spacing and plant population, weed control, and time of planting. Field crops plant spacing ranges from 15 cm in groundnuts to 75 cm in maize, while in fruits this ranges from 5m in apples to 9m in macadamia. Research has also recommended planting with first rains for all crops as late planting has been shown to reduce crop growth, yield and quality. In terms of weeding, research has recommended two good weedings in maize and has demonstrated that with good weeding, farmers can achieve high yields at half the recommended fertiliser rates.

There has also been substantial work on cropping systems, mostly on intercropping where a range of crop mixtures and arrangements have been developed. Some research output in this area has been the demonstration of intercropping benefits from cassava and groundnuts, maize and sweet potatoes, cowpeas and beans. Research has also shown that grain-legume rotations have great benefit to soil fertility.

(iii) Soil fertility improving technologies: Early research defined crop response zones in Malawi (Brown, 1962). This identified areas that are generally deficient in nitrogen, phosphorous and sulphur. In response to this, research has over the years developed technologies that address issues of organic and inorganic fertilisers as well as improvements in soil organic matter. Recommendations on fertiliser types, fertiliser levels, application frequencies and methods are available for most crops. In maize, area specific fertiliser levels have been developed for all EPAs in the country and applications of 90kg nitrogen has been shown to increase maize yields from one tonne to about five tonnes. The same is true in tobacco where applications of about 98kg nitrogen and 100kg each of phosphorus and potassium have led to very high yields and improved quality of the tobacco leaf.

Soil fertility research has also extended to organic sources of fertiliser and work on soil conservation. A classical example is the use of rhizobia inoculum to increase modulation in soybeans. Research has shown increased yields from inoculation and this has now been adopted as a standard recommendation. The use of agroforestry tree species to increase soil organic matter and nutrients has also received attention. Research has demonstrated that inorganic fertilisers may be reduced if high quality leaf biomass from leguminous tree species such as *Leucaena leucocephala* or *Tephrosia vogelli* is applied in conjunction. Other agroforestry technologies include alley cropping or hedge row intercropping, interplanting *with Faidherbia albida*, improved fallows and under sowing with fast growing leguminous tree species such as *Sesbania sesban*. In terms of soil conservation practices, research has developed several technologies including the use of stone lines of rock bunds, cultivation ridges, marker ridges and contour ridges to reduce soil erosion and land degradation.

(iv) Irrigation: Research has developed technologies for irrigation of rice and a range of vegetables. In rice, research has recommended irrigation regimes and water management techniques. There have been some recommendations for the growing of crops such as maize, sweet potatoes and beans using residual moisture in dimbas. These recommendations include plant populations, varieties and fertiliser levels for these crops.

(v) Pest management: Research on control of pests and diseases has resulted in recommendations for their control in a number of crops. Several chemicals have been recommended for the control of pests and diseases, such as use of carbaryl for the control of boll worms, leaf eaters and jassids in cotton; Dimethoate for the control of aphids and red spider mites in vegetables, among many others. Research has also recommended methods for the monitoring and control of migratory pests such as red locust and army worms. There are also recommendations for the biological control of certain pests, such as the use of the parasitic wasp for the control of cassava mealy bugs. As part of an IPM approach, research has established economic thresholds for the control of some pests, such as boll worms and jassids in cotton and the stink bug and borer in macadamia.

(vi) Farm mechanisation: A wide range of technologies for mechanisation of most farm operations including those for production, cultivation, transport, processing and irrigation have been developed. Technologies such as ox-drawn ploughs and ridgers have been adapted for use in Malawi. Others include ox-drawn carts and cultivators; grain dehullers and grain treating machines; small scale ram press oil expeller and fruit juice making machines.

4.3.1.2 Livestock Research: Livestock research, especially in animal production is currently being conducted by DARTS, Bunda College of Agriculture while animal health research is mainly conducted by DAHI. Livestock research covers cattle, goats, sheep, pigs, poultry and more recently non-conventional livestock and wildlife. Research in these livestock commodities has mainly concentrated on improvement of breeds, fodder crops and vaccines.

Some research achievements worth noting include a substantial pasture and browse programmes initiated in the late 1960's under which a range of recommendations was produced such as the use of Rhodes, star, Napier and Guinea grasses; Leucaena and forage to improve livestock nutrition. Research on livestock nutrition also concentrated on improved utilisation of crop residues and by-products for both stall-fed beef and dairy cattle. The use of locally formulated urea/molasses/mineral blocks is now a major supplementary feeding recommendation for large ruminants.

A Malawi Zebu improvement programme based on selection within the Zebu breed has been in place since 1966 and an evaluation of dairy breeds was carried out in the 1980s together with a study on calf rearing systems. To date, several breeds of the livestock commodities have been recommended such as the Holstein/Friesian and their crosses with Malawi Zebu for dairy production; the Malawi zebu, Brahman and their crosses for beef production; the dual purpose Black Australorp poultry breed for meat and egg production; the local goat, boer and their crosses for goat meat production; the local sheep, Dorper and their crosses for mutton production and the Land Race and Large White pig breeds for pork production.

Livestock research in management has looked at improvement in village production systems as well as formulation of non-conventional poultry nutrition rations using locally available ingredients for small and medium scale farmers. In DAHI, livestock research has concentrated on generation of vaccination technologies against tick-borne diseases, especially East Coast Fever; by using regional strains of *Theileria parva* from East and Central Africa. Safe field delivery of these vaccines has received considerable attention. DAHI also conducted dipping trials in the 1990s over a 5-year period and came up with a recommendation of a strategic dipping regime for the control of ticks and tick-borne diseases in all ADDs except Shire Valley ADD.

Little research has been conducted by the private sector. However, Malawi Industrial Research and Technology Development Centre has designed some low cost small-scale equipment for rural farm use while the Pharmaceutical industry has conducted trials on pyrethroid acaricides and on tick resistance to commonly used acaricides in Malawi. The impact of this livestock research has been an obvious increase in some livestock products due to the uptake of the recommendations or generated technologies by the livestock farming community. The smallholder dairying, now firmly established is based on the Friesian x Malawi Zebu cattle. This project is contributing around 50% of the fresh milk marketed in the country, with some farmers producing yields that are comparable with those from other countries in Africa. Management technologies have however been slow in uptake. This has resulted in low on-farm husbandry levels and reproductive efficiency contributing further to the dwindling livestock numbers.

4.3.2 Factors That Supported the DARTS Programmes

4.3.2.1Government policy: There was a clear government policy in favour of maize research to increase yields to attain food self-sufficiency. Government introduced a subsidy policy on fertilisers and this helped to increase maize production. ADMARC established marketing channels throughout the country for both inputs and outputs and this accelerated uptake of new technologies. To promote quality seed production, government established a seed inspection and certification scheme and directed that the National Seed Company of Malawi assists in financing part of its operations. During the 1980s, a team approach to maize research brought together breeders, agronomists and plant protection scientists to breed high yielding varieties. There was also a clear policy on the production of horticultural crops which included financial assistance and improvements in the farmer-extension linkages.

For livestock, government policy supported research on upgrading the Malawi Zebu by crossing with Brahmans to increase beef production. The upgrading of the Malawi Zebu by crossing with dairy breeds, especially Friesians, also involved the introduction of artificial insemination services to improve dairy production. Research by Bunda College of Agriculture contributed to the success of the programmes. Another strategy was to provide shelter and good management. These improvements resulted in an increase in milk production in the milk shed areas of the country. One of the indicators of success in livestock research is the establishment of milk shed areas in the country and the processing of milk into various products. The market infrastructure is in place for milk through the dairy industry. Development of cattle feedlots in Chikwawa district assisted the beef industry in producing choice grade beef of export quality.

Conducive government policy also increased uptake of new technologies for tobacco production. In addition, the 1995 Special Crops Act laid down rules and regulations for the production of the crop for any grower wishing to sell tobacco at the auction floors. This compelled the grower to produce the desired quality and amount of the commodity. Market infrastructures for the crops are well organized; the auction system ensures that good tobaccos fetch better prices, thus encouraging growers to use research information to produce good quality leaf.

4.3.2.2 Funding: Financial resources from government and donors were not limiting. CIMMYT collaborated with the maize commodity team in the provision of genetic materials and supported short and long term training. Lifuwu Rice Experimental Research Station collaborated with IRRI and IITA in germplasm evaluation and breeding. ICRISAT provided sorghum germplasm for screening and evaluation, and provided training in breeding and entomology to those scientists and technicians working on sorghum. Government also supported the scientists through short and long-term training, leading to higher degrees. The new varieties were disseminated to the farming community through extension personnel using circulars, radio programmes and demonstration plots. Adequate laboratories, greenhouses, vehicles and office space were provided.

Donor-funded projects enhanced the release of most of the technologies. The 1980 USAID-funded project assisted the fruit and vegetable research programme, including postgraduate degree training. There was continuity of research programmes with USAID staff when the Malawian scientists were away on training in the USA. There was good collaboration with the University of Florida for the

exchange of planting material, personnel and support through training. With financial assistance from IITA/SARNET, government expanded cassava and sweet potato production through accelerated multiplication and distribution of cassava and sweet potato planting materials.

Financial assistance through donor-funded projects helped in the development of most technologies in legumes. ICRISAT, which has the global mandate in groundnut and pigeon peas, assisted the programme whereas CIAT, with funding from donors such as DFID, is still supporting bean research. The University of Malawi, through donor funding, has contributed significantly to the development and release of bean technologies. ADMARC constructed a groundnut processing factory together with a laboratory at Liwonde for aflatoxin determination of quality export groundnuts. Staffing was adequate for the research programme which included breeders, agronomists and plant protection scientists from DARTS, University Colleges and overseas institutions who worked together to develop production packages.

Government also encouraged donors to support projects to improve the agricultural technical services within DARTS. These included plant protection, information services, soil analysis and advisory services. Infrastructures such as buildings, laboratories, and vehicles were provided by donors like ODA, GTZ, USAID, the Rockefeller Foundation and ICRISAT. Training in related fields was also offered at various levels.

In tobacco and tea, funding through a producer levy charged on sales ensures stable annual funding for research and extension. The programmes are matched with available funding. Priority research is adjusted to growers' needs, and projects are identified based on determined priorities. Since additional funds for research could only come from improved quality and increased sales of tobacco, there was every encouragement for the researchers and extensionists to promote the uptake of improved technologies. This in turn, led to less staff who are better renumerated in contrast to civil service research staff. The formation of ARET was driven by tobacco growers who felt the need for a specialized research organization to serve the industry better.

4.3.2.3 Research organisational structure: Focus on a single commodity concentrated resources on priority problems. For example, Lifuwu Rice Experimental Station was established to specifically conduct research on rice.

4.3.2.4 Research-farmer-extension linkages: The programme strengthened research, extension, NGOs and farmer capacity in multiplying and distributing improved planting materials of cassava and sweet potatoes. Training was offered to staff from research, extension and NGOs. Dissemination of information on new technologies reached beneficiaries through on-farm trials, on-farm demonstrations, field days and training of farmers at Residential Training Centres. Extension circulars and radio programmes have been produced for dissemination of information to end-users of technologies.

4.4 DEPARTMENT OF FISHERIES

4.4.1 Outputs From the Fisheries Programme

4.4.1.1Capture fisheries research: Most of the research programmes on aquaculture fisheries have been on stock assessment and limnological studies. A number of research programmes to assess the potential of fish stock in the pelagic waters of Lake Malawi have been conducted by FAO (1970-1982) and ODA (1987-1992). Limnological and taxonomic investigations have been carried out and some site stock assessment studies have been done.

Biological research on Chambo led to the establishment of regulations on: - mesh size restrictions, closed season minimum takeable size and restricted fishing by the commercial sector. Stock assessment studies of Chisawasawa led to the current management guidelines for this type of fish. Taxonomy research has provided a description of 250 fish species. Recent research on Usipa has recommended "Usipa lift net fishing", whereas research on Mbuna stocks has provided the current management guidelines for this species. Research on the stocks of Lake Malombe provided the current guidelines for managing stocks of this lake.

4.4.1.2 Aquaculture research: Research has developed technologies for the management of aquaculture fishes. Early work on aquaculture research involved biological observations on various fish species including breeding, feeding habits, growth rates and ecology of *Tilapias*, *Labeo*, *Barbus Haplochromis* spp, *Barillius* spp. and *Engraulicypris* spp.

A number of aquaculture technologies have been developed. Three fish species, *T. rendali, O. shiranus* and *C. gariepinus* are used. Technologies on pond management, such as pond inputs, production cycles, seed production, pond site selection, predation control, integrated agriculture/aquaculture, harvesting and dam construction have been developed and recommended to fish farmers. *Mosambicus* have proved to be the most productive of all indigenous fish species although its growth potential of less than 1g/day is slow. Brood stock management of Ntchira (*Labeo mesops*) is easier than Mpasa (*Opsaridium microleps*). These technologies have increased pond fish production from approximately 800 kg/ha to 1500 kg/ha from 1990 to 1996.

4.4.2 Factors That Supported the Fisheries Programme

4.4.2.1 Funding: Donor funding provided by FAO, JICA, ICLARM, DFID, EU and ICEIDA have facilitated fisheries research with relatively little dependence on government funding for the operational budget. Donor funds also supported research on the processing and preservation of fish, especially Chisawasawa in Lake Malawi.

4.4.2.2 Research management: Prioritization of research areas was done by considering the importance and relevance of each area to the prevailing situation in the fisheries industry. Research resources were channelled into these high priority areas. Targets were set with a specified time frame since all the expatriate scientists were on short-term contracts.

4.4.2.3 Collaboration: Collaboration with the MALDECO, SUCOMA, and Malawi Development Corporation on fisheries has assisted the fisheries department to tailor research programmes to specific needs of end-users and the Fishermen Association of Malawi.

4.5 FORESTRY RESEARCH INSTITUTE OF MALAWI (FRIM)

Forestry research was initiated in 1957 at the Silvicultural Research Station in Dedza. This was later changed to FRIM when it moved to Zomba. Funding for research was provided by the government and donors. The institute conducts three year planning meetings for researchers and stakeholders.

4.5.1 Outputs From the FRIM Programmes

Technologies have been developed for plantation forestry, nursery establishment, tending and harvesting of trees for several species of pines, *Eucalyptus* and *Gmelina*. Pest and disease control technologies have been developed, especially for the control of *Phoracantha* beetle, termites, aphids, leaf defoliators, leaf blight, powdery mildews and Blue Stain on wood. Some technologies which utilize various wood products have been established, including wood slabs and joineries. Standards for some wood products have been developed by the Malawi Bureau of Standards.

Recommendations have been made for the use of trees in different farming systems, including management strategies for *Sesbania sesban, Gliricidia sepium, Moringa oleifera,* and *Faidherbia albida*. In collaboration with DARTS and the SADC/ICRAF project, two technologies have been released; namely mixed cropping of maize with *F. albida* and relay cropping maize with *Sesbania* to improve soil fertility and crop yields. Useful products, such as Karaya gum for the confectionery industry, wild mushrooms and fruits, and Masuku for wine-making from the Miombo woodlands, have been characterized and recommendations on seedling establishment and ecology of these have been developed for different silvicultural zones. FRIM established an apiculture programme with the Department of Parks and Wildlife for bee-keeping and processing of honey. Research on seeds has succeeded in storing some difficult succulent species, including Masuku and neem, which can now be stored with viability retained for over a year. Seeds of species that are in high demand, such as those of *Gliricidia* and *Sesbania,* have been multiplied, and standards developed by the Department of Land Resources Conservation through the Promotion of Soil Conservation and Rural Production Project. Farmers have been trained in tree selection and community seed collection of Sambamfumu, Mlombwa and *Acacia*.

Technologies on propagation, species and provenances screening, plantation establishment, stand management, wood processing and utilisation have been recommended by Forestry Department. These have been adopted by various end-users, notably the Wood Industries Corporation and Viphya Pulpwood. Similarly, tree seed technologies have been adopted by the National Tree Seed Centre which is able to produce and distribute well more than 15 tonnes of seed/year.

4.5.2 Factors That Supported FRIM Programmes

4.5.2.1 Research management: The development of the four strategy areas of research has enabled the department to rationalise its research programme and concentrate on priority areas. DFID has assisted in plant protection research, whereas GTZ has assisted on apiculture. Human resource

development through short and long-term training provided a number of staff with higher degrees.

4.5.2.2 Policy: The forestry policy, Seed Merchant Amendment Act of 1996, the Forest Act of 1997 and the Plant Protection Act provide policy and legal frameworks for the programme. In general, the policy and legal instruments seek to promote participatory forestry research, liberal access to research fields by beneficiaries, while protecting the intellectual and property rights of the scientists and the state.

4.6 LESSONS LEARNED FROM THE PAST RESEARCH PROGRAMMES

There are many factors which influence the productivity of any research system. Some of these are endogenous to the research system itself while others lie well beyond the system. Successes and failures have been recorded by several researchers and some of the success has resulted into generation of technologies which have positive impact in agriculture.

Some of the factors which have influenced the productivity of the research system include funding, human resources, training, marketing infrastructure, research focus, collaboration, technology diffusion mechanisms, government policies, consumer preference, and planning and management of research. Some of these factors are briefly discussed below. A review of the past programmes has revealed such factors which contributed to either successes or failures of the national research system. Lessons to be learned and the knowledge will enable the government to develop well-focussed research strategies for the future.

4.6.1 Funding Levels and Sources

Provision of adequate funding is necessary for the success of any research program. Organisations or scientists who have both government and donor funding have recorded more successes than those solely dependent on revenue budget. Government has, therefore, to consider increasing its budget allocation to researchers as a way of increasing productivity in the research system. Otherwise, scientists will continue to depend on donor-funded programs.

4.6.2 Human Resource Numbers and Quality

Having critical mass of well-qualified scientists to do research is a guarantee to research success. Institutions that had adequate number of staff who are also well trained had outstanding outputs. This emphasises the fact that research requires adequate numbers of professional staff who are well trained in their fields of specialisation.

4.6.3 Training

Both long term and short term training courses are necessary for the advancement of science. It has been noted that outputs of researchers who were well trained were better than those who were poorly trained. The long training upgrades the staff to MSc and PhD degree levels and thus they become competent and confident in their discipline. The short courses are necessary for upgrading the staff and updating them on the latest technologies and scientific procedures.

4.6.4 Government Policies

There are obviously many areas where government policy has a dominant effect on the agricultural sector. Investment in areas such as infrastructure, taxation or subsidies on inputs or outputs and land tenure have profound effects. Policies on national and household food security are also influential. In terms of natural resources development, sectoral linkages are obviously very important. For example, the ALDSAP and the NEAP have addressed the need for inter-sectoral linkages in order to ensure that cross-sectoral problems such as deforestation, environmental and natural resources degradation, are jointly addressed.

Researchers hold strong opinions on the negative effects of government policies such as the liberalization of the market and currency devaluation on the dissemination and uptake of new technologies. The removal of subsidies on fertilizer and devaluation of the Malawi currency at the time flint hybrids were being introduced meant that many farmers were unable to try out these new varieties. Clearly, as long as input costs exceed produce prices realised by farmers, there will be no adoption of the technologies. It is also important to note that government may have laudable goals and objectives in its development plans. However, it is usually fairly nebulous about the role of research in achieving these goals. Researchers, therefore, have to make the effort to show government what science and technology can offer to national economic development.

4.6.5 Research Focus and Target Audience

Most scientists have been able to define the problem and develop a research strategy to solve the problems. However, one problem has been lack of focus to achieve the intended results. There is, therefore, the need to do a logical framework when designing research programs to enable the researchers focus on research which will solve the problem. Targeting of the technologies has also its own problems. Most researchers have usually targeted the smallholder farmer while neglecting the commercial sector. It is worth noting that the commercial farmer needs research technologies and has adequate resources to adopt technologies and commercialise them. The commercial farmer or commercial companies have the ability to significantly contribute to agricultural output, yet they are neglected in the planning process including development of the research agenda.

4.6.6 Planning and Management of Research

The planning and management of research programs and activities play a major role in the implementation and success of research programs. Poor problem identification at farmer level tends to distort the accurate setting of research priorities. Poor funding and inadequate training of researchers tend to exacerbate the problems of management leading to generation of poor technologies. Another weak aspect of research management has been its inability to adjust to major macro and micro economic policy changes which also tend to have significant impact on success of research adoption and application of scientific technologies.

4.6.7 Capacity of End-users

Due to poverty, illiteracy and lack of credit facilities, many end-users fail to adopt the technologies. This is an important factor to be considered when designing experiments to generate the needed

technologies. Most technologies have not been adopted either because they are too complex, require money, capital or knowledge.

4.6.8 Research Capacity

Many researchers have not been able to conduct certain types of research due to lack of facilities, i.e. soil or leaf analysis, or tissue culture. Some institutions have received equipment and facilities for research from donors but have not effectively utilised them.

The research system has limited capacity for postharvest research and for adding value, and thus creating fewer opportunities for agro-industries. Consequently, there is substantial importation of many products which could be processed locally. There are substantial produce losses in storage which require immediate attention in addition to premature selling of produce early in the season.

Another important problem is the perishability of horticultural produce which is further compounded by inadequate post harvest technologies. There is also serious manpower constraint in the field of veterinary science and this, apart from other factors stated elsewhere, have contributed negatively to livestock productivity. There is, therefore, need to undertake a skills-gap assessment and correct the situation accordingly.

4.6.9 Collaboration

It is important to work in multidisciplinary teams and collaborate with other scientists working on similar problems. Collaboration is currently weak and scientists tend to work as individuals; hence, failure to produce a total package of information needed by the end-users.

4.6.10 Consumer Preference

Researchers whose technologies take into account consumer preference usually succeed. Hence, scientists should implement demand driven research in order for them to achieve success because such technologies are readily adopted. The maize programme in the mid-70s disregarded consumer preferences. Research priority was given to hybrid dent varieties, whereas Malawians prefer hard seeded, flint varieties that are poundable and resistant to storage pests. The dent hybrids, despite being high yielding, probably addressed the needs of only about 10% of maize growers, mostly medium to large estate owners, who have access to credit for essential inputs. Another example of disregard of consumer preference was that of rice in which the high yielding, unscented variety failed to replace the low yielding, scented varieties preferred by the consumers. In capture fisheries research, the large fishermen were favoured at the expense of small fishermen, yet most of the fish consumed in Malawi is caught by the latter. In forestry, consumers prefer hard wood for timber and firewood while researchers recommended the fast growing soft-wooded species. These are clear examples of the need for researchers to consider consumer preference when designing research programs.

4.6.11 Climate

Agriculture is dependent on natural resources and the environment. The impact of technologies will depend on the existence of a favourable climate such as rainfall, temperature and soil fertility, soil structure. Years of adverse climatic conditions have had a negative influence on impact of technologies. However, these factors are beyond the control of the researcher and end-users of technologies.

4.6.12 Diffusion Mechanisms, Uptake and Impact of Technologies

The establishment of clear mechanisms of technology transfer is essential. The productivity of the research system is also measured by the number of technologies transferred and adopted by the end-users. Where technology transfer procedures were nonexistent or weak, most technologies remained on the shelf; hence, limiting their impact in the agricultural and natural resources sector. Research institutions with strong and clear mechanisms such as ARET and TRF have been able to transfer their technologies and have had impact.

4.6.13 Technology Transfer

There is a general perception that there is inadequate dissemination of useful technology and that many results remain on the shelves of experiment stations in unprocessed and unpublished form. On the other hand, research findings are often presented in technical language that is difficult to understand by the non-scientific community. The responsibility for removing these barriers of communication to aid technology transfer, lies with both the research and extension staff.

The ultimate measure of success of any agricultural technology is its uptake by farmers and impact on production. However, a general concern of many research projects is the perceived lack of uptake and impact of the technologies. There is thus an increasing emphasis, especially by donors, on studies dealing with farmers' needs assessment in the hope of identifying potential technologies that will diffuse quickly and have a rapid impact at the farm level. Nevertheless, there often appears to be lack of understanding of the complex processes involved and thus a tendency to blame the researchers exclusively for the failure of technology uptake. Diffusion rates are a result of many interrelated factors. These include labour, farm size, capital and credit, prices, infrastructure and markets, soil, climate, farmer age, education, family size, and socioeconomic status. Some technologies, like the highly yielding varieties have very obvious positive attributes and high visibility. However, technologies with low visible benefits, such as soil conservation or nitrogen fixation by legumes, which are very beneficial in the long run, will have a much slower uptake rate and impact.

One of the problems in measuring uptake and impact of research in Malawi is the lack of information. Maize is one of the few commodities for which substantial information is available. This is because of its dominance in smallholder agriculture so that its uptake and impact have been studied extensively. For other commodities, only aggregated information is available. The liberalization of hybrid maize seed production and marketing in 1993-94 and the removal of fertiliser subsidies between 1992-1994 have had major impacts on maize production. Research has shown that the present hybrids can be widely accepted by farmers if they can afford to purchase the seed; hence, the tendency to recycle seed from F_1 hybrids. Since fertiliser is beyond the reach of most resource-poor

farmers, the yield advantages of hybrids, though positive, are small and likely to decrease with decreasing soil fertility.

4.6.14 Staff Conditions

Conditions of service in the Civil Service and the University of Malawi have led to frustration of the scientists leading to low working morale. Attempts to boost the morale have not been successful. Other possible measures to address the problem may include restructuring of the research system. If institutions became semi-autonomous, they would probably be more effective and have better incentives for the research staff. The assumption is that government would continue funding research while donors would increase their allocation of funds to research.

CHAPTER FIVE

RESEARCH PRIORITIES FOR AGRICULTURE AND RENEWABLE NATURAL RESOURCES

5.1 INTRODUCTION

Research priority setting is a means of ensuring efficient allocation and use of limited human, financial and physical resources in the implementation of research programmes to achieve set goals and objectives. Priority setting is thus a technique for determining which research activities would make the greatest contribution to a set goal such as poverty reduction. It is well recognised that research can significantly contribute to the overall agricultural and natural resources productivity, hence leading to reduction of poverty and enhanced economic growth.

An effective priority setting criteria will accord highest priority to research areas that will accrue highest benefits in terms of productivity, growth and sustainable development. Changes in both domestic and international economic conditions, which also alter the comparative advantage of commodities, make it imperative to select and develop technologies that promote the country's competitiveness. Structural adjustment programmes, especially market liberalisation and floatation of the exchange rate, make some traditional commodities less economic in terms of household income and foreign exchange earnings; hence, enhancing the country's scope for diversification. Budgetary cut-backs associated with liquidity constraints and changing government priorities are also important reasons to prioritise research programmes. One of the most important outcomes of the priority setting exercise is the development of a framework for reference by researchers. The research plan of action, while providing investment criteria for sector investment programmes, serves as a benchmark for monitoring and evaluating research activities.

This chapter identifies current government objectives and goals, and sets research priorities among commodity groups and commodities; constraints to productivity; researchable areas and areas of research focus.

5.2 NATIONAL GOALS AND STRATEGIES

The priorities developed in this master plan will be used as a tool for government to achieve its goals and objectives. The goals emphasize the improvement of the living standards of the people through attainment of sustainable food security levels, high household cash incomes and high nutritional status. They also focus on increasing and expanding the export base to increase foreign currency reserves, agricultural diversification, development of agro-processing industry through the increase in production of raw materials, and finally sustainable use of the natural resources and protection of the environment. Strategies to achieve these goals are indicated in Table 5.1.

Table 5.1 National Goals and Selected Strategies

Goals	Selected strategies
Attain food security	Increased productivity and efficiency per unit area
Raise household incomes	Promotion of production of high value commodities
Increase export potential	Promotion of production of high value export commodities
Attain high nutrition status and improved living standards	Increased supply of commodities with high nutritive values
Diversify commodities	Promotion of production of close substitutes for the major traditional commodities
Supply raw materials to the agro- based industry	Promotion of industry targeted production system
Sustainable use of natural resources and protection of the environment	Promotion of environmentally friendly farming system activities and technologies

5.3 PRIORITY SETTING CONCEPTS

There are several priority setting methods that have been developed for research planning purposes. These methods differ in data requirements, ease of application and interpretation. Owing to the scarcity of detailed statistical data for various agricultural and natural resource commodities in the country, a combination of four research planning methods have been used to develop the commodity and research priorities. The methods used include: (i) congruency; (ii) weighted scoring; (iii) comparative advantage measured by the Domestic Resource Cost Ratio; and, (iv) intuition based on a checklist of questions.

5.3.1 Congruency Method

The Congruency method is used to determine priorities amongst competing commodities using the same proportion of their current contribution to the Gross Domestic Product (GDP) by considering current quantitative data. The method aims at promoting the production of commodities that are already contributing significantly to the GDP to their optimum level. This approach increases chances of success in identifying commodities that increase with productivity and growth in the agricultural sector and natural resources. However, this method has a setback where the current important commodities keep on getting the most research funds; while commodities currently with little or no contribution to GDP get little or no funds at all regardless of having high potential contribution to the economy.

5.3.2 Weighted Scoring Method

The commonly used research planning tool is the weighted scoring method which involves: (i) determination of criteria to be used in comparing the relative importance of commodities or research programmes; (ii) subjective determination of weights and assigning the weight to the criteria to express the relative importance of each criterion; and (iii) assigning scores to indicators of the degree

of contribution or importance of the commodities or research programme. Specifically, the weighted scoring method: (i) is transparent, easy to understand and can involve many stakeholders in a participatory approach; (ii) can be administered within a short period of time; (iii) does not require substantial statistical data and can use both qualitative and quantitative data; (iv) permits the weighting of multiple goals and objectives; (v) can rely on judgment of well informed individuals based on their local experience and knowledge; and (vi) allows effective ranking of a long list of commodities and research programmes. However, the method has the following shortcomings: (i) inability to discount future benefits and costs; (ii) inability to accurately account for research benefit spillovers; and (iii) failure to incorporate effects of the domestic and trade policies.

5.3.3 Comparative Advantage Measured by the Domestic Resource Cost Ratio Method

Domestic Resource Cost (DRC) ratio indicates where Malawi's comparative advantage over other producers in the world market lies (Rudolf and Bottomley, 1989). The DRC shows the cost of domestic inputs into the production of a commodity compared with the foreign exchange cost of importing the commodity. The following formula was used:-

$$\text{DRC Ratio} = A/(B-C)$$

where A = Current cost of domestic resources per unit of the commodity produced locally
B = Import costs of the commodity
C = Costs of imported inputs

The credibility of this method rests in its ability to show the contribution of domestic inputs, including labour, land and capital to value-adding processes. A DRC ratio of less than one shows comparative advantage in the commodity being produced, whereas ratios greater than one indicate the opposite. The lower the DRC ratio, the greater the country's international comparative advantage. At country level, a set of DRC ratios can be used to determine the ranking of commodities in terms of their competitiveness. However, like congruence, DRC ratios are only useful in determining priorities at the strategic level where commodities as a whole are under review and not among individual lines of research within commodity programmes.

5.3.4 Intuition and Checklists

Key questions are developed as a checklist for different criteria that can be used as indicators of the relative importance of the various commodities and programmes. The questions probe into farmers' constraints, available information, value of the commodity, alternative sources of information, emphasis and relevance of research, contribution of the commodity to food security, nutritional needs, household cash incomes, foreign exchange and market potential. The approach allows stakeholders to make decisions by intuition.

The checklist method is useful where the project identification process presents a large number of alternative lines of research. Thus, the approach can be used to eliminate most of the alternative scenarios without resorting to benefit/cost ratio analysis. However, the main problem is that it does not tell us precisely what relative significance of one criterion or issue is against another.

5.4 THE PRIORITY SETTING PROCESS

The priority setting process involves the collection of data, information and views of all stakeholders on specific issues followed by processing, analysing and discussing the results with them. Specifically, the priority setting process involves the following: (i) developing a list of commodities, commodity groups, research programmes and strategies to be prioritised; (ii) identifying information needs and sources, and the means for collecting the information; (iii) collecting data and information from published sources, through interviews or workshops; (iv) developing a list of objectives and criteria for priority setting; (v) attaching relative weights to the criteria and objectives; (vi) processing and analysing data and information to derive rankings of commodities and researchable areas; (vii) presenting and discussing the results with stakeholders individually or groups for further refinements; and (viii) producing the final report on commodity and priorities for research programmes.

Through a combination of the above methods, priority setting for Malawi was developed at five levels to provide a broad picture of crucial issues that require attention. The levels are as follows:

Level 1 Priorities among commodity groups e.g., cereals, fruits, monogastric animals, aquaculture or indigenous forests.

Level 2 Priorities among commodities within a commodity group e.g., maize, rice, sorghum and wheat within the cereals group.

Level 3 Priorities among constraints to productivity e.g., declining soil fertility, pests and diseases, labour shortage, lack of appropriate technologies.

Level 4 Priorities among researchable areas e.g., crop improvement (breeding), crop management (agronomy), irrigation, farm mechanisation.

Level 5 Priorities among research focus that outline specific research projects e.g., develop high yielding and early maturing flint maize varieties, fine-tune compost making procedures.

5.5 PRIORITIES AMONG COMMODITY GROUPS (LEVEL 1)

The commodity groups were prioritised based on the total contribution of their individual commodities to the national economy using the congruency method and intuition and checklists. The average annual production output (tonnes) for two years (1996 and 1997) was used to obtain the total production value (MK) of each commodity at national level. In addition, data on gross margins, export value and DRC ratios was used. The total values of the various commodities within a commodity group were added together to come up with a total value for the commodity group.

For the intuition and checklists method, a list of questions was developed to assist the stakeholders in making a decision on the relative importance of each commodity group as follows: (i) what is the contribution of a particular commodity group to food security, nutrition, household cash incomes, exports, sustainable utilisation of the natural resources, environmental protection and biodiversity conservation? (ii) what proportion of the population is involved in the production of that particular

commodity group or affected by the commodity group? and (iii) is the demand for the product high enough to justify further expansion of the commodity group?. The scores for the production value and intuition were weighted, and are presented in Annex 5.1 and 5.2. A final list of the commodity groups was established in order of priority (Table 5.2). The commodities were prioritised within the commodity groups using the methods indicated above. The full priority list is presented in Table 5.2.This table shows that cereal crops contribute the most to the national economy followed by cash crops, root and tubers, vegetables, legumes and oilseeds, fisheries, livestock, fruits and floriculture, spices and lastly forestry. The cereals group is the most important because they are produced in large quantities although the unit value is relatively small. Furthermore, cereals have a significant social value, particularly on food security. Maize the staple crop contributes the most to national economy in the cereals commodity group.

These priorities show that most resources for research should be allocated to commodities in the categories that have the high and medium contribution to the economy. Little or no resources should be allocated to commodities in category three because their contribution is insignificant. It is worth noting that owing to the significant contribution to the economy of Malawi, research on tobacco and tea was privatised. Hence, research priorities for tea and tobacco are determined by the TRF and ARET, respectively. Sugarcane and rubber research is also undertaken by the industry using their own funds, so that these crops do not require public resources. However, it should be noted that some commodities, for example forestry though ranked lowly in Table 5.2, still have socio-economical benefits that may not easily be quantified by the methodology used in prioritising commodities in this chapter.

5.6 PRIORITIES AMONG COMMODITIES WITHIN A COMMODITY GROUP (LEVEL 2)

The commodities were prioritised within the commodity groups using the methods indicated above. The full priority list is presented in Table 5.2.

5.7 PRIORITIES AMONG CONSTRAINTS TO PRODUCTIVITY (LEVEL 3)

Malawi's agriculture is characterised by low productivity. This plan has made a realistic assessment of the constraints that will have to be checked to improve productivity in agriculture and natural resources. Clearly, increased productivity can only be achieved after overcoming both technical and non-technical constraints. The scope of this plan, however, is limited to the technical constraints and these have been discussed, and priorities have been set among them. Productivity constraints were identified through a process of consultations and discussions with a wide range of stakeholders including small/ large scale farmers, extension staff, scientists and policy makers.

Priorities among production constraints were set based on the intuition and checklists methods which involved teams of reviewers drawn from stakeholder institutions and organisations. A checklist of questions was developed to assist in the process as follows: (i) what are the major limiting production factors/constraints to farmers/producers ? (ii) what is the effect and impact of each constraint to the low productivity or efficiency ? (iii) what is the potential increase in production or improvement in quality if a particular constraint is removed ? (iv) which production factor/constraint exerts the most impact to productivity that if removed would have the most significant increase in yield or

improvement in quality ? and (v) how much effort (human resources, finances and time) is required to overcome a particular constraint? The responses were scored on a scale of 1-5 where 1 meant least and 5 meant most limiting. The production constraints were prioritised based on the total scores.

Table 5.2 List of commodity groups and commodities ranked in order of their priority based on high, medium and low contribution to the economy

Rank	Commodity group	High contribution	Medium contribution	Low contribution
1	Cereals	Maize Rice	Sorghum Pearl Millet	Wheat
2	Industrial and cash crops	Tobacco Sugarcane Tea Cotton	Coffee Rubber Macadamia Cashew	Palms
3	Root and tubers	Cassava Sweet potato	Potato	Yams Coco yams
4	Vegetables	Tomato Cabbage Onions Pumpkins	Amaranthus Carrot Mushroom	Okra Cucumber Cat whiskers
5	Legumes & oilseeds	Beans Groundnuts Pigeon peas Soyabeans	Sunflower Cowpeas	Sesame
6	Fish	Utaka Usipa Kambuzi Chambo	Kampango Chisawasawa Mpasa Matemba Mlamba	Ntchira Ndunduma Mbuna Sanjika Makumba
7	Livestock	Cattle Chickens Goats	Pigs Sheep	Ducks Rabbits, guinea fowl Donkeys Turkey
8	Fruits & flowers	Banana Mango Citrus Flowers Pineapple	Guava Avocado pear Pawpaw Apple, Peach	Indigenous fruits Granadilla Strawberry Grapes
9	Spices	Chillies Paprika	Ginger Tumeric	Chana Coriander
10	Forestry	Indigenous forest Plantation forests	Trees on farm	Ornamental forests Botanical Garden

The constraints for each group have been classified into three priority areas (Tables 5.3-5.5). The first group comprises the most limiting constraints which research needs to address as a matter of high priority in the short term. Overcoming constraints in this area will improve productivity to a greater extent. The second group comprises moderately limiting constraints and should receive medium priority from research. Overcoming these will add benefits to productivity but should be considered in the medium-term. The last group comprises constraints that are deemed to be of low priority and should receive low priority in research programmes because it does not pose much threat to productivity

5.7.1 Constraints to Crop Production

5.7.1.1 Low soil fertility and poor nutrition: Most soils have been cropped continuously with little or no addition of fertiliser making them low in organic matter and essential nutrients. There is also serious land degradation due to deforestation and failure to use such sustainable cultural practices as contour bands, marker ridges, incorporation of crop residues and crop rotation, among many others. All these have led to excessive erosion and leaching of nutrients. This is particularly serious in the production of commodities with high nutrient demand such as cereals, fruits, vegetables and industrial crops.

5.7.1.2 Poor varieties: Most of the available varieties have poor desirable characteristics. Consumers demand flint maize varieties but most hybrids are dent. Although scented rice varieties are in high demand, the most available varieties are high yielding but unscented. The sorghum and millet varieties have poor storage qualities and start deteriorating while in the field. Most farmers prefer open pollinated varieties whose seeds are recyclable, but the seed which is available is of hybrid type and is costly.

5.7.1.3 Poor crop management practices: Practices such as late land preparation, late planting, low planting density, late weeding, and poor fertiliser management contribute to low productivity and cause high losses in yield and quality of produce. This is a major problem across all commodities in cereals, fruits, vegetables, legumes and roots and tubers.

5.7.1.4 Inappropriate labour-saving technologies: Labour shortage during ridging, planting, fertiliser application, weeding and harvesting affect crop yields and quality. There is a critical lack of appropriate animal-drawn implements and hand-operated machines, especially in cereals and legumes where delays in planting, weeding or fertiliser application lead to serious losses in yield and quality. The use of herbicides is also limited due to high cost.

5.7.1.5 Pests and diseases: There is a high incidence of migratory, field and storage pests that affect crop productivity and threaten food security and the economy. Pests such as army worm and red locusts devastate most field crops annually, whereas diamond back moth and late blight are serious pests in tomato and potatoes respectively.The situation is worsened by the high cost of pesticides such that most farmers cannot afford them.

5.7.1.6 Post harvest losses: There is significant loss of quality and value of produce due to poor post harvest handling including on-farm storage losses. This is more important in perishable crops such as fruits, vegetables, roots and tubers. There is a general lack of information on handling,

grading, packaging, storage and transportation for perishable crops.

5.7.1.7 Inadequate processing and utilisation: Most crop produce is marketed raw due to lack of processing skills and infrastructure. This makes the produce less competitive on the market. There is also lack of technology for utilisation of certain crops, such that farmers rely mostly on traditional technologies that are ineffective. This limits the scope of the commodity marketability and all-year round availability. Lack of viable processing and utilisation technologies discourage farmers from expanding areas planted to these crops. This is particularly a major constraint in fruits (mango and citrus) and in root and tuber crops. Processing adds value to the produce and should be encouraged.

5.7.1.8 Drought and inadequate irrigation: Over the past few years, low and erratic rainfall has had a negative impact on crop productivity and the food security situation in the country. Lack of appropriate technologies on drought management and irrigation, is a major constraint to all the crops. This is more serious for annual crops where drought during critical stages of the growth cause severe yield losses. Irrigation infrastructure including water delivery systems and management practices are poor.

5.7.1.9 Shortage of seed and other planting materials: There are inadequate quantities of improved seed for major crop varieties. Few local companies are keen to produce seed of hybrid maize and tobacco. Farmers are, therefore, forced to use poor quality seed or, as is the case with vegetables, imported seed which is expensive. Technology on seed production methods for various crops is also lacking. This is a major problem in cereals, legumes and vegetables. In fruits and industrial crops the problem of vegetatively-propagated planting material is mostly due to the inadequacy of facilities rather than technologies.

5.7.1.10 On-farm storage losses: This is an important constraint for such highly perishable crops as root and tubers, vegetables and fruits where poor on-farm storage often leads to losses in both quantity and quality. The problem also occurs in cereals and legumes in which the ordinary grain weevil and the larger grain borer cause heavy damages to stored grain if not treated with effective storage pesticides.

5.7.1.11 Non-technical constraints to crop production: Crop productivity is also affected by many constraints which are not researchable but require government policy reforms, development of appropriate strategies and making human and financial resources available. Some of the constraints are as follows: (i) inadequate seed multiplication programs and distribution system; (ii) poor linkages, technology dissemination and adoption; (iii) poor input/output pricing policies; and (iv) inadequate information on alternative utilisation of produce.

5.7.2 Priorities Among Constraints to Crop Production

The most important constraints to crop production in the order of priority are presented in Table 5.3. These include (i) poor management practices, (ii) low soil fertility, (iii) poor varieties, (iv) pests and diseases, (v) drought and water shortage, and (vi) shortage of labour saving technologies. In addition, timeliness in carrying out crop management practices, which include ridging, planting, weeding and fertiliser application, has high impact on crop productivity and, therefore, require

urgent attention. Pests and diseases and soil fertility involve a vast range of areas, some of which are non researchable, but require attention by government and policy makers. These include areas of fertiliser and chemical prices which reduce the use of those products. Although droughts are natural, supplementary irrigation, which can mitigate effects of drought need urgent attention. This is more important in cereal crops, like maize and in vegetables where production in dimbas can be boosted. Although seed shortage is an important constraint, it may not require research.

Table 5.3 Priorities among constraints to productivity of crop commodity groups classified on the extent of their limitation

Commodity Group	Most limiting	Moderately limiting	Least limiting
Cereals	Low soil fertility Poor crop management practices Poor crop varieties	Inappropriate labour saving technologies Shortage of seed Drought and water shortage	Pests and diseases Inadequate processing and utilization On-farm storage losses Post harvest handling
Fruits & Fflowers	Poor crop management practices Shortage of seed Poor varieties	Pests and diseases Low soil fertility Post harvest handling	Inadequate processing and utilization Drought and water shortage On-farm storage losses Inappropriate labour saving technologies
Industrial & Cash crops	Pests and diseases Poor varieties Poor crop management practices	Low soil fertility Shortage of seed Drought and water shortage	Inappropriate labour saving technologies Inadequate processing and utilization Post harvest handling On-farm storage losses
Legumes & Oilseeds	Pests and diseases Poor crop management practices Poor varieties	On-farm storage losses Low soil fertility Inadequate processing and utilization	Drought and water shortage Shortage of seed Inappropriate labour saving technologies Post harvest handling
Vegetables, Roots, tubers, & Spices	Pest and diseases Poor crop management practices Post harvest handling	Poor varieties Low soil fertility Shortage of seed	Drought and water shortage Inadequate processing and utilization On-farm storage losses

5.7.3 Constraints to Livestock Production

5.7.3.1 Poor pastures, feeds, feeding and nutrition: Most animals do not grow to their full potential because of limited access to feeds with high nutrient content. In poultry, for example, feeds are expensive because some ingredients and supplements have to be imported. In ruminants, there is seasonal variability in the availability and quality of grazing pastures and this adversely affects productivity for both meat and dairy animals. The high cost of feeds and feed supplements, reduces profitability of most livestock enterprises, a scenario that discourages most farmers. Besides, livestock have to compete with humans for cereals because most of their rations are grain-based.

5.7.3.2 Diseases and parasites: Numerous diseases and parasites adversely affect livestock and cause direct losses due to mortality as well as stunted growth and productivity. In poultry, new castle disease and coccidiosis can be devastating if not controlled. In ruminants, especially cattle, there is a whole range of internal and external parasites, tick-borne diseases, foot and mouth

disease, trypanosomiasis, heart water and others that affect production. In sheep and goats, internal parasites, such as worms are very common. In pigs, the African swine fever is very devastating. Often, these diseases are not effectively controlled mostly due to high cost of drugs and very rudimentary husbandry and management systems.

5.7.3.3 Inadequate breeding stock: Inadequate improved breeding stock of most animal types is a major problem. Farmers are forced to use unimproved stock that has poor growth and productivity. In poultry, the problem arises from inadequate poultry hatcheries and animal multiplication centres in the country. In cattle, this is mostly because artificial insemination services are inadequate, inefficient poorly equipped and poorly managed. Most livestock in Malawi are of unimproved breeds with low genetic potential and low productivity even under intensive management. There is, therefore, need to identify superior breeds that are adaptable to the local environment. This is especially important for ruminants. However, the Malawi Zebu is a general-purpose breed which is well-adapted to the local environment and performers well under generally poor levels of management found in most villages. Efforts to select superior Malawi Zebu breeds should be encouraged.

5.7.3.4 Poor management practices: Poor housing, sanitation, feeding and effective disease control are the major constraints to all livestock. They contribute to stress that reduces productivity in animals. In most cases, this is dictated by economic and sociocultural considerations such as communal grazing.

5.7.3.5 Poor meat and milk processing technologies: There is a considerable loss of meat and milk products due to poor processing. For example, most milk spoils at both farm and factory level due to poor storage and pasteurisation. Packaging technologies and grading standards are available but are rarely used.

5.7.3.6 Nontechnical constraints to livestock production: Non-researchable areas affecting production which need to be addressed include: (i) human population pressure leading to increased pressure on land and reduced communal grazing areas; (ii) a breakdown in security resulting in increased stock theft; and (ii) poor harvest, increased prices for inputs particularly fertiliser and other essentials of life have resulted in an increased off-take of livestock, including breeding stock, leading to herd structure that cannot sustain herd numbers under current conditions of high mortality rates.

5.7.4 Priorities Among Constraints to Livestock Production

The five priority constraints affecting livestock productivity include: (i) poor management practices; (ii) inadequate breeding stock; (iii) poor feeding; (iv) inappropriate breeds; and (v) parasites and diseases (Table 5.4). Slight variations exist in the extent for which these constraints affect the various livestock types, but these do not in any way change the areas of emphasis. In animal husbandry, the major problem is housing and sanitation of both ruminants and monogastrics. The problem of inadequate breeding stock may not be entirely researchable as it appears to originate from lack of infrastructures and facilities and not the availability of techniques for multiplication. The area of feeds is researchable in so far as the development of rations or supplements that fortify locally available raw materials is concerned.

The introduction and breeding of improved animal breeds need attention. Adaptable breeds for production under intensive or semi-intensive production systems are not available to farmers and yet they have an immediate impact on meat and milk production. The control of pests and diseases poses a problem largely because of high cost of chemicals. Farmers have access to some simple lowcost technologies that are of direct and immediate benefit to use in livestock, e.g. paraffin incubators.

Table 5.4 Priorities among constraints to productivity of livestock commodity groups classified based on the extent of limitation

Commodity group	Most limiting	Moderately limiting	Least limiting
Monogastric Livestock	Poor management practices Inadequate breeding stocks Nutrition	Diseases and parasites Poor breeds	Poor meat and milk processing Low reproductive performance
Ruminant Livestock	Poor management practices Inadequate breeding stock Poor nutrition	Poor breeds Diseases and parasites Poor meat and milk processing	Low reproductive performance

5.7.5 Constraints to Fish Production

5.7.5.1 Poor fishing practices, methods and gear: This is a major problem in capture fisheries as most fishermen use inappropriate fishing methods, gear and vessels. Since most fishing gear comprises small boats with low horse power, fishermen often catch juvenile fish leaving a lot of deep water fisheries untapped. Boats used are too small with low horse power for deep water fishing.

5.7.5.2 Handling, processing and storage losses: The existing traditional processing methods, particularly sun-drying, lead to high losses of fish. This becomes more serious in the rainy season during which sunshine hours are reduced. Poor storage methods prior to or during marketing also contribute to losses in fish quality. This is more of a problem in capture fisheries than in aquaculture as production levels are low in the latter.

5.7.5.3 Poor genotypes: This is a problem mostly in aquaculture fisheries where current fish types have low genetic potential and low growth rates. This also applies to the local riverine species that can be brought under aquaculture production.

5.7.5.4 Destruction of spawning habitats: The spawning habitats are being destroyed by siltation and pollution of lake waters and other water bodies due to soil erosion from upland catchment areas and waste damping sites. This is aggravated by deforestation and agricultural expansion to marginal lands.

5.7.5.5 Poor feeds and feeding: This is a major constraint in aquaculture production which requires the use of feed rations, feed supplements and fertilisers for fish ponds. Since these are either expensive or unavailable, farmers do not use them, as a result, fish grow slowly and do not

attain their full size. In addition, this acts as a deterrent to prospective farmers as it makes fish farming unprofitable.

5.7.5.6 Lack of fingerlings: This is a major problem facing aquaculture production. Lack of fingerlings for stocking fish ponds is a result of inadequate hatchery technologies and high fry mortality rates during shipment and early days of stocking.

5.7.5.7 Nontechnical constraints to fish production: There are a number of non-researchable areas in fisheries that need to be addressed. These are mostly policy issues, strategies, funding, human resource development and services such as: (i) limited credit facilities and marketing infrastructures; (ii) limited fishing areas; (iii) limited government funding for fisheries research; (iv) poor essential services like fish landing facilities, boat building, engine services, stocking of spare parts; (v) restrictive licensing of fisheries operation; (vi) limited monitoring, evaluation and policing capacity; (vii) inadequate technology and information dissemination mechanisms; and (viii) inadequate manpower for both research and extension services in terms of numbers and quality.

5.7.6 Priorities Among Constraints to Fish Production

The major constraints to capture fisheries (Table 5.5) include: (i) inappropriate fishing methods, gear and vessels; (ii) destruction of spawning habitats; and (iii) post harvest handling, processing and storage. The major constraints to aquaculture are poor fish genotypes with slow growth rates, lack of appropriate formulated feeds and inadequate supply of fingerlings.

Table 5.5 Priorities among constraints to the productivity of fish based on the extent of their limitation

Commodity group	Most limiting	Moderately limiting	Least limiting
Capture fisheries	Poor management strategies Poor fishing practices and methods Poor postharvest technologies	Poor fishing gear and technologies Destruction of spawning and nursery habitats	Poor genotypes Lack of processing facilities On-farm storage loses
Aquaculture fisheries	Lack of fingerlings Poor genotypes Lack of feeds Poor pond management	Predators Poor pond water management practices	Poor post harvest handling Lack of processing facilities Disease and parasites

5.7.7 Constraints to forestry production

5.7.7.1 Deforestation: Most indigenous forests are being depleted rapidly due to high demand for fuelwood, construction poles, charcoal making, and forest fires. Unfortunately, reafforestation efforts are limited considering the fact that 150,000 ha are destroyed every year, while 1000 ha/year are planted. Deforestation is, therefore, exceeding regeneration and afforestation rates.

5.7.7.2 Pests and diseases: Pest and disease pressure is increasing in all forest types. The major

ones include the pine aphid, leucaeana psyllid and leaf borers whose control is a big challenge at the present moment.

5.7.7.3 Forest fires: The Forestry Department does not have appropriate fire fighting equipment which is in good working condition. Furthermore, fire prevention methods, like fire breaks and controlled burning are not done effectively due to limited human and financial resources.

5.7.7.4 Low productivity: There are poor growth rates of trees in plantations, woodlots and with natural forests due to low genetic base, rainfall and soil fertility and high incidences of pests.

5.7.7.5 Poor seed viability: The viability and germination capacity of tree seeds, particularly indigenous species is very low leading to low levels of seedling production for reafforestation programmes. This is aggravated by low seed yields especially among indigenous trees. The seed has a short shelf-life; hence, there is a need to conduct biological and physiological research on key indigenous trees and their seeds, with a view to increase seed production and prolong their shelf-life.

5.7.7.6 Nontechnical constraints to forestry production: The forestry sector plays a major role in providing a sustainable base for agricultural production. In addition to protecting the environment and conserving biodiversity, it is also a source of raw materials for the construction industry. Most of the issues are not researchable but require sensitization of the public on the dangers of deforestation, the need to take afforestation initiatives seriously, and to conserve biodiversity. Some of the non-researchable areas in forestry include: (i) inadequate manpower, particularly socio-economists; (ii) poor funding of forestry programmes; (iii) scarcity of information and extension messages; (iv) poor technology and information dissemination; and (v) low commercialisation of non-wood forestry products such as vegetables, fruits, mushrooms, herbs, wild game and beekeeping.

5.7.8 Priorities Among Constraints to Forestry Production

The forestry sector has various constraints (Table 5.6). The unique problems for the sector include: (i) deforestation due to forest fires, diseases and pests, cutting of trees for fuel wood and as an income generating activity; (ii) poor seed germination of trees for afforestation; and (iii) low productivity of forests in general.

Table 5.6 Priorities constraints to productivity of forestry classified based on the extent of their limitation

Commodity group	Most limiting	Moderately limiting	Least limiting
Forests	Deforestation Pests and diseases Forest fire Poor seed germination	Low productivity Poor labour saving technologies	Storage losses Processing losses

5.8 PRIORITIES AMONG RESEARCHABLE AREAS (LEVEL 4)

The low productivity in agricultural and natural resources sectors is of great concern to the nation and research has a role to play to attain the desired productivity. Current research programmes have contributed to the present productivity, but the impact at smallholder farmer level is insignificant. There is, therefore, need to prioritise research efforts and activities, commensurate with government strategies, priorities, plan of action and limited resources. This section has summarised research priorities for the short, medium and the long term with emphasis on researchable technical constraints as described in the earlier section. The researchable areas have been defined based on the identified constraints to increased productivity and prioritised using criteria described earlier. The research themes on the other hand, were arrived at by putting together research activities that have a common research approach to the solutions. Priorities at this level were set using an "Attractiveness and Feasibility Matrix" and the intuition and checklist method. The Attractiveness and Feasibility matrix was used by employing the following five factors:

Factor A: Potential benefits of research. What is the expected impact of the particular research in overcoming or reducing the effects of the constraints? Considerations of the expected benefits assume their perfect capture, full technology transfer and use.

Factor B: Capacity for uptake of research technologies. What is the likelihood of the end users adopting technologies resulting from the research? This shows the ability of farmers to capture the benefits by converting the technical innovations into commercial returns.

Factor C: Probability of research success. What are the chances of research achieving its objectives? Is the research in an area where success is the norm or is in one where there are major challenges?

Factor D: Research capacity. What is the capacity of the Malawian research system in terms of well-trained scientists and scientific facilities to conduct research on the programme?

Factor E: Availability of on-shelf technology. To what extent is technology available nationally, regionally or internationally, in either the public or private sector, which can be utilised by the end-users? This takes into account the existing technologies and identifies the need to conduct more research or acquire technologies from regional and international research institutes.

The first four criteria are scored on a scale of 1 to 5. A score of 5 means the highest and 1 the lowest. The scoring for Factor E is handled differently. The objective here is to determine how much usable technology is available. If the type of technology is abundant, then the potential benefit for the country engaging in the development of the same technology through research will be minimal and efforts in this direction will have to be rationalised. The system of scoring is thus designed to decrease the potential benefit by a factor measuring the amount of on-shelf technology as follows:

Score	Descriptions
0.7	Proven technology available in Malawi
0.8	Technology available in Malawi but requiring on-farm research
0.9	Technology available regionally/internationally but requiring adaptive research
1.0	Little or no technology available

By multiplying the scores of the potential benefits of research and capacity for uptake by one of these factors, the potential outcome from further research in Malawi is adjusted so that there is a relatively greater potential benefit from concentrating on research areas where knowledge and technology are lacking. This yields the probability of success. The score for probability of success is multiplied with that for research capacity to come up with a degree of **feasibility** for a particular research project. The scores for potential benefits, capacity for uptake and on shelf technologies are multiplied to come up with **attractiveness**. The research project which is highly attractive and highly feasible will be of high priority. If the results show that a particular project is attractive for Malawi but its feasibility is low, then the question is raised whether adding or diverting research resources from elsewhere would improve feasibility. On the other hand, an outcome with low attractiveness may suggest that the research is of low priority or it is not worth doing.

Priority Setting by Intuition: In the intuition and checklist method, the following questions were used: (i) what is the expected increase in yield or improvement in quality from particular types of research? (ii) what is the likely impact of research and will the technologies to be developed have the most positive impact? (iii) what will be the acceptability of particular types of technologies? (iv) what is the possible degree of adoption? (v) to what degree is the research important and in line with government policy objectives? and (vi) can the research information needed be obtained or adapted from other sources? Researchers, extension staff and policy makers were involved in the evaluation of the research factors based on the given criteria. Tables 5.7 to 5.9 show the researchable areas and arranged by commodity to show the areas requiring urgent attention up to those which require least attention in terms of funding. The prioritised areas were further grouped into high, moderate and low priorities for purposes of implementation. Research effort and resources need to be devoted to the highest priority group. The second research category has moderate contribution - hence, should receive moderate allocation of resources for research. The third research category should receive little or no research effort at all because the contribution of the research outcome to improvement in productivity of agricultural and natural resources is minimal. However, whenever specific technologies are needed, the currently available technologies will be adapted, including importation of some of the technologies from other countries.

5.8.1 Priority Research Areas for Crops

Researchable areas for crops have been classified into: (i) crop improvement; (ii) crop management; (iii) soil fertility and plant nutrition, (iv) on farm storage; (v) post harvest handling; (vi) labour saving technologies; (vii) pests and diseases; (viii) irrigation and water management; (ix) processing for value-adding and utilisation; and (x) seed production, quality and vegetative propagation. The order of priority of these areas for each crop is shown in Table 5.7.

Table 5.7 Researchable areas for crops classified in order of importance

Group & Commodity	High priority	Medium priority	Low priority
Cereals Maize	Soil fertility and plant nutrition Crop improvement Crop management	Labour saving technologies Irrigation and water management Pests and diseases	Seed production and quality On-farm storage Post harvest handling Processing and utilisation
Rice	Crop improvement Irrigation and water management Soil fertility and plant nutrition	Pests and diseases Crop management Labour saving technologies	Seed production and quality Post harvest handling Processing and utilisation On-farm storage
Sorghum	Crop improvement Crop management Pests and diseases	Seed production and quality Soil fertility and plant nutrition On-farm storage	Post harvest handling Processing and utilisation Labour saving technologies Irrigation and water management
Millet	Crop improvement Crop management Processing and utilisation	Seed production and quality Pests and diseases Soil fertility and plant nutrition	Post harvest handling On-farm storage Labour saving technologies Irrigation and water management
Legumes & Oilseeds Beans	Crop improvement Crop management Pests and diseases	Post harvest handling Seed production and quality Soil fertility and plant nutrition	On-farm storage Processing and utilisation Irrigation and water management Labour saving technologies
Groundnuts	Pests and diseases Crop management Crop improvement	Post harvest handling Seed production and quality Labour saving technologies	On-farm storage Processing and utilisation Irrigation and water management Soil fertility and plant nutrition
Pigeon peas	Crop improvement Pests and diseases Crop management	Seed production and quality Post harvest handling Processing and utilisation	Irrigation and water management Labour saving technologies On-farm storage Soil fertility and plant nutrition
Soybeans	Crop management Crop improvement Processing and utilisation	Seed production and quality Post harvest handling On-farm storage	Pests and diseases Labour saving technologies Irrigation and water management Soil fertility and plant nutrition
Sunflower	Crop improvement Pests and diseases Crop management	Seed production and quality Processing and utilisation Post harvest handling	On-farm storage Soil fertility and plant nutrition Labour saving technologies Irrigation and water management
Cowpeas	Crop improvement Pests and diseases Crop management	Seed production and quality Post harvest handling Processing and utilisation	Soil fertility and plant nutrition On-farm storage Labour saving technologies Irrigation and water management
Industrial & Cash Crops Tobacco	Crop improvement Pests and diseases Soil fertility and plant nutrition Crop management	Post harvest handling Labour saving technologies	Irrigation & water management Seed production and quality Processing and utilisation On-farm storage
Tea	Crop improvement Crop management Processing and utilisation Soil fertility and plant nutrition	Irrigation & water management Post harvest handling Labour saving technologies	Pests and diseases On-farm storage Seed production and quality

Group & Commodity	High priority	Medium priority	Low priority
Sugarcane	Irrigation & water management Crop management Crop improvement	Soil fertility and plant nutrition Labour saving technologies Seed production and quality	Pests and diseases Post harvest handling Processing and utilisation On-farm storage
Cotton	Pests and diseases Crop improvement Crop management	Labour saving technologies Seed production and quality Post harvest handling	Soil fertility and plant nutrition Irrigation & water management On-farm storage Processing and utilisation
Macadamia	Crop management Crop improvement Pests and diseases	Post harvest handling Soil fertility and plant nutrition Processing and utilisation	Seed production and quality Irrigation & water management On-farm storage Labour saving technologies
Coffee	Crop improvement Crop management Irrigation and water management	Pests and diseases Soil fertility and plant nutrition Processing and utilisation	Seed production and quality Post harvest handling Labour saving technologies On-farm storage
Cashew	Crop improvement Pests and diseases Crop management	Processing and utilisation Seed production and quality Soil fertility and plant nutrition	Post harvest handling Labour saving technologies Irrigation & water management On-farm storage
Roots and Tubers Cassava	Pests and diseases Post harvest handling Processing and utilisation	Crop improvement Seed production and quality Crop management	On-farm storage Soil fertility and plant nutrition Labour saving technologies Irrigation & water management
Sweet potato	On-farm storage Post harvest handling Seed production and quality	Crop improvement Crop management Pests and diseases	Soil fertility and plant nutrition Processing and utilisation Labour saving technologies Irrigation & water management
Potatoes	Seed production and quality Crop improvement Pests and diseases	Crop management Soil fertility and plant nutrition Post harvest handling	On-farm storage Irrigation & water management Labour saving technologies Processing and utilisation
Vegetables Tomato	Pests and diseases Irrigation & water management Post harvest handling	Crop management Seed production and quality Soil fertility and plant nutrition	Labour saving technologies Crop improvement On-farm storage Processing and utilisation
Cabbage	Pests and diseases Irrigation & water management Crop management	Soil fertility and plant nutrition Seed production and quality Post harvest handling	Crop improvement On-farm storage Labour saving technologies Processing and utilisation
Pumpkins	Crop improvement Seed production and quality Soil fertility and plant nutrition	On-farm storage Crop management Post harvest handling	Pests and diseases Irrigation & water management Labour saving technologies Processing and utilisation
Onions	Seed production and quality Crop improvement Soil fertility and plant nutrition	Crop management Irrigation & water management On-farm storage	Pests and diseases Labour saving technologies Post harvest handling Processing and utilisation
Amaranthus	Crop management Crop improvement Seed production and quality	Soil fertility and plant nutrition Post harvest handling Irrigation & water management	On-farm storage Processing and utilisation Pests and diseases Labour saving technologies

Group & Commodity	High priority	Medium priority	Low priority
Carrot	Crop improvement Crop management Seed production and quality	Soil fertility and plant nutrition Post harvest handling Irrigation & water management	On-farm storage Processing and utilisation Pest and diseases Labour saving technologies
Mushroom	Spawn production and quality Crop management Pests and diseases	Post harvest handling Crop improvement Soil fertility and plant nutrition	On farm storage Labour saving technologies Processing and utilisation
Spices Chillies	Crop improvement Crop management Post harvest handling	Soil fertility and plant nutrition Seed production and quality Pests and diseases	Irrigation and water management Processing and utilisation Labour saving technologies On-farm storage
Paprika	Crop management Crop improvement Processing and utilisation	Post harvest handling Pests and diseases Seed production and quality	Soil fertility and plant nutrition Irrigation and water management Labour saving technologies On-farm storage
Ginger	Crop improvement Crop management Soil fertility and plant nutrition	Seed production and quality Post harvest handling Processing and utilisation Irrigation and water management	On farm storage Pests and diseases Labour saving technologies
Turmeric	Crop management Crop improvement Soil fertility and plant nutrition	Seed production and quality Irrigation & water management Post harvest handling Processing and utilisation	On farm storage Pests and diseases Labour saving technologies
Fruits & Flowers Mango	Seed production and quality Crop improvement Processing and utilisation	Pests and diseases Crop management Post harvest handling Irrigation and water management	On-farm storage Soil fertility and plant nutrition Labour saving technologies
Banana	Pests and diseases Crop management Seed production and quality	Irrigation and water management Post harvest handling Soil fertility and plant nutrition	Crop improvement On-farm storage Labour saving technologies Processing and utilisation
Citrus	Seed production and quality Crop management Pests and diseases	Post harvest handling Irrigation and water management Processing and utilisation	Crop improvement Soil fertility and plant nutrition On-farm storage Labour saving technologies
Pineapple	Crop management Seed production and quality Soil fertility and plant nutrition	Crop improvement Irrigation and water management Post harvest handling	Processing and utilisation On-farm storage Pests and diseases Labour saving technologies
Flowers	Irrigation and water management Seed production and quality Crop management	Crop improvement Post harvest handling Pests and diseases On-farm storage	Soil fertility and plant nutrition Labour saving technologies
Guava	Pests and diseases Post harvest handling Crop management	oil fertility and plant nutrition Processing and utilisation Irrigation and water management	Seed production and quality On-farm storage Crop improvement Labour saving technologies

5.8.2 Priority Researchable Areas for Livestock

Livestock research areas are classified into eight categories: (i) feeds, pasture and nutrition; (ii) diseases and parasites; (iii) rapid stock multiplication; (iv) breed improvement; (v) livestock management; (vi) processing, storage and utilisation; (vii) post harvest handling of animal products and by-products; and (viii) labour saving technologies. The order of priority of these areas for each livestock type is shown in Table 5.8.

Table 5.8 Researchable areas for livestock classified in order of importance

Group & Commodity	High priority	Medium priority	Low priority
Monogastric Livestock			
Chickens	Feeds and nutrition Poultry management Rapid stock multiplication	Parasites and diseases Breed improvement Labour saving technologies	Meat processing, storage and utilisation Utilisation of wastes
Pigs	Management Breed improvement Feeds and nutrition	Parasites and diseases Rapid stock multiplication	Meat processing, storage and utilisation Labour saving technologies Utilisation of wastes
Rabbits	Management practices Feeds and nutrition Rapid stock multiplication	Breed improvement Meat processing, storage and utilisation	-Parasites and diseases Utilisation of wastes Labour saving technologies
Ruminant Livestock			
Cattle	Pastures & nutrition Management practices Breed improvement	Milk production, processing, and utilisation Rapid stock multiplication Parasites and diseases	Labour saving technologies Utilisation of wastes
Goats	Breed improvement Management practices Rapid stock multiplication	Pastures and nutrition Parasites and diseases Milk processing, storage and utilisation	Labour saving technologies Utilisation of wastes
Sheep	Breed improvement Pastures and nutrition Parasites and diseases	Management practices Rapid stock multiplication	Meat processing, storage and utilisation Utilisation of wastes Labour saving technologies
Non-conventional livestock			
(Donkeys, Ducks, Turkeys, Guinea fowl, Pigeons)	Management practices Feeds and nutrition Rapid stock multiplication	Breed improvement Parasites and diseases Animal & meat processing, storage and utilisation	Labour saving technologies Utilisation of wastes

5.8.3 Priority Researchable Areas for Fisheries

Researchable areas for fisheries have been classified into the following categories: (i) fishing vessels and gear; (ii) fishing methods and practices; (iii) post harvest handling of fresh and dry fish; (iv) processing for value adding and utilisation; (v) fish biology and ecology; (vi) management of spawning habitats and fish stocks; (vii) feeds and nutrition; (viii) fish breed improvement; (ix) fingerling production and management; (x) predators and parasites; (xi) fish pond management; and (xii) labour saving technologies. The research priorities are shown in Table 5.9 by commodity group and category.

Table 5.9 Researchable areas for fisheries classified in order of importance

Commodity	High priority	Medium priority	Low priority
Capture Fisheries	Management strategies Fishing methods and practices Post harvest handling	Fishing vessels and gear Fish biology and ecology	Processing and utilisation Labour saving technologies
Aquaculture Fisheries	Fingerling production and management Feeds and fish nutrition Development of community aquaculture	Fish genotypes improvement Fish pond management Labour saving technologies Predator control	Diseases and parasites Post harvest fish handling Processing and utilisation

5.8.4 Priority Researchable Areas for Forestry and Environment

Forestry and environmental researchable areas have been grouped and defined based on the core activities in the forestry and environment sector. The established researchable areas are as follows:

5.8.4.1 Forestry: (i) forest management; (ii) species improvement; (iii) pest and diseases; (iv) fire prevention and control; (v) seed production storage and quality; (vi) labour saving technologies; and (vii) post harvest handling (wood processing treatment and storage).

5.8.4.2 Environment: (i) deforestation control and prevention; (ii) land degradation control and prevention; (iii) sustainable utilisation of natural resources; (iv) biodiversity conservation; (v) water and air pollution control and prevention; and (vi) climate change, variability and desertification control. The information in Table 5.10 shows priorities for forestry and environmental issues.

Table 5.10 Research areas for forestry and environmental issues classified in order of importance

Commodity	High priority	Medium priority	Low priority
Forestry Indigenous Forests	Forest management Seed production, storage & quality Species improvement	Pests and diseases Fire prevention and control	Post harvest handling Labour saving technologies
Plantation and \woodlot forests	Species improvement Forestry management Fire prevention and control	Seed production, storage & quality Pests and diseases	Post harvest handling Labour saving technologies
Environmental Issues	Deforestation control & prevention Land degradation control & prevention Sustainable utilisation of natural resources	Water pollution control & prevention Biodiversity conservation Climate variability	Air pollution, control and prevention Climate change and desertification control

5.9 PRIORITIES AMONG RESEARCH FOCUS AREAS

This section is aimed at enabling the researchers and policy makers determine the focus for each priority research area. The methods used involve the Attractiveness and Feasibility Matrix complemented by Intuition as discussed in Section 5.8.

The criteria consider the following: (i) are the expected results able to provide plausible solutions to the constraints? (ii) what is the expected increase in productivity or improvement in quality from the research? (iii) what is the likely impact of the research? (iv) will the technologies to be developed have positive impact? (v) what will be the acceptability of the technology to end-users? (vi) what is the possible degree of adoption? and (vii) can the required information be obtained or adapted from other sources?

A list of projects or activities is prepared for each priority research area and is subjected to the priority setting process as described above. The research focuses for immediate attention are described by commodity group in the following sections.

5.9.1 Priority Research Focus for Crops

5.9.1.1 Cereal crops: Research priorities for cereals have been developed in an attempt to increase food production in the country. The following research focus areas have been identified for each researchable area:

(i) Soil fertility and plant nutrition: As a priority area, the soil fertility initiative will address both inorganic and organic fertiliser technologies. This will specifically focus on the development of agro-ecological area-specific inorganic fertiliser recommendations on rates, types and mixes with emphasis on: nitrogen, phosphorous, potassium, zinc, sulphur and boron; compost manure making and application rates, use of nitrogen fixing legumes, and use of high nitrogeb content leguminous agroforestry tree species in rotation or intercropping systems. Research effort should also focus on developing sustainable farming systems for marginal lands, including dambos and steep slopes. Soil fertility initiatives should, therefore, focus on soil and water conservation measures such as

realigning ridges on the contour, box ridging and planting of vetiver grass on the marker ridges.

(ii) Crop improvement: Crop improvement has been rated second highest and should concentrate on breeding for high yield, and early maturity; pest and disease tolerance especially with respect to viral diseases like maize streak virus and gray leaf spot and rust. The emphasis should be on both hybrid and open pollinated flint maize varieties, scented rice varieties, and sorghum/millet varieties with good milling qualities and storage properties.

(iii) Crop management: Crop management research should focus on time of planting; time and rate of fertilizer application and management to improve efficiency of fertiliser use; timely weed control particularly witch weed which if done on time and efficiently can easily double crop yields. This can also be achieved by employing labour saving technologies.

(iv) Labour saving technologies: Farmers face seasonal labour shortages during the cropping season. Research should, therefore, develop lowcost labour saving technologies for ridging, ploughing, weed control, draught animal power, maize shellers, rice threshers, sorghum and millet dehullers, low cost water pumping systems and rural transportation facilities especially for resource poor farmers. These technologies should enable timely and efficient execution of operations.

(v) Irrigation and water management: Research in this area should aim at water delivery systems, water requirements in crops and management of irrigated crops.

(vi) Seed production and quality: Research strategies should promote, develop and supply least-cost rapid seed multiplication technologies for all cereal crops; especially, the open pollinated varieties which are demanded by the majority of smallholder farmers because of their nature to be recycled, pound ability and resistance to storage pests.

5.9.1.2 Vegetable and spices: Six researchable areas were identified as of high priority and the following are the focus areas in each of them.

(i) Crop management: Develop improved agronomic practices and systems including those addressing time of planting, nursery management, fertilizer management, low cost water delivery systems and weed management.

(ii) Seed production and quality: Develop appropriate seed production technologies for the production of viable seed at an affordable price. Emphasis should be on open pollinated vegetable varieties and the rapid multiplication of rhizomes for ginger and tumeric.

(iii) Crop improvement: Introduce and evaluate improved high yielding varieties of vegetables and spices with acceptable qualities and resistance to diseases. Emphasis must be on the introduction of open pollinated vegetable varieties from Asian Vegetable Research Development Centre (AVRDC) in Taiwan and the SADC vegetable (CONVERDS) programme in Tanzania.

(iv) Soil fertility and plant nutrition: The research emphasis should be on plant nutrition particularly on inorganic fertiliser types and management to optimise production of the vegetables and spices. Efforts should also be made to investigate the use of compost manures.

(v) **Post harvest technologies:** Being highly perishable crops, vegetables require intensive research on post harvest handling. This must include appropriate grading, packaging, storage processing and preservation technologies.

(vi) **Pests and diseases:** Insect pests and diseases are a big problem especially in vegetables. Develop IPM technologies for the control of the important pests and diseases affecting vegetables and spices, such as early and late blight in tomato and potato, red spider mites in tomato, diamond backmoth and soft roots in cabbage, viruses in chillies, and bacterial diseases in paprika.

5.9.1.3 Fruits and Floriculture: Specific areas of research focus to be implemented in the short and medium term are outlined as follows.

(i) Seed production and quality: Develop technologies for rapid vegetative propagation by using conventional methods or tissue culture of various fruit types, flowers and field establishment techniques. This will address the critical shortage of planting materials of the desirable varieties.

(ii) Crop management: Develop management technologies and improve the available ones to increase production. Emphasis should be on pruning, irrigation rates and frequency, inorganic fertilizer rates and timing, and weed control in orchards.

(iii) Crop improvement: Introduce and evaluate improved fruit varieties and select those of commercial value that are high yielding, have good quality, are adaptable to local conditions and are tolerant to major diseases.

(iv) Pests and diseases: Develop IPM strategies for the economic control of pests and diseases in fruit orchards including powdery mildew, fruit fly and the weevil in mangoes; panama disease, black sigatoka, bunch top, nematodes and weevils in bananas; aphids, woolly white fly and fruit fly in citrus and aphids and leaf eaters on flowers.

(v) Postharvest technologies: Develop appropriate handling, grading, packaging, storage and processing technologies for home consumption and the agroprocessing industry particularly juice extraction; fruit and juice preservation; and storage of perishable flowers.

5.9.1.4 Cash and Industrial crops: The specific activities in which technologies need to be generated are described by the research area.

(i) Crop improvement: Continue to introduce, breed and select improved high yielding varieties with acceptable qualities and tolerance to drought, diseases and insect pests. These varieties ought to be commercially attractive and have potential for high economic returns.

(ii) Crop management: Improve the current agronomic practices to suit the changing social and economic environment, particularly time of planting, nursery management, pruning, weeding, grading, processing and irrigation. Development of labour saving technologies would make a positive impact on crop management.

(iii) Pests and diseases: Develop IPM strategies for the control of important pests and diseases affecting cash crops in Malawi, including wildfire, bushy top, cutworms and nematodes in tobacco, thrips, red spider mites, mosquito bug, and root rot disease in tea, leaf miners, antesia bug, leaf rust and coffee berry disease in coffee; stainers, red spider mites and jassids in cotton; stink bugs, two-spotted bugs, yellow-spotted bugs and blossom blight in macadamia; and mosquito bug and powdery mildew in cashews.

(iv) Soil fertility: The soil fertility initiative on these crops should emphasise the use of inorganic fertilisers with special attention to the frequency of application and economic amounts to be applied.

(v) Irrigation and water management: Develop technologies for irrigation systems to supply water during water stress, drought periods, and for dry planting of crops in anticipation of the onset of the planting rains, and nurseries.

5.9.1.5 Legumes and oilseeds: The areas of research focus that need attention include:

(i) Crop improvement: Select and breed high yielding and early maturing varieties that have the desired consumers' preference for grain and cooking qualities, resistance to major insect pests and diseases and other abiotic stresses, tolerance to low nitrogen and phosphorous, and adaptable to different agro-ecologies to allow for wider acceptance of the technologies.

(ii) Crop management: Develop improved agronomic practices including fertiliser management, intercropping and relay cropping systems and dimba cultivation under residual moisture.

(iii) Seed production and quality: Develop rapid seed multiplication technologies and investigate seed viability, pathology and storage.

(iv) Pests and diseases: Develop IPM strategies for the control of fungal, bacterial, viral, nematode diseases and insect pests affecting legumes in the field and in storage.

(v) Postharvest technologies: Develop appropriate technologies for storage, processing, and utilisation (including oil extraction and cooking). This will help add value to crops and raise household incomes.

5.9.1.6 Root and tuber crops: Research focus in these areas is outlined as follows:

(i) Crop improvement: Select, breed and introduce cassava and potato varieties and lines that are high yielding, have high dry matter content, and are resistant to major pests and diseases.

(ii) Seed production and quality: Develop rapid seed multiplication technologies and screen sprout suppressant chemicals for potatoes.

(iii) Pests and diseases: Develop effective and economic control methods for pests and diseases especially cassava mealy bug, cassava African mosaic, soil burrowing rodents, cassava green mite, bacterial blight, sweet potato weevil, potato tuber moth and the potato virus complex.

(iv) Parasites and diseases: Assess the effectiveness of vaccines and traditional techniques for the control of parasites and diseases. Also, develop pen-side tests for common diseases.

(v) Rapid stock multiplication: Evaluate oestrus synchronisation technologies including artificial insemination programmes using imported semen, and from local superior breeds.

(vi) Processing, storage and utilisation. Develop community-based and low cost technologies for milk and meat processing and storage.

5.9.2.3 Non-conventional livestock: Priority research focus areas for non-conventional livestock such as guinea fowls, turkey, geese, pigeons and ducks.

(i) Management practice: Develop management requirements for non-conventional livestock.

(ii) Feeds and nutrition: Develop nutritional requirements for these animals.

(iii) Rapid stock multiplication: Develop technologies for rapid multiplication of these species of livestock.

(iv) Breed improvement: Select superior local breeds for cross breeding to improve the genetic potential of these non-conventional livestock.

(v) Parasites and diseases: Study disease resistance factors in non-conventional livestock as compared with conventional types.

5.9.3 Priority Research Focus for Fisheries

5.9.3.1 Capture Fisheries: The priority researchable areas and focus in capture fisheries are:

(i) Management of spawning habitats and fish stocks: Identify ecological niches for spawning in lakes and other water bodies by fish species/type and develop protection and conservation measures.

(ii) Fishing methods and practices: Develop effective, appropriate and low cost fishing methods.

(iii) Post harvest technologies including handling, processing and storage: Develop effective, appropriate low cost preservation technologies, especially sun drying, handling and storage technologies including fresh and dry fish storage.

(iv) Fishing vessels and gear: Develop effective, appropriate labour saving and low cost fishing vessels and gear.

(v) Fish biology, ecology and stock improvement: Determine the relationships among limnological, biological and ecological factors and fishing gear on fish catches of the major water bodies.

5.9.3.2 **Aquaculture:** Priority research focus areas in aquaculture are as follows:

(i) Fingerling production and management: Develop appropriate technologies to optimise mass production of fries and fingerlings in hatcheries. Improve handling of fries from hatchery to rearing units. Develop and introduce appropriate fry collection methods.

(ii) Feeds and nutrition: Determine stocking rates and nutritional requirements and optimum feeding regimes for fish in ponds. Develop feed rations based on the locally available raw materials.

(iii) Breed improvement: Screen and select suitable indigenous and/or introduced fish species for aquaculture in addition to selective breeding for tilapias.

(iv) Pond management: Determine stocking requirements and improve inputs to increase productivity of the pond.

(v) Fish predators and parasites: Design predator traps and parasite prevention and control measures for small fishermen.

5.9.4 Priority Research Focus Areas for Forestry and Environmental Issues

5.9.4.1 **Forestry:** The priority research focus areas for forestry are:

(i) Seed production, storage and quality: Identify superior trees for collection of seed and establish collection areas and study the development of clonal seed orchards for the production of seed. Furthermore, study in situ and ex situ conservation and storage of seed to prolong storage life. Develop technologies to increase the germination capacity of seed through seed pre-treatments.

(ii) Species improvement: Introduce fast growing exotic tree species that can easily adapt to local conditions, and identify superior indigenous tree species for propagation and reafforestation programmes.

(iii) Management practices: Study the possibility of: (i) applying fertilisers to young forests to accelerate growth and increase forestry productivity; (ii) under sowing forest land with desirable multipurpose grass species and shrubs to increase the value of the forests; and (iii) developing alternative sources of energy and construction materials for home and industrial use.

(iv) Pests and diseases: Develop biological control methods for the major pests of economic importance such as the conifer aphid, termites, beetles and the *Leauceana* psyllid. The use of IPM should also be encouraged for safe and effective control of insect pests.

(v) Labour saving technologies: Fire prevention can be done using fire breaks and controlled burning. However, most of the fire fighting equipment in the Forestry Department is obsolete and nonfunctional. Research is required on the development of low cost fire fighting equipment using local materials that can be serviced locally.

(vi) Post harvest technologies: Investigate the natural durability of indigenous timber species against biological deterioration caused by microorganism, wood processing, storage and utilisation.

5.9.4.2 Environment: Environmental degradation is a factor of human activity and industrial development; hence, require extensive research for proper management. The major areas that need immediate attention include:

(i) Deforestation control and prevention: Identify and develop alternative sources of biomass energy to reduce over dependency on wood and charcoal. In addition, considerable research is required to develop alternative sources of construction materials, e.g. cement brick making. Research on deforestation control strategies should also emphasize reafforestation and the promotion of agroforestry initiatives and non-wood forest products.

(ii) Land degradation control and prevention: There is need to identify and develop land management practices that are environmentally friendly. The planting of vetiver grass on marker ridges, protection of marginal lands and rehabilitation of degraded areas need to be emphasised.

(iii) Sustainable utilisation of natural resources: Study and develop appropriate practices for the sustainable use of the country's natural resource base which is the basis for human survival.

(iv) Biodiversity conservation: Study and develop appropriate methods and practices for the conservation of the nation's biodiversity including rehabilitation, restocking and taking an inventory where necessary.

(v) Water and air pollution: Degradation of the water bodies and air quality is becoming a major concern for human life. Studies of the effects of agro-chemicals, green house gases, climate change, desertification and unplanned squatters must be conducted to establish standards.

An assessment of the current projects being implemented by the scientific community shows that most of them are defined and conducted on an *ad hoc* basis and that the major problem is that most of the projects are not focussed and their implementation is inefficient. This has resulted in generation of technologies which are not appropriate and in some cases irrelevant to the problems faced by the end-users. Consequently, most of the current research technologies have had little or no impact at all in the agricultural and natural resources sectors. The problem is aggravated by the misallocation of human resources. Most areas that require serious research have no trained manpower. In the areas where adequate human resources are available, good research has already been conducted. There is therefore need to redeploy human resources and train more people in areas deficient of scientific manpower. Restructuring within the institutions and at national level in order to effectively and efficiently utilise the available resources is also necessary. It is advisable that the ARC, ASC, ARET, TRF, RPC and other research coordinating bodies are critical about the research focus when appraising and approving new research proposals. Within each commodity and priority research area, the Boards or Councils appraising research project proposals need to use the "attractiveness and feasibility matrix approach" complemented by Intuition and checklist as established in this chapter.

CHAPTER SIX

REORGANISATION AND IMPROVED MANAGEMENT OF THE RESEARCH SYSTEM

6.1 INTRODUCTION

It is of little value for Malawi to spend substantial time and financial resources on setting priorities for research unless the national research system has the capacity to transform itself to address these priorities and manage the research in an effective and efficient manner. The current structure and management of the agriculture and natural resources research system as described in Chapter III shows that the system is presently fragmented. Thus, scientists and equipment are dispersed over too many research institutions resulting in lack of a critical mass for efficient use of facilities and resources.

This chapter analyses the operations of the present research system in an attempt to identify its strengths and weaknesses in terms of its ability to address the set priorities in a systematic and sustainable manner. It proposes how agriculture and natural resources research could be organised to prepare it for the next decade, and describes how to manage the transition phase. Finally, it outlines a system of management procedures for the transformed organisation in an era of stretched financial resources.

6.2 REVIEW OF THE PRESENT RESEARCH SYSTEM

It must be realised that under any circumstances, a research system is only as productive as its useful outputs. Chapter IV has shown that there has been a substantial output by the system but that the uptake and impact have been limited. In that sense, much of the past research has not been particularly useful; a view reflected in the Vision 2020 statement that agricultural research in Malawi has contributed rather little to agricultural development in the country. This is a perception that is shared by many, including donors. On the contrary, Chapter III shows that there has been substantial investment in the research system for the past thirty years. If research and technology development have had limited impact on agriculture and natural resources development, a question arises as to why government and the donors continue to invest in it. It is clear from discussions with stakeholders that, while being convinced that improved technology is essential for increasing productivity in the country, the ability of the research system to deliver the technologies using the present organisation is questionable. Consequently, most donors usually finance individual research projects, which they can control, rather than support the research system as a whole.

Closely related to the question of the relatively low impact of new technology is the rate of population growth and the government's desire to match or exceed this in the growth of agriculture and natural resources productivity, which would need to be around 4% per annum. With little opportunity for land expansion, achieving this on a sustained basis is an almost unattainable target. Historically, maximum values of around 3% per annum have been recorded in Europe and the USA over the period 1940-80.

6.2.1 Funding of Research in Short and Long Term

Chapter III has shown that the national agricultural and natural resources research system has a substantial number of highly qualified scientists and that the research support services including experimental stations, administration, vehicles, equipment and other facilities are good. The present situation owes much to the substantial investment in the last two decades, largely by donors. This cannot be quantified as complete records are not available. However in 1985, the first research project provided US$ 30 million from IDA and USAID, equivalent to K129 million at current exchange rates. The current World Bank ASP has provided US$2.3 million (K98.9 million) to DARTS from 1994 to mid-1998. Other donors have also made substantial investments in providing buildings and equipment, operational costs, training and provision of technical assistance. When contribution of the government is added, the total investment in the national agricultural and natural resources research system over the past two decades may be approaching US$ 80 million (MK3,480,000 million). It can therefore be argued that adding to these resources would not make the research system more effective. The strengths of the system lie in its substantial resources; while the weaknesses lie in how the resources are managed.

6.2.1.1 Revenue Budget: Although the overall level of funding is good, its sources and application are not. Most important is the instability and unpredictability of the government revenue budget which has deteriorated over time (Table 3.2). Salaries, which have dropped greatly in real value, now absorb for example, more than 80% of DARTS revenue budget. Operational budgets, even when approved, may be cut if there is an unanticipated shortfall in revenue. The operational needs of agricultural research are often "lumpy" due to seasonal needs but the flow of funds under the current budget system does not match these needs. Perceived low priority activities: - library, spares, short-term training are not well funded. Effective logistics for research with farmers is strongly dependent on adequate and stable funding yet the lack of this leads to work being abandoned in midterm. These areas should be adequately funded. More importantly, there is need for Malawi to have a Cooperative Research Act that will encourage funding of research by the private sector.

Low staff salaries are symptomatic of the meagre resources of the government and the large number of civil servants that are employed by it. This in turn is reflected in low morale, loss of good staff in search of better opportunities and emphasis on *per diem*, to supplement income. Slow promotion rates and the lack of a reward system that recognises excellence and indicts poor performance greatly influence researchers in their attitude to work.

The ratio of operational costs to personal emoluments needs to be improved. However, to determine the "right" level depends on several factors. ARET and TRF, for example, spend about 40% of the budget on staff but this may be inflated by higher salaries in the private sector. On the other hand, the budgets cover capital investments in buildings, vehicles and equipment, whereas the public sector relies heavily on donors for such investments. These considerations suggest that, in the Malawian situation, personal emoluments should not exceed 50% of the total research budget.

6.2.1.2 Donor funding: There are two basic kinds of donor funding, one for institutional development and programme support and another for project support, as in most bilateral programmes. Without donor funding, particularly for capital development and operational costs, much less research could have been undertaken. In that sense, donor funding has been vital to the operation of the system. But there are also some negative aspects to donor funding. It encourages competition for funds outside the system rather than within it. This puts little pressure on the policy makers to support research. In the absence of a government determined system of priorities, bilateral projects are managed by donors based on their view of priorities. While many have provided training, their relatively short-term nature and concentration on technology generation limit their contribution to institution building and improving the organisation, including management.

In the short term the research system in Malawi will unfortunately have to depend to a considerable degree on donor financing for operational costs and for capital investments. The system must not only plan for this form of financing in the near term but must also aim at decreasing dependence on it and eventually turn to national financing. If this approach is accepted, then it has important implications for the eventual size and scope of the system, for the manner in which donor financing should be handled in the near term and for the planning of a national system, eventually financed from national public and private resources. Thus, the size of the system would have to be based on what the country is likely to be able to afford. This is obviously a political decision which will be greatly influenced by the impact of research over the next ten years. Varying guidelines have been described, mainly based on the value of the AGDP. Thus, the DAR Master Plan shows that the present public expenditure on agricultural research is equivalent to 0.5% of AGDP and suggests that it should be raised gradually to 2%. At present, tea research spends 1.4% of the value of the crop on research. These may provide useful target figures.

The management of donor financing is currently incoherent and inconsistent with national systems. Donors have a major role not only in financing research but also in determining its direction. This is not a satisfactory way in which to build a national research system, which must move towards some kind of consolidated funding mechanism. Under this system, the sources and application of funds would be clearly stated and would support a coherent programme, that is, managed by the Malawian national research system. Donors, for a variety of reasons, are very reluctant to move to any kind of consolidated funding. In the near-term, however, they may support defined activities within an agreed plan. Hopefully they will phase out their involvement in the detailed design of these activities and will accept a system of monitoring and evaluation which will report to both government and donors. At the same time, an accounting and financial management system readily used by all those involved will need to be designed and institutionalised.

6.2.2 Research Management.

Management should have the authority to control the direction of research and ensure that it is working on the high priority problems of its end-users. However, there appears to be a consensus, especially among donors, that a major reason for the apparent lack of impact of research and technology development has been due to the fact that the researchers have not always consulted

farmers on their problems and priorities. As a result of this perception, donors have invested substantial resources, often with expatriate scientists, in studies at the farmer level to determine the priorities and to work with them in testing technologies. Malawian scientists dispute this perception, arguing that their background is often rural and that intuitively they have a good understanding of farmer problems, though they may not have formalised this in reports. There has to be respect for this view but it still leaves unanswered the question as to why much research is confined to experiment stations.

Rather than a lack of knowledge of farmers' priorities, the answer may lie in a reward system that encourages and compensates scientists for "successful" research as measured by experimental results rather than necessarily useful results.

Donors, and indeed the system, generally seem much less concerned with the quality of research. Yet, all research, regardless of how appropriate its objectives, will not be of any value if it is not imaginative and carried out with scientific rigour. A large percentage of Malawian scientists have a postgraduate degree, and the quality of their work is closely supervised. However, this supervision and attention to scientific rigour are often missing in the day-to-day activities of the research system. High calibre and relevant research are also essential in the university system, especially at the postgraduate level. The opportunity and the encouragement to publish in high quality journals are important for quality control but these appear to be missing at present.

One aspect that has to be noted is that the research management system has comparatively grown. The development of institutional capacity to manage such a large team of well-qualified scientists has not matched the rapid increase in numbers.

6.2.3 Dissemination and Uptake of Research Findings

Dissemination of research findings to the users needs an effective two-way system of communication among all stakeholders. The information generated from research needs to be re-packaged and results communicated to various clients-farmers, policy makers, extension workers, field assistants, agricultural input suppliers, research scientists and the donor community through journal articles, newsletters, bulletins, extension circulars, field days, seminars, workshops, symposium and joint monitoring and evaluation exercises.

While donor-funded projects have had adequate and stable funding and close supervision by visiting scientists, evaluation of uptake and impact of technologies generated from those projects has been mainly confined to maize varieties. It would appear that relatively few of the projects have had an impact assessment to indicate their influence on development. Indeed, there are several accounts of donor-funded R&D projects which collapsed as soon as the funding ceased. If this is a general experience, it must raise questions as to whether the problems lie in the design of the projects and the shortcomings of project-funded research - usually over a three to five-year period though sometimes extended; or in the inability of the national research system to integrate and continue these projects when the donor withdraws; or in the failure of the other components of the research-extension-input supplier-farmer linkage to work efficiently.

Weak linkages, especially those between research and extension are a constant source of complaint in most research systems of developing countries including Malawi. However, links with input suppliers are equally important. The semi-flint maize hybrids, for example, were popular with farmers who could afford the hybrid seed and fertiliser to exploit the high yield potential, but only a small proportion of farmers could do so. As discussed in Chapter IV, useful varieties of several other crops have been produced and tested. Production and distribution of quality seed are a serious constraint but the time needed from adaptive research, i.e. testing on-station and on-farm, through seed multiplication to adoption of the technology by farmers is substantial. A well-documented case of a wilt-resistant chickpea variety in India shows that it took 15 years from the start of testing for the variety to be adopted by 30% of the farmers.

There may be other and perhaps more profound reasons for the limited impact of technology such as the capacity of the Malawian smallholder agricultural community to absorb new technology. Experience in other parts of the world would suggest that agricultural productivity rolls along at a very modest rate of increase but eventually reaches a critical point at which it begins to increase rapidly. Clearly many factors - social, economic and technical are involved in determining that critical point but the implications for Malawian agricultural research and what it can accomplish require serious attention. There is a widespread assumption that if only researchers did the "right" kind of research and that if there are "strong" linkages with extension then the uptake of the new technology could be rapid with a corresponding increase in productivity. This assumption should be challenged for there are many factors other than the "right" technology that influence success. To quote from recent experience in Zimbabwe- "Development projects in smallholder farming areas face serious problems arising from lack of dialogue and collaboration among farmers, jealousy, envy and even hatred. Experience has shown that these problems threaten technological innovations more than the technically related constraints of these innovations" (Nyagumbo, 1997).

Related to the social, economic and attitudinal capacity to absorb new technology is the question of poverty, which is all-prevailing in the rural areas. Not only is agricultural research a very blunt instrument for tackling poverty, but its potential impact is limited by the capacity of rural and peri-urban areas to use its outputs. On the other hand, the capacity of the commercial sector to take up new technology is considerably greater; and, hence, the likelihood of a much more rapid impact.

6.3 CHARACTERISTICS OF A DESIRABLE MANAGEMENT SYSTEM

Management strategies will have to involve the development of several important new procedures in order to control the system efficiently. These cover human resources and financial management processes including a management information system which links the various libraries, documentation and communication networks for popularising research results amongst end-users. The objectives of the procedures are outlined in the following paragraphs. These procedures need perfecting once the final shape of the agriculture and natural resources research system is agreed upon and put in place.

6.3.1 Research Management

Good research management should allow managers to keep track of the progress and encourage researchers to meet the objectives on time and within the allocated budget. Good management is

a powerful tool for improving the effectiveness and efficiency of research through the setting of goals and objectives; establishing proposal preparation; review and approval mechanisms; providing time and resource parameters; and guidelines for research project implementation and monitoring. The current research institutions have a series of management procedures, some of which are noted below, but which are not always used effectively. There is need for establishment of uniform set of procedures for agricultural and natural resources institution.

6.3.2 Research Guidelines and Planning

Although the fact that each research institution has mechanisms for managing its research programmes, the degree of commitment to the implementation of such a system varies from one institution to another. Generally, most institutions have technical committees or subcommittees that evaluate and appraise the quality of proposed research projects. However, the task of these committees is made difficult because of lack of guidelines for scientists in the preparation of research project proposals. The various committees also lack clear criteria for reviewing and assessing the quality of research proposals; hence, the need for specific guidelines to be developed for this. An important tool for research planning is the use of a Logical Framework (logframe) which is a tool for the preparation, monitoring and evaluation of projects. It is also useful for analysing the components of a project and the logical linkages between means and ends. The process is used by many development agencies to design projects and programmes, review progress and check that objectives are being achieved. A logframe should be able to allow flexibility to adjust certain components of the programme to be in line with changing circumstances. It can also be used as a framework for benefit cost analysis and reviews. It is also useful in bringing researchers and stakeholders together; and in providing a basis for structured discussions of the goals and measurable indicators of the plan, and the means of verification.

6.3.3 Financial Management System

The major constraints facing most research institutions in Malawi are inadequate funds and the proper management of the available and often meagre financial resources. The common outcry is that there are inadequate funds for conducting research. This may be generally the case but not always true. For example, money for travel expenses does not appear to be limiting in most institutions. This indicates that lack of proper financial allocations and poor financial management are also major problems faced by these institutions.

A good financial management system ensures that funds are used to achieve the institution's goals in the most cost effective manner. Programme budgeting can be used to achieve this by developing a budget that is related to programmes, projects or activities. The advantage of programme budgeting is that when insufficient funds are allocated, appropriate adjustment can be made to the programme and allow only very high priority projects to be implemented. Priority projects can be retained through the postponement or cancellation of low priority projects. The system also equips research managers with detailed information how to defend the programmes should need arise. However, in the current system of disbursing funds on a quarterly or monthly basis; whereby, the amount of funds provided from one quarter or month to the next is often unpredictable, programme budgeting is less useful. Thus, for successful programme budgeting, the total funds for the financial year need to be secure so that the manager can plan which

projects/programmes to implement at a given resource level. A fundamental requirement for implementing programme budgeting is an accurate account of available resources to the research institution.

To support and enforce the process of programme budgeting, the Malawi Government has prepared a Mid-Term Expenditure Framework (MTEF) Draft Handbook. The MTEF is a management tool or a planning and budgeting process for allocating resources in line with government policies and priorities to different programmes. This should be used as a framework for the agricultural and natural resources research programme planning and budgeting.

6.4 ORGANIZATIONAL IMPROVEMENT OF THE RESEARCH SYSTEM

The foregoing discussion shows that generation and uptake of new technology are very complex processes. On the other hand, it is obvious that Malawi's agriculture and natural resources problems while not unique, are very serious and that it will require a really imaginative research programme, managed by an efficient organisation, to make significant contributions to the solution. From the above discussion, one can conclude that project-funded research cannot substitute for a weak national system. Its usefulness is likely to be greatly enhanced when it is working with a strong national system. The question is then how to manage Malawi's research resources to build such a system.

There is widespread perception that privately-funded research is more effective and efficient than the publicly-funded one; and that, being accountable to its end-users, is more superior in its management of human and financial resources than the latter. It is, therefore, seen as a model in terms of productivity and efficiency. Indeed, there have been suggestions within the research system of enacting a Cooperative Research Act to encourage private sectors' research funding. Nevertheless, public sector-supported research will continue to play a major role in R&D in Malawi. The challenge is to bring its productivity, by whatever changes close to that of private research. However, in planning for change, it must be recognised that restructuring *per se* will not ensure a more effective and efficient organisation. It must also be recognised that there will be resistance to change at several levels. Researchers will resent losing a near monopoly on research funds. Managers and Ministries also resent the loss of power when competing for funds. Thus, there will likely support maintaining the *status quo*. In the end, such changes must be supported by politicians and policy makers who must be satisfied that a transformation of the system is essential if they are to give it that support. They must be convinced that a reorganised system can be a major contributor to rural development and improvement of rural livelihoods. Scientists need to be reassured that the restructured system will give them opportunities for productive research and reward them accordingly. Donors will need to be persuaded that their funds will be used efficiently for mutually agreed priority projects.

The general objective of a reorganised research system is to develop a public-private organisation, combining the goals of the former with the effectiveness and efficiency of the latter. It must be able to match the output of the system with the potential absorptive capacity of the farming community. To have a lot of unused technology "on the shelf" is a waste of resources. This will not only require an assessment of today's problems but also of those likely to be important ten years in the future.

One of the most important aspects of this future is the globalisation of agricultural and natural resources trade, information and research. This will surely accelerate in the next millennium when interregional and international trade is expected to grow rapidly. There is, for example, an increasing trade in tropical fruits, vegetables, livestock and livestock products in which the country hopes to participate. Malawi, with limited arable land, will have to concentrate on intensive agriculture, while its three neighbours; Mozambique, Tanzania and Zambia, which have ample land will be able to rely on extensive agriculture. As regional infrastructure, trade liberalisation and political stability develop, these will have far reaching implications for Malawi's agriculture.

The country must position itself to take advantage of these global developments and to make the best combination of farmer skills, imported and locally generated technology to add value to its local and imported raw materials. Within these objectives, the reorganised system would have nine purposes, viz.: (i) make the staff and physical resources of the research system more productive by operating in multi-disciplinary and multi-institutional teams; (ii) make it more responsive to the needs of the farming and the agro-industry community; (iii) enable the GOM and the donor community to get better value for money by managing its financial resources efficiently; (iv) make it more pro-active to changes in government policy and market opportunities, both domestic and foreign; (v) ensure a close working relationship among MoAID, MoNREA, the University of Malawi, the private sector and donors; (vi) ensure that personnel policies are conducive to motivation and good performance; (vii) ensure that administrative procedures and financial controls reflect the primary needs of a productive research system; (viii) improve the dissemination of technology through better research-extension-farmer linkages and transfer mechanisms; and (ix) enhance the capacity of end-users to adopt the technologies.

To move towards these objectives, there would appear to be four potential choices: (i) maintain the status quo - Improving the management could achieve some of the objectives, noted above. DARTS could develop an effective research programme using its revenue budget but it would need to reduce its personal emolument costs by half in order to release enough funds for operations. However, the existing structure is very unlikely to provide an effective and efficient system as it will retain the present fragmentation, dependency on donor project funding and poor staff motivation; (ii) devolve each of the research groups, agriculture, livestock, forestry and fisheries into four semi-autonomous institutes. This might be able to improve staff conditions but would result in increased management overheads, fragmentation as before and probably even less access to ministry funds as the institutes would have to compete with other ministry activities; (iii) a coordinating mechanism, such as a committee or council. This too could achieve some of the objectives of ensuring closer working relationships between the various ministries and departments. However, it could not ensure more efficient management of research. In fact such committees have a poor record of managing research unless they have control over staffing and funding and (iv) a national semi-autonomous organisation to fund and manage agricultural and natural resources research. Such an organisation could accomplish most of the objectives set out above, though, it would not be free of the financial problems besetting any organisation involved in the public sector. Experience from other countries that have restructured their agricultural research systems such as Kenya, Uganda, Tanzania, Ghana, and South Africa has shown that the creation of a national semi-autonomous research organisation can lead to successful management of research.

6.4.1 Establishment of the Foundation for Agricultural and Natural Resources Research

The Agricultural Sciences Committee in Malawi has demonstrated the advantages of a national body to manage and fund research, albeit on a smaller scale. Using this as a model, it is proposed that a semi-independent parastatal organisation be set up by an act of parliament called ***Foundation for Agriculture and Natural Resources Research (FANRR)***. The FANRR would be an umbrella organisation for agricultural and natural resources research in Malawi.

6.4.1.1 The Structure of FANRR: FANRR will have a Board consisting of representatives from all stakeholders including Directors of private research institutes, relevant ministries as ex-officio members, the university, the donors, the private sector, farmer groups or organisations and Non-governmental Organisations (NGOs). It is envisaged that the Board would have about 15 members, meeting perhaps quarterly and reporting directly to the Minister responsible for Science and Technology who shall also effect their appointments on recommendation from the NRCM.

The Board would be responsible for research policy, annual budgets and making decisions on the employment and remuneration packages for the Foundation's employees. It would make decisions on the overall research priorities, and through its wide membership, identify new opportunities for research. Once constituted, the Board would be responsible for appointing the Chief Executive, Deputy Chief Executive, and Directors of Research Institutes on a five-year renewable contract based on performance. To fulfill its mandate, the Board would create three subcommittees: Finance and Investments; Appointments and Disciplinary; and Technology Generation Transfer and Commercialisation.

The Foundation would have a secretariat headed by the Chief Executive. The composition of the secretariat would include sections responsible for Finance and Investment; Administration and Human resources; and Technology Development and Public Relations. The foundation would have the following specialised institutes; Field Crops; Horticultural Crops; Agricultural Engineering; Livestock; Fisheries; Forestry and specialised services. Each institute shall have the mandate to carry out research in unique focus areas to be headed by Chief Scientist answerable to the Director of the Institute. Each institute in turn shall have a committee comprising relevant stakeholders. The proposed organisational structure of FANRR is shown in Figure 6.1.

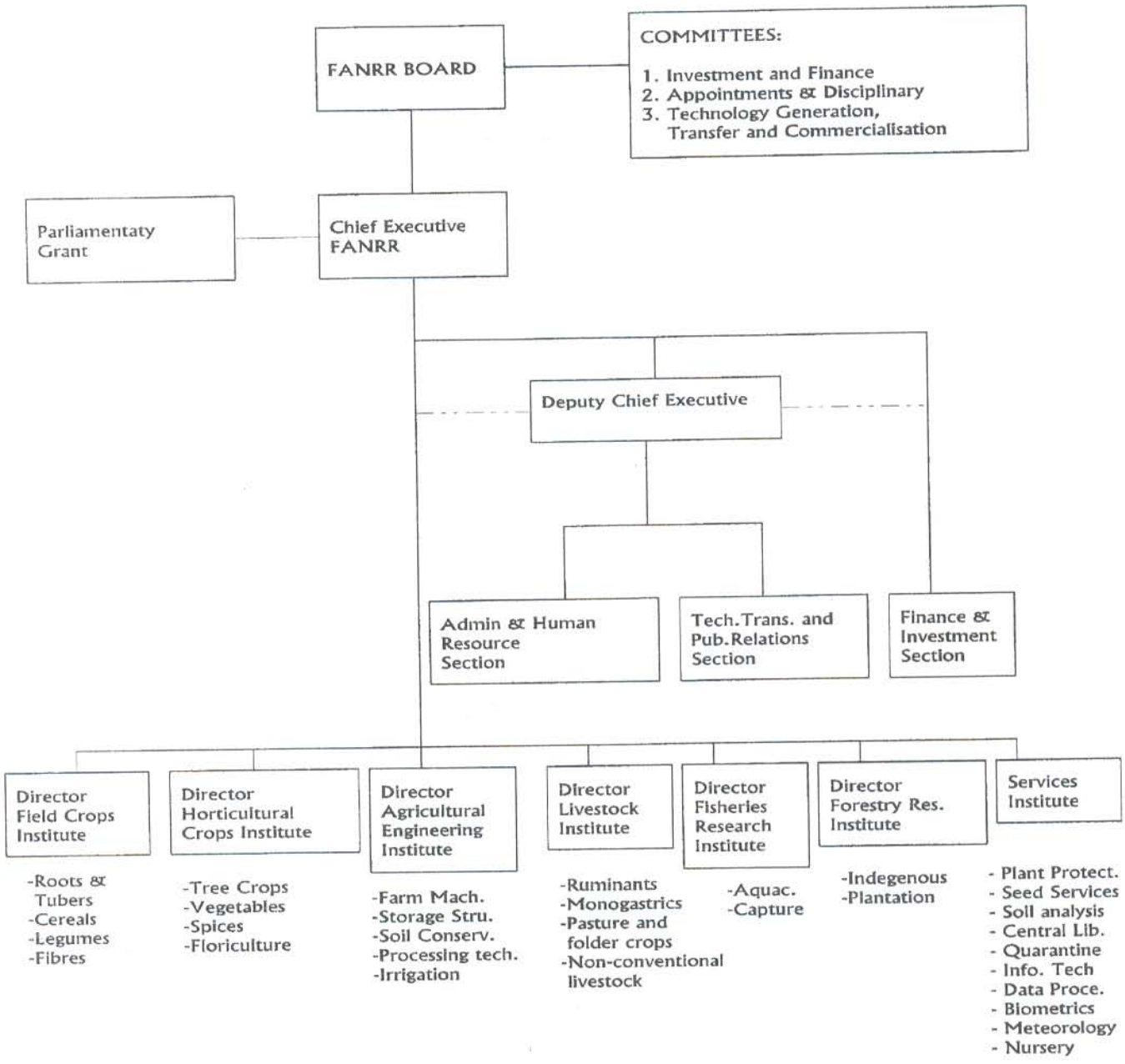
6.4.1.2 Functions of the FANRR:

(i) The Foundation would be responsible for organising and managing finances for funding core research, contract research, adaptive research and commissioned research in priority researchable areas.

(ii) It would develop a management information system covering all aspects of research on agriculture and natural resources in Malawi and would be responsible for constant updating of such a system.

(iii) It would facilitate the exchange and collection of scientific information, the creation of data bases and banks, specialized subject bibliographies, installation of new information systems and publication of research results.

Fig 6.1 ORGANISATIONAL STRUCTURE OF THE FOUNDATION FOR AGRICULTURAL AND NATURAL RESOURCES RESEARCH (FANRR)



(iv) It would be responsible for human resource needs assessment and the organisation of both short-term and long-term training for scientists and support staff.

(v) It would be responsible for encouraging formal and informal national, regional and international cooperation.

(vi) Most importantly, the Foundation will play a key role in technology transfer, particularly helping to design novel ways, as expounded in the Research/Farmer/Extension linkage mechanisms guide of MoAID to strengthen and improve, among researchers, extension staff, input suppliers and the end-users, and encouraging and institutionalizing participatory research/extension methodologies in jointly identifying problems and solutions.

(vii) It would further be responsible for monitoring and evaluation of the research system and reviews of any research programme(s) including conducting impact assessment.

(viii) FANRR would be responsible for conducting socioeconomic and policy analysis, commissioning commercial research projects including application and commercialisation of technologies.

6.5 MANAGING CHANGE

The plans for reorganising the research system, set out above, are designed to bring about major changes in the way the system will operate in Malawi. However, achieving the objectives of a transformed research system requires a thoroughly thought-out strategy to ensure a smooth transition. Managing change is recognised as one of the most difficult tasks confronting any management for it involves not only a transformation in the way business is conducted but also a radical change in attitudes. The transformation in the conduct of research will require more attention to the government's priorities, globalization of agriculture and natural resources and limits of publicly-funded research. Furthermore, attitudinal change will involve an increasing sense of responsiveness to the clients of research - its paymasters, for the more efficient use of resources and its end-users, to give increased attention to their needs.

Handled improperly, reorganisation can have serious negative effects on staff morale, trust and transparency including destruction of informal linkages. The reorganisation must be seen as an opportunity rather than as a threat by the staff. Reorganisation by decree is, thus, to be avoided.

6.6 STEPS IN SETTING UP THE FOUNDATION

It is proposed that the FANRR be established soon as part of implementation of the master plan. In setting up the institution, special attention will be paid to the following critical steps:

(i) the appointment of the Board of the foundation and the promulgation of details of how it would operate. This would include a short period of induction of board members so that they are clear about their roles and responsibilities; and their legal obligations as stipulated in the relevant legislation.

(ii) the appointment of the Chief Executive for the Foundation as the manager of the new research system, responsible for overseeing the transition. The manager would basically be an eminent scientist with good management skills. Other staff will need to be appointed as and when programmes develop.

(iii) establishment of management procedures, would include short-term training programmes.

(iv) recruitment of staff, including directors and scientists.

(v) the preparation of work plans and budgets, the securing of funds, and the location of an appropriate base for the programmes.

(vi) facilitate the development of linkage mechanisms with policy makers, extension staff, end-users, NGOs, researchers and the donor community.

6.7 HUMAN RESOURCE MANAGEMENT

The effectiveness of a research institution depends upon the quality of its leadership as much as its scientists. Good leadership gives direction to an organization and its programmes, motivates staff and identifies the organization with its stakeholders. Effective leadership ensures efficiency in planning, conducting research, procurement and reporting. It is important to ensure that candidates with the ability to manage human resources, strategic planning, project planning, proposal writing, project management and financial management are appointed to top positions. In addition they would have a good track record of leadership in previous positions coupled with a transparent and an open recruitment process.

The present system in government research organisations is pyramidical and hierarchical so that very few scientists are promoted even if their performance is outstanding, resulting in low morale. Promotion is based on seniority rather than merit and does not require accountability from scientists and managers. FANRR's management would have to aim at providing researchers with adequate, competitive salaries and other incentives such as professional recognition and satisfaction of scientific interest. A transparent system of promotion, based on merit and clearly understood by all scientists would have to be developed and utilised by the foundation to ensure staff development and career growth. This system, set out in a staff appraisal guide, would take into account job descriptions, achievement of goals and objectives, administrative, leadership and managerial skills of the scientist, publications and technologies generated. Such a management practice would encourage productivity, accountability, creativity and responsibility among scientists.

6.8 FINANCING RESEARCH

Measured against AGDP, the current levels of funding are quite generous for the research system as a whole (See Table 3.2). On the other hand, the sources and application of the funding illustrate the following problems: (i) decreasing government support and its instability; (ii) increasing dependence on donor funding; and (iii) large percentage of the budget being used for staffing and management. Staff costs are more than 80% of the DARTS revenue budget. DARTS spends

nearly 40% of its development budget on management. Staff costs, the upkeep and management of the substantial number of research stations account for about 60% of total expenditure (Table 3.2) Development funds are meant for such investments as capital and staff training but not for daily operational costs.

Research has usually been funded from both the recurrent and development budgets. A critical examination of both the sources and the application of funding is necessary for stability of funding and the ability to manage fluctuating flows of funds are obviously important. There is, therefore, need to diversify funding sources and to seek for more local funding. This will require politicians and policy makers to be convinced of the importance of research and its potential impact on agricultural and natural resources production which translates into food security, poverty reduction and sustainable utilization of the natural resource base. It is envisaged that the Foundation would have five sources of funding namely; revenue budget, development budget, income generating activities, grants from donors and the private sector.

6.8.1 Parliamentary Grant

There is need for the creation of a Science Vote through which funds voted for in Parliament for all types of research to be conducted in Malawi will be channelled. This vote would be administered by a central body such as the proposed National Commission for Science and Technology located in the office of the minister responsible for Science and Technology. The parliamentary grant from this vote will constitute the main source of funds for the FANRR for both salaries and operational costs. However, the Foundation is expected to play a more proactive role in identifying other sources of funds both internally and externally.

6.8.2 Development Budget

Funds from this will be needed to cover most of the operational costs as without donor funding very little research, particularly on-farm, will be possible. While seeking donor funding is important, it has its own problems such as donor dependency, fragmentation of research efforts, lack of continuity in programmes, increasing requirements for "counterpart" staff and funds, and failure to link research funding to policy reform. In the long term, the Foundation would have to rely more on other sources of funding to broaden its income base.

The challenge is to make donor funding more effective by placing more emphasis on improving research quality as opposed to expanding research programmes, by more effective use of existing human and financial resources, by setting priorities for donor-funded projects and by linking research funding to institutional reform.

6.8.3 Income Generating Activities

For sustenance of the foundation, there should be some consideration for broadening the income base. These would include: (i) charging full commercial costs for statutory government services, e.g. phytosanitary certification; (ii) charging full commercial costs for other services, e.g. soil and plant analysis; machinery testing; pest and disease identification; (iii) raising and/or propagation of planting materials for fruit trees, production of basic or foundation seed, sweet potato vines,

cassava cuttings; vaccines and breeding stock; (iv) using spare land in government experiment stations for commercial farming and seed production; and (v) charging loyalties on the use of agricultural technologies that are backed by adequate intellectual property rights. This will have to be backed by appropriate legislation.

Charges for activities in (i) and (ii) can be worked out following rates currently being used by private research institutions and commercial value of the activity to be undertaken. The treasury would need to forgo the revenue from these activities and allow the Foundation to use it for research without the Treasury reducing its contributions accordingly. Clearly a phasing-in of this procedure would be needed.

6.8.4 Levies and Cess

This would raise funds from stakeholders and/or associations through levies on commercial crops such as coffee and cotton. As such, it would encourage farmers to participate in setting the research agenda. An estimate of the potential revenue based on what growers presently pay can be worked out using percentages being used by private research institutions. Contract research could also include cost-sharing with private research organisations on, for example, livestock management for smallholder tobacco farmers.

6.8.5 Grants from Agribusiness, ADDs and Farmer Associations

This would be done by developing partnerships or collaborative research activities. The agribusiness sector is usually better at identifying opportunities for interregional and international trade but lacks the technical capacity to capitalise on this. Pharmaceutical, feed and agro-chemical companies may be interested in supporting near-market research. This contract research would be done through competitive research grants; whereby, the private sector could contract out research on specific products or crops for specific markets. Contracts with the private sector would offer an opportunity to increase the utilisation of the research facilities, but the sector would need to be assured that its support will deliver high quality research.

This would entail the ADDs having earmarked funds, probably from donors, for adaptive or near market research of particular relevance to the local problems as decided by farmers. The Foundation would support them in preparing research proposals and in developing the contracts for implementation.

6.8.6 Donors

The role of donors in the development and implementation of research programmes is very important. FANRR will, therefore, develop strategies to actively involve donors in funding research programmes, infrastructure development and technology transfer.

6.9 RESEARCH PROGRAMMES TO BE SUPPORTED

The Foundation would support priority programmes directly or by commissioning other research organisations or by a combination of the two.

6.9.1 Commissioned Research

One of the activities of the Foundation would be to commission research in areas where it has no sufficient capacity to effectively take such programmes to the university or private research organisations. The Foundation would then be responsible for the supervision, monitoring and evaluation of such commissioned research and be accountable to the stakeholders.

6.9.2 Contract Research Programmes

The Foundation would provide competitive grants to scientists or groups of scientists to undertake high priority research projects on a contract basis. Under this arrangement, the Foundation would ensure the formation of multi institutions and multi-disciplinary teams including support from social scientists and extension specialists. The rationale for selection of programmes for support by the Foundation would be clearly laid out and should be an agreed part of its Board policy. The rationale would include: (i) support for high priority aspects of government policy; agricultural diversification and poverty alleviation as examples; (ii) requirement for multi-disciplinary teams usually drawing on more than one department or institution. There is overwhelming evidence that several outstanding problems require such an approach yet it has proved impossible to form such teams under the present organisation. Research on livestock/crops, agricultural/forestry, water management/aquaculture are possible candidates for this kind of team work; (iii) where the research is of a long-term nature, support may be phased but with the understanding that the phases fit into a programme with a long term strategy; (iv) support for the "Development" side of "R&D" with the private sector. This would support "near market" development programmes in which one or more technologies ready for commercialisation can be supported; and (v) some limited amounts of high priority strategic research in collaboration with advanced scientific institutes from overseas. Such programmes would be designed on the basis of the highest priorities and could be phased in over a three-year period. The priorities would be based on specific and cross cutting commodities such as soil fertility, postharvest handling, processing and marketing, farm mechanisation, plant protection and irrigation and meteorology.

6.9.3 Core Research Programmes

The Foundation would support core research programmes to be implemented by its institutes based on agreed priorities on commodities and researchable areas. The core research programmes would cover researchable areas such as breeding, pest and disease management, crop or forestry management, animal husbandry and fish management.

6.10 MONITORING AND EVALUATION

Monitoring of ongoing research projects will be an essential function of FANRR and would involve a periodic review of research in progress, with emphasis on primarily the use of resources, management decisions for redesign or termination, and achievements. It would begin when funds are released and continue until the project has been completed or terminated. Evaluation is concerned with appraising the value or quality of research, whether it is proposed, ongoing, or completed. The implementation of M&E system should be viewed as an integral part of the

research system but research managers need to understand its value. It should not be something that is forced on managers as experience has shown that when the initiative for M&E comes from outside the organization, managers view it as something to be tolerated rather than something useful.

While M&E of donor supported research projects is quite common, there is little formal M&E of other research project and few evaluations of completed agricultural and natural resources research projects have been carried out in Malawi. Some of the reasons include laxity in the accountability requirements, unusually long duration of research projects and higher costs incurred in evaluating completed projects compared to other kinds of evaluations such as annual project reviews. Nevertheless, the Foundation would have to institutionalise M & E to ensure transparency and accountability in the whole research system. In line with this, FANRR also needs to develop mechanisms that ensure the utilisation of M&E information in the decision making process, for example, in staff assessment and promotions and research success. Effective M&E systems need to incorporate participatory research mechanisms and the involvement of other stakeholders including internal and external reviewers.

The newly introduced Medium Term Expenditure Framework (MTEF) budgeting system calls for M&E for its success. For many institutions at present, research monitoring for internal use is informal, and, hence not properly planned. In order to improve the M&E, the following key factors would be considered: (i) focus on key management and accountability needs; (ii) avoid over ambitious M&E objectives; (iii) think of M&E as a process that integrates decision making, planning, and implementation, not a series of disconnected activities; (iv) assign responsibilities for M&E and for follow-up action; (v) inform management and staff about the purposes, principles, and uses of M&E; (vi) plan an M&E system that fits the organizations' resources and needs; (vii) jointly plan, coordinate, and facilitate M&E activities in case of donor-funded projects to satisfy donor requirements and minimize disruption of research; (viii) use simple and practical methods to minimize time, cost, and paperwork; (ix) provide information on a timely basis for decision making; and (x) summarize M&E results for managers and present options for action.

Several methods will be used in FANRR to evaluate agricultural and natural resources research including: (i) checklists; (ii) scoring techniques; (iii) logframe analysis; (iv) benefit cost analysis; and (v) impact evaluations. The checklist approach is the most widely used because it is the least sophisticated, single and easiest to use. Nevertheless, it requires a considerable understanding of the research and development processes.

6.11 IMPACT ASSESSMENT

This is an evaluation of the effects of agricultural and natural resource research. Various kinds of effects can be assessed, including changes in yield, production, income, food security, social welfare, and the environment. *Ex-ante* assessments can help decision makers identify the most promising directions for future research. *Ex-post* assessments can extract lessons to improve the design of future research. Impact evaluation determines the longer-term effects of research and the extent to which research results have contributed to broader development goals, such as increased farm production, food self-sufficiency, or natural resource conservation. An economic impact evaluation can estimate the rate of return on a research investment several years after

research has been completed. These evaluations can be compared with *ex-ante* evaluations, where the expected outputs were projected during planning. Research organizations should conduct occasional impact assessments of selected research projects to demonstrate the benefits from research to policy makers. This assists in maintaining strong linkages among researchers, policy makers and end-users. The FANRR would, therefore, periodically carry out impact assessment exercises of outputs of the research projects.

However, undertaking an impact assessment can be expensive both in time and financial terms, hence, should be done only when the need is clearly defined. Its usefulness will depend on the quality of data and on how well research managers and policy makers understand it. Adoption studies are part of impact assessment. These studies trace the results of an innovation from research through networks of adopters and analyse the underlying patterns of adoption and use of the new practices/technologies. While it is desirable to carry out an impact assessment for the research system, its usefulness will depend on how the research managers and policy makers understand and make use of its findings. The studies should be based on real information needs assessment, and attention should be paid to the quality of data that affect the quality of the results or findings. The results and recommendations must be presented in a form that is meaningful to policy makers, politicians, farm managers, research scientists and end-users.

6.12 MANAGEMENT INFORMATION SYSTEM (MIS)

FANRR would need management information system for ongoing data collection and analysis system that will provide managers with timely information on research inputs, activities and outcomes. The management information system would contain information on personnel, budgets, research projects and physical facilities. The MIS would also be used to lobby for additional resources for research and influence policy reforms at national level while at institute level, it can be used to improve planning, programming and evaluation of the research system. Currently all research institutions in Malawi collect and keep data and records on personnel, finances, equipment and physical structures, and experiments; but such records are usually collected and kept by different people in different places and used for different purposes. There is little integration of such diverse information from various parts of the organization such that it can be used by research managers. Implementation of a Management Information System requires careful planning, starting with the information already available. Pilot schemes would be carried out in small units or parts of the organization. The pilot scheme would concentrate on careful designs of the system, paying attention to compatibility, coherence and collaboration so that unnecessary data collection is avoided.

CHAPTER SEVEN

IMPLEMENTATION OF THE RESEARCH MASTER PLAN

7.1 INTRODUCTION

The world today is dependent on Science and Technology as a catalyst for sustainable socioeconomic development. However, for the science and technology to have the much needed impact, there is need for timely generation and dissemination of demand driven technologies to the end-users. The current research system is unlikely to respond quickly to technological demands because: (a) it is fragmented into two ministries, several departments, the University and private research institutions making it difficult to use available human and financial resources and facilities efficiently; and (b) funding for research is unstable and inadequate leading to poorly implemented research programmes, delayed release of technologies and an erosion of staff morale. The existing weakness of the research system necessitated the proposal for the establishment of FANRR (Chapter VI) to ensure a well coordinated, efficient and effective research system.

7.2 IMPLEMENTATION

In order to revitalise the research system, the master plan has highlighted the following areas that require implementation. These are: - establishment of a new effective management system with a new organisational structure; strategies for human resource development; developing sustainable funding mechanisms; implementation of priority research programmes; mechanisms for monitoring and evaluation strategies for technology transfer; enabling policy for research and production strategies.

The details of issues recommended for implementation are outlined in the following sections, and the logical framework for an implementation plan is summarised in Table 7.1.

7.2.1 Establishment of an Effective Management System

The government should consider setting up a **Commission for the Establishment of the Foundation for Agriculture and Natural Resources Research (COFANRR).** The Commission should be charged with the responsibility of setting up FANRR. NRCM or NCST should prepare terms of reference (TOR) for the Commission. The TOR should, among other responsibilities, include human resource management, multidisciplinary coordination and management of research programmes and funding mechanisms for FANRR. The TOR should also define the time frame for accomplishing the establishment of FANRR.

7.2.2. Human Resource Development

The objective of this plan is to improve human capacity and performance following the successful restructuring of the research system and programmes, and conditions of service.

Presently, government plans to limit the size of the public sector indicating that there cannot be any expansion in the overall number of posts for research scientists in the agricultural and natural resources research sector. Thus, any additional posts for new areas of high priority will have to come from existing positions. Redeployment of scientists is, therefore, an essential element for implementing the priority research programmes, an area that has negated any past attempts to change priorities of the research system.

The human resource redeployment and reassignment require substantial reorientation and retraining. Thus, a training needs assessment and human resource training plans, mainly for short-term courses must be given precedence. Study tours, internships and attachments to regional and international agricultural and natural resources research centres could form the major part of the retraining programme. In addition, there is need to strengthen institutional capacity for specific subject areas/commodities for the effective implementation of the priority research programmes.

Despite describing priorities on a commodity and factor of production basis, research must be conducted with a farming systems perspective that requires multi-disciplinary team approach. Such teams should include subject matter specialists, socioeconomic and extension experts to cover beneficiary-researcher linkages. The socioeconomic and extension expertise must be part of the research team from planning to the execution of the research. However, the provision of this expertise might have to be on contract basis to take care of institutional human resource imbalances in the system.

7.2.3 Development of Sustainable Funding Mechanism for Research

COFANRR once formed should (i) prepare necessary documentation for the creation of the parliamentary grant; and (ii) conduct an investment appraisal of potential income generating activities which could include charging levies or cess on some commodities to support research and technology in those commodities. It should also set up a policy for consultancies and develop revenue sharing mechanisms from such consultancies with employees.

7.2.4 Implementation of Priority Research Programmes

The priorities for commodities and researchable areas have been established in Chapter V based on identified constraints to productivity. An analysis of the established priorities reveals that three to four research themes cover the major constraints to productivity (Table 7.2). Where the commodity is closely supported by regional and international research effort, emphasis will be on management and adaptive research. Low priority commodities are given the least attention in resource allocation and effort would dwell on importation of technologies and doing verification trials or adaptive research.

Implementation of the research programmes is dependent on the available human resources in government, private research institutions, the University of Malawi, and International Agricultural Research Centres. The information in Table 7.2, therefore, gives an outline of the high priority commodities and research themes, research focus, critical staff requirement and responsible organisation or institution.

While awaiting the establishment of FANRR, research managers should begin to implement high and medium research priorities as outlined in this plan and allocate resources to the highest priority commodities and researchable areas first followed by the medium priority. Resources to the low priority commodities and researchable areas are allocated based on special need and anticipated large gains in productivity.

Research programmes need to be implemented at the four levels namely core research, contract research, commissioned research and on-farm/adaptive research/verification trials.

7.2.4.1Core research: All long term research like breeding and agronomic trials will be the mandate of the FANRR.

7.2.4.2 Contract research: All constraints for which FANRR does not have the ability and capacity to conduct research should be contracted out to institutions and individuals that have the capacity to implement such programmes.

7.2.4.3 Commissioned Research: All projects that are supposed to be implemented during a short time to generate the required results be commissioned to organisations and institutions who have the capacity to do so. Furthermore, FANRR would be required to conduct research assigned to it by the private organisations, government and donors.

7.2.4.4 Adaptive Research/On-farm Research/Verification trials: All technologies which require verification and adapting to local situations are conducted by the institution as adaptive research, on-farm research or verification trials. The end-user must fully participate in the implementation of such trials.

Implementation of the Core research, Contract research, Commissioned research and Adaptive research demand substantial numbers of scientists. However, the available scientists as indicated in Chapter III are adequate to implement an effective programme if contracting arrangements, staff redeployment and reassignment, reorientation and retraining programmes are done effectively.

7.2.5 Monitoring and Evaluation of Research Programmes

FANRR should, therefore, develop M&E systems that encompass various aspects including the following:

7.2.5.1 Project approval mechanisms: FANRR should set up technical committees or subcommittees responsible for appraisal and approval of research programmes. The committees will develop specific guidelines for the preparation of research project proposals; and clear criteria for reviewing and assessing the proposals, for example, through the use of a logical framework.

7.2.5.2 Quarterly and annual reports: FANRR should ensure that scientists prepare quarterly and annual reports on their research programmes. This will ensure accountability by the scientists and also make available documented information on their activities. These reports will be followed up closely by the relevant committees and will be made a condition for continued funding of research programmes. FANRR should standardise formats, pertinent to their activities, for use by scientists.

7.2.5.3 Periodic visits to research sites: Visits to project implementation sites are very important as they confirm implementation of projects. FANRR should, therefore, set up monitoring teams to visit project sites once or twice in a season and observe implementation progress and constraints. The teams should comprise a wide range of stakeholders equipped with appropriate evaluation criteria. The teams should produce reports of their visits as well as develop a set of recommendations for further action.

7.2.5.4 Technology reporting fora: Individual institutes should set up periodic fora at which their scientists present results to stakeholders. The Foundation should, in turn, set up national fora at which scientists in agriculture and natural resources present near market technologies to stakeholders for information and feedback purposes.

7.2.5.5 Impact assessment: Stakeholders often assess effects of technologies based on their impacts. As resources become more limiting, FANRR will need to make justifications for continued support and funding, and positive impact assessment data could help achieve this. Research institutes should, therefore, conduct impact assessments of their technologies as a justification for their continued existence. To achieve this, institutions will need to collect baseline information as well as technology indicators on which both *ex-ante* and *ex-post* impact assessments should be based.

7.2.6 Strategies for Technology Transfer

The success of any research programme is measured by the adoption rate of its technologies by the intended users. To achieve good success rates in technology adoption, developers of technology must attach strategies for transfer, adoption and application. The existing mechanisms for technology transfer are weak, not effective and innovative enough resulting research is failing to have the desired impact on productivity.

In order to improve the transfer of technology from research and feedback to research, the FANRR should develop effective linkages for technology transfer and communication networks by establishing a research-extension liaison unit in each institute, establishing documentation centres at strategic locations such as ADD headquarters, thus strengthening and broadening outreach programmes.

Specifically FANRR should gather, process and disseminate relevant information on technologies, coordinate information transfer among stakeholders, broaden participation at field days by conducting research station and on-farm field days, hold public seminars, annual scientific conferences and workshops, and utilise alternative forms of information dissemination such as print and electronic media.

7.2.6.4 Strengthening the technology clearing committee, which will appraise and approve annually all technologies developed.

7.2.6.5 Identification of potential end-users who will act as early adopters, evaluators and trainers.

7.2.6.6 Identification of highly skilled communication personalities, who can work with researchers and extension staff in re-packaging research results into messages and fact sheets for end-users.

7.2.6.7 Identification of end-users and target those with the will and capacity to adopt the technologies.

7.2.6.8 Improvement in collaboration with the agribusiness sectors such as MIPA and MEPC with the aim of developing business ventures involving application and commercialisation of technologies.

7.2.7 Policies

Government policies have impact, not only on agriculture and natural resources productivity, but also on the performance and output of research. There are certain policies and policy changes that are required for research to gain ground. Areas that government needs to give consideration include:

7.2.7.1 Government policies that favour commercialisation of smallholder agriculture including, group dynamics and mobilisation, out grower schemes, concentration into specialised commodities such as spices and flowers. Such policies will enhance technology uptake as there will be areas of demand from groups whose capacity will have been improved.

7.2.7.2 Government policies on research that encourage the development of technologies for both the smallholder and commercial sectors. Current policies emphasize smallholder technologies and this has resulted in reduced impact. There is growing realisation that food self-sufficiency and increased agricultural production cannot be achieved by developing the smallholder sector alone because the capacity of smallholders is limited. There is need to balance subsistence and commercial farming.

7.2.7.3 The issue of Intellectual Property Rights (IPR) is gaining ground not only in international protocols but also in Malawi. There is currently no clear policy on this in Malawi, a situation that has led to loss of locally bred varieties to commercial organisations without due recognition to the relevant scientists. This in turn has led to frustration, especially among breeders. It is, therefore, crucial that NRCM pushes for IPR policies to protect locally bred materials and provide motivation to scientists.

7.2.7.4 Integration of research policies in overall government plans and strategies: This integration is in most cases lacking and has led to policy contradictions and emphasis on certain policies only. Government needs to integrate research policies with other micro and macro and socioeconomic policies.

7.2.8 Production Strategies

The Master Plan has outlined some production strategies for various commodities (Table 7.3). The achievement of the desired production levels of any commodity will not just depend on technologies developed by research, but also for government to create an enabling environment. Operationalising the stated strategies is the key to increased productivity. For example, maize production in the country will not increase unless policies that promote the use of improved technologies like certified seed, fertilizers and proper land use practices are implemented. The Plan is not an end in itself, but a means for achieving sustainable agricultural and natural resources production.

Table 7.1 Logframe for the Implementation of the Malawi Agricultural and Natural Resources Research Master Plan

ISSUES	OBJECTIVES	STRATEGY	ACTIVITY	OUTPUT	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	LEAD AGENCY	ASSUMPTION
Poor research systems	Establish an effective research system	Creation of the Foundation for Agricultural and Natural Resources Research (FANRR)	Form a commission for the establishment of FANRR (COFANRR)	COFANRR formed	COFANRR in place by Dec. 1999	Reports COFANRR office	NRCM (OPC)	Master plan adopted by September 1999
				-FANRR formed	Board in place by December 2000	Reports	COFANRR	Act of Parliament passed Finances secured from Government /Donors
					FANRR secretariat in place	Reports	FANRR	Research Staff in place August 2000
					FANRR institutes in place	Reports	FANRR	
						Progress Reports	FANRR	
Low productivity of human resources	To improve human resource capacity and performance	Development of an attractive career structure	Develop criteria for a staff appraisal	Staff appraisals criteria developed	Staff appraisals criteria in place	Reports	FANRR	
		-Development of an attractive remuneration and incentive packages	Develop conditions of service and job descriptions	Conditions of service and job description developed	Conditions of service and job descriptions in place	Reports	FANRR	
		Staff appraisal system	Develop a career structure	A career structure developed	A career structure in place	Reports	FANRR	
		Training of staff	Conduct training needs assessment	Training needs assessed and documented	Training needs in place	Reports	FANRR	FANRR in place

ISSUES	OBJECTIVES	STRATEGY	ACTIVITY	OUTPUT	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	LEAD AGENCY	ASSUMPTION
Insufficient financial resources	To secure sustainable funding for research programmes	Source funds from the Science and Technology vote	Prepare work plans and budgets	Work plans and budgets submitted	Budget approved and Departmental warrant issued	Funds flowing, work plan activities undertaken	FANRR	Resources available and parliament ratifies budget estimates
		Sourcing funds from donors and private sectors	Prepare proposals for funding by donors and the private sector	Proposals for donors prepared Proposals for levies and cess prepared	Proposals for funding in place by December 2001	Reports	FANRR	Donor/private sector supports proposals
		Commercialisation of some research services	Conduct an investment appraisal of potential income generating activities Institute revenue sharing mechanisms with members of staff involved in consultancy	Investment appraisal formulated Guidelines for consultancies developed	The investment appraisals available Guidelines for consultancies in place by December 2000	Investment appraisal reports Guidelines	FANRR (Institutes)	
			Charge for specialised services	Schedule for fees and charges for specialised services developed	Schedules for fees and charges in place by Dec. 2000	Schedule reports	FANRR (Institutes)	

ISSUES	OBJECTIVES	STRATEGY	ACTIVITY	OUTPUT	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	LEAD AGENCY	ASSUMPTION
Poor prioritisation of research programmes	To conduct demand driven research	Prioritisation criteria for research programmes	Prioritise research programme	Research programmes prioritised	List of research priority programmes in place	Reports of lists of priorities	FANRR	Priority programmes agreed upon by stakeholders
			Match available resources with identified priorities.	Available resources matched with identified priorities	Priority programmes with matching resources in place	Reports	FANRR	
			Implement prioritised resource programmes	Priority research programmes implemented	Implementation plans in place	Implementation progress report	FANRR	

ISSUES	OBJECTIVES	STRATEGY	ACTIVITY	OUTPUT	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	LEAD AGENCY	ASSUMPTION
Inadequate appraisals of research progress	To improve output and productivity of research programmes	Establishment of an effective and efficient M&E system	Develop transparent criteria and indicators for research activities and outputs	M&E criteria developed	M&E criteria in place by Dec. 2000	Reports	FANRR	
			Develop data bases and bank	Data banks developed	Data bank in place	Reports/Data banks	FANRR	
			Conduct *ex-ante* and *post ante* impact assessments	*Ex-ante* and *post-ante* M&E carried out	Impact assessment in place	Impact assessment	FANRR	
			Develop an M&E procedure	M&E procedures developed	Procedures in place	Guidelines and procedures report	FANRR	
Weak mechanisms for technology transfer	To improve linkage between developers and end-users of technology	Development of an effective linkage mechanism	Use participatory approachesin defining research problems and technology transfer	Participatory approaches utilised	Participatory institutions in place	Reports	FANRR	
			Utilise a wide range of technology dissemination mechanisms	Various technology dissemination mechanisms utilised	Increased stakeholders' participation	Reports on stakeholders participation	FANRR	
					Various dissemination mechanisms in place	Reports on field days, number of data bases and banks	FANRR	
			Establish a research extension liaison unit	Extension liaison units established	Extension liaison units established Level of attendance in terms of numbers	Research/Extension Liaison office	FANRR	

ISSUES	OBJECTIVES	STRATEGY	ACTIVITY	OUTPUT	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	LEAD AGENCY	ASSUMPTION
Lack of enabling policies for a productive research system	To initiate macro-and micro policy reforms for improvement of the research system	Integration of macro and micro-economic policies with those of research	Review current policies and strategies and make necessary amendments	Research policy integrated in government plans	Enabling research policy in place	Policy document reports	FANRR (Institutes)	FANRR consulted in government policy; review and foundation.

Table 7.2 Priority research programmes, staff requirements and responsible institutions

Group & Commodity	Research Themes	Research Focus	Staff Requirement (critical mass)	Responsible Institution
Cereals Maize	-Soil fertility & plant nutrition	-Inorganic fertilisers -Organic fertilisers	3x Plant Breeders 4x Agronomist 1x Irrigation Agronomist 1x Soil Scientist 0.5x Nutritionist 0.5x Entomologist 0.5x Socioeconomist 1x Pathologist 1x Mechanical Engineer	FANRR
	-Crop improvement	-Flint OPV's and flint hybrid varieties		
	-Crop management	-Chemical and mechanical weed control & fertiliser management		
	-Labour saving technologies	-Farm mechanisation for land preparation		
Rice	Crop improvement	-High yielding, scented varieties		
	Irrigation & water management	-Water management and irrigation frequency		
	Soil fertility & plant nutrition	-Inorganic fertiliser management		
	Pests & diseases	-Bird control -Rice blast disease control		
Sorghum & Millet	Crop improvement	-Dwarf, high yield, hard grain		
	Crop management	-Production technologies		
	Pests & diseases	-Birds control		
	Processing, & utilisation	-Recipes& utilisation		

Group & Commodity	Research Themes	Research Focus	Staff Requirement (critical mass)	Responsible Institution
Legumes and oil seeds Beans	Crop improvement	-High yielding, disease resistant & early maturing varieties	3x Plant Breeders 3x Agronomists 2 x Pathologist s 1x Food Scientist 1x Mechanical Engineer 0.5x Nutritionist 0.5x Socioeconomist 0.5x Entomologist	FANRR, BCA
	Crop management	-Plant population & fertiliser management		
	Pests & diseases	-IPM Technologies		
	Post harvest technologies	-Cooking technologies and recipes		
Groundnut	Pests & diseases	-Rosette, leaf spot control -IPM		
	Crop management	-Agronomic practices		
	Crop improvement	-High yield good oil content & seed size		
	-Post harvest handling	-Harvesting and shelling		
Pigeon Pea, Soyabean, Sunflower & Cowpea	Crop improvement	-High yielding, early maturing & disease resistant		
	Pests & disease	-IPM strategies		
	-Crop management	-Agronomic technologies		
	Processing & utilisation	-Recipes, processing & utilisation		

Group & Commodity	Research Themes	Research Focus	Staff Requirement (critical mass)	Responsible Institution
Monogastric Livestock Chickens	Feeds & nutrition	-Lowcost, high quality feeds		FANRR BCA
	Poultry management	-Improved housing		
	Rapid stock multiplication	-Use of mini-incubator technology at village level		
	Parasites & diseases	-Disease control, disease resistant breeds		
Pigs	Pig management	-Improved housing		
	Breed improvement	-Upgrade local pigs		
	Feeds & nutrition	-Low cost rations		
	Parasites & diseases control	-Traditional medicines & practices in disease control.		
Ruminant Livestock Cattle	Feeds, pastures & nutrition	-High quality, low cost feed rations -Pasture & forage management for extended feed supply & quality	3x Breeders 2x Livetock Husbandry Specialist 2x Nutritionists 2x Dairy Technologists 1x Veterinarian 1x Socioeconomist	FANRR BCA
	Management practices	-Improved housing and disease and tick control -Vaccines, traditional techniques for ticks & diseases control. -Diagnostic tests for cattle health problems		
	Breed improvement	-Increase animal size & population		
	Milk production, processing & utilisation	-Low cost -Processing technologies		
	Rapid stock multiplication	-Novel technologies for rapid stock multiplication		
Goat & Sheep	Breed improvement	-Upgrading the size of local animals and population		
	Management practices	-Reduce high mortality rates in kids & lambs		
	Rapid stock multiplication	-Selection for twinning		
	Feeds, pastures & nutrition	-Improve management of feeding systems for optimum use of browse and crop		

Group & Commodity	Research Themes	Research Focus	Staff Requirement (critical mass)	Responsible Institution
Industrial & Cash Crops				
Tobacco	Crop improvement	-High yielding & leaf qualities -Tolerance to drought, diseases & insects	2x Plant breeders 1x Soil Scientist 1x Agronomist 1x Mechanical Engineer 1x Pathologist 1x Nematologist 1x Economist 1x Seed Physiologist 1x Biometrician 1x Entomologist	ARET
	Pest and diseases	-IPM strategies		
	Soil fertility & plant nutrition	-Inorganic fertilisers		
	Crop management	-Effective crop rotation regimes -Economic weed control technologies -Dry planting technologies		
	Post harvest technologies	Leaf drying technologies		
Cotton	Pests & diseases	-Effective IPM technologies -Effective chemical application	1x Plant Breeder 1x Agronomist 1x Processing Engineer 2x Entomologists	FANRR, ARET
	Crop improvement	-High yielding, pests & disease resistant		
	Crop management	-Plant populations to optimise production.		
Sugarcane	Irrigation & water management	-Water management & application frequency	1x Plant Breeder 1x Agronomist 1x Soil Scientist 1x Irrigation Agronomist 1x Pathologist	ILLOVO, FANRR
	Crop management	-Cultural practices for chewing sugarcane		
	Crop improvement	-High yielding & high sugar content		
	Soil fertility & plant nutrition	-Fertiliser management technologies		
Tea	Crop improvement	-High yielding tea clones with high leaf quality & resistant to insect pests.	1x Plant Breeder 1x Horticulturist 1x Soil Scientist 1x Agronomist 1x Irrigation Agronomist 1x Processing Engineer 1x Pathologist 1x Entomologist 1x Economist	TRF
	Crop management	-Nursery management for clonal tea -Vegetative propagation.		
	Irrigation & water management	-Water management & supp. Irrigation		
	Soil fertility & plant nutrition	-Inorganic and organic fertilisers		
Macadamia, Cashew & Coffee	Crop management	-Fertiliser management	1x Horticulturist 1x Agronomist 1x Post-harvest Technologist 1x Pathologist 1x Entomologist 0.25x Soil Scientist	TRF, FANRR
	Crop improvement	-Evaluate clones for adaptability, high yield & quality.		
	Pests & diseases	-IPM strategies		
	Post harvest handling	-Post harvest handing of nuts and processing		
Root & Tuber crops Cassava,Sweet & Irish potato	Pests & diseases	-Pests & diseases control	2x Plant Breederss 1x Agronomist 1x Horticulturist 1x Processing Engineer 1x Pathologist 1x Entomologist 0.5x Food Scientist	BCA, FANRR
	Post harvest technologies	-Storage structures, processing techniques recipes & alternative industrial products.		
	Crop improvement	-High yielding resistant to disease & pests		
	Plant propagation technologies	-Seed production & quality		

Group & Commodity	Research Themes	Research Focus	Staff Requirement (critical mass)	Responsible Institution
Vegetables Exotic (Tomatoes, Cabbage, Onion & Carrot)	Pests & diseases	-IPM strategies	3x Horticulturists 1x Irrigation Agronomist 1x Postharvest Technologist 2x Pathologists 1x Entomologist 1x Nutritionist/Food Scientist 0.25x Soil Scientist	FANRR, BCA
	Irrigation & water management	-Water management and application frequency		
	Post harvest technologies	- Packaging, grading & preservation technologies		
	Crop management	--Seed production & quality & OPV's		
Indigenous (Pumpkin & Amaranthus)	Crop management	-Plant population and fertiliser management		
	Crop improvement	-Variety selection and testing		
	Post harvest handling	-Processing and preservation		
	Seed production	-Seed production and quality control		
Mushroom	Seed production and quality	-Spawn production.		
	Crop management	-Composting & cultivation of both indigenous & exotic mushroom.		
	Pests & diseases	-Disease control in mushroom houses		
	Post harvest handling	-Storage of mushrooms & processing		
Spices (Chillies, Paprika, Ginger & Tumeric)	Crop improvement	-Variety development and selection		FANRR
	Crop management	-Fertiliser and nursery management		
	Post harvest technologies	-Storage, grading & preservation techniques		
	Soil fertility and plant nutrition	-Inorganic fertiliser management		
Fruits (Bananas, Plantains, Mango, Citrus, Pineapple & Guava)	Plant propagation & quality	-Vegetative propagation and nursery management	1x Horticulturist 1x Postharvest Technologist 1x Pathologist 0.25x Soil Scientist	BCA FANRR
	Crop management	-Fertiliser and population management		
	Pests & diseases	-IPM strategies		
	Post harvest technologies	-Grading, packaging & preservation and juice production		
Flowers	Irrigation & water management	-Water management & irrigation frequency	1x Horticulturist 1x Post-harvest Technologist 1x Pathologist 1x Entomologist	FANRR, BCA
	Plant propagation	-Multiplication of plants		
	Crop management	-Insect pest & disease control methods including nutritional requirements of plants		
	Post harvest technologies	-Storage & transportation of flowers and plants		

Group & Commodity	Research Themes	Research Focus	Staff Requirement (critical mass)	Responsible Institution
Forests & Environment	Management practices	Under sowing forestry land with grass species Fertiliser application to young forests	1x Silviculturists 1xx Seed Physiologist 1x Tree Breeder 1x Entomologist 1x Pathologist 1x Forest Management 1x Botanist 1x Environmentalist 1 x Socioeconomist 1x Land Husbandry	FANRR
	Seed production & quality	Seed collection from superior trees		
	Species improvement	Study in-situ and ex-situ conservation of seed germination studies		
	Pests & diseases	-IPM approaches to pest & disease control		
	Deforestation control & prevention	Developing alternative sources of energy and construction materials		
	Land degradation control & prevention	Rehabilitation of degraded areas		
	Sustainable utilisation of natural resources	Sustainable utilisation studies		
	Water pollution control & prevention	Effects of agro-chemicals, green house gases and climate change		
Fisheries Capture fisheries	Management strategies	-Management and nursery of spawning habitats; closed season, commercial fishing system -Stock assessment -Fish biology, Aquatic Biology	2x Fish Biologist 1x Ecologist/ Limnologist 1x Post-harvest Technologist 1x Gear Technologist 1x Marine Engineer 0.5x Socioeconomist 1x Fish Breeder 1x Boat Engineer	FANRR
	Fishing methods & practice	-Efficient fishing methods, gear, vessels & appropriate engine horse power		
	Post harvest technologies	-Effective drying of fish using fire drying kilns or solar power/heat -Fish preservation and processing		
	Fishing vessels & gear	-Design, fabrication and testing of boats and nets		
Aquaculture Fisheries	Fingerling production & management	-Production of fingerlings and sustainable transportation systems to increase survival rate	1x Fish Breeder 1x Fish Nutritionist 2x Aquaculturist 1x Geneticist 1x Socioeconomist	ICLARM, BCA
	Feeds & fish nutrition	-Nutritional requirements of fish in ponds & rations based on local ingredients -Feed formulation		
	Production systems	-Integrated fish farming, commercial -Aquaculture systems, fish stocking ratios, densities		
	Fish genotype improvement	-Screen, breed & select suitable local fish species for aquaculture		

Table 7.3 Production strategies by commodity

Cereals *Maize*	1)	Liberalize the price of maize completely to make production of maize profitable
	2)	Encourage farmers to use high yielding composite and hybrid varieties and recommended fertilisers. Fertiliser companies must be encouraged to repackage fertilizers into smaller and affordable packages of 10, and 25 kgs bags in addition to the 50 kg bags.
	3)	Intensify the setting up of farmer clubs for purposes of accessing loans for inputs and improved technologies. At the same time, efforts should be made to set up an incentive scheme to encourage estate production of maize to promote food security.
	4)	Intensify efforts towards the production of dimba or irrigated maize in all suitable areas and ensure that improved technologies are made available to maize farmers.
	5)	Set up smallholder seed production schemes for composites to ensure wide and timely availability of seed to as many smallholders as possible.
	6)	Encourage farmers to use good cultural practices such as early land preparation, dry planting, fertilizer application and timely weeding.
Rice	1)	Promote the production of rice in schemes under rainfed and irrigated conditions and in dambos alongside the use of improved varieties that are high yielding, scented and with hard endosperm.
	2)	Monitor and control the free movement of seed between schemes to limit the spread of diseases such as rice blast.
	3)	Promote the marketing of improved rice seed.
Sorghum	1)	Promote increased production and use of sorghum as a security crop in the traditional sorghum growing areas such as the Shire Valley.
	2)	Promote the production of improved cultivars that are white grained, earlier maturing than maize and high yielding through, among other things, the provision of seed.
Grain legumes and oilseeds	1)	Encourage both smallholder and estate farmers to increase production using improved technologies and encourage the marketing system and processing enterprises to play a part in the production cycle.
	2)	Set up seed multiplication schemes involving both smallholder and estates in order to ensure availability of improved seed varieties and undertake deliberate efforts to promote production of grain legumes in rice irrigation schemes.
Industrial & cash crops *Tobacco*	1)	Continue issuing increased quotas for both smallholders and estates to grow and market burley tobacco, encourage the participation of more buyers and processors.
	2)	Boost production of oriental tobacco by encouraging buyers to contract directly with farmers at the same time ensuring that farmers are not exploited.
	3)	Increase crop management by smallholder farmers especially the use of certified seed, disease control and fertilizer application and closed season by uprooting tobacco stalks as soon as harvesting is completed.

Tea	1)	Make concerted effort to expand existing markets and develop new markets particularly in Eastern Europe.
	2)	Expand production on large estates and smallholder farming through replanting old and unsatisfactory tea varieties with new high yielding and quality clonal materials.
Sugar Cane	1)	Expand production at both Nchalo and Dwangwa estates, including the smallholder schemes and also open up new land for smallholder schemes near the existing estates.
Cotton	1)	Encourage farmers to observe the closed season for cotton and train farmers in scouting techniques and strict spraying regimes in order to reduce pest incidences.
	2)	Ensure the production of certified seed by contracting farmers to grow seed
	3)	Encourage buyers and ginners to ensure that there are no varietal admixtures in seed cotton through separation of types or varieties at processing.
Macadamia	1)	Promote the production of macadamia through targeted smallholder schemes in suitable areas such as Mwanza and Viphya plateaux; and develop outgrower schemes around the existing processing plants in Thyolo and Nkhata Bay.
	2)	Encourage the production of macadamia from approved clones using only vegetatively propagated trees to ensure uniformity during processing and to maintain competitiveness on the export market.
	3)	Develop nurseries for mass production of vegetatively propagated plants for supply to smallholder and estate farmers.
Additional general strategies for industrial crops	1)	Promote the liberalisation of cash crop production and the removal of restrictions on the production of the traditional cash crops to allow more smallholder participation.
	2)	Ensure that farmer organisations are efficient and providing the required services to farmers for improved yields and quality, and enforce regulations and policies regarding cash crop production, marketing and processing.
	3)	Improve the local and international marketing of cash crops by encouraging a transparent and fair marketing system including the extension of the auction system for paprika and cotton.
	4)	Encourage farmers to use certified seed and use plant material of high yielding varieties that have proved adaptable to the local environment together with improved technologies
	5)	Intensify the setting up of farmer clubs in the production of cash crops for the purposes of accessing loans for improved technologies; and enforce the use of soil and water conservation measures such as contour ridging, planting vetiver grass on marker ridges and water harvesting techniques.
	6)	Encourage the development of out grower schemes in areas where most cash crops are established and promote contracting out where buyers enter into agreements with growers in certain crops.

Vegetables	1)	Promote the specific ecological production of vegetables for export to the European markets by both smallholder and commercial farmers targeting the early part of the European winter.
	2)	Promote the local production of certified seed of known high performance varieties of cabbage, tomato and onions including pumpkins to reduce dependence on imported seed.
	3)	Organise farmers into clubs or associations for purposes of accessing loans and marketing
	4)	Encourage off season production that is complemented with appropriate processing facilities for excess vegetable produce including puree and juices.
	5)	Provide technologies and training to farmers on post harvest handling like grading, packaging, shipment and establish central collection points where post harvest handling facilities or infrastructures can be provided.
	6)	Encourage the establishment of special vegetable wholesale and retail market outlets (including auction floors) to promote interaction between buyers and sellers and afford the growers access to a marketing system for their produce.
Fruits	1)	Encourage the establishment of nurseries for the vegetative multiplication of planting material by farmers and entrepreneurs to ensure the availability of improved fruit plants.
	2)	Promote the production of fruits by using improved high yielding and quality varieties and improved production technologies including planting, fertilisers, pruning, harvesting and post harvest handling techniques.
	3)	Encourage the formation of cooperatives, associations and clubs for purposes of easy transportation, distribution and organised marketing of fruits for local and international markets targeting specific fruit types such as mangoes, citrus, banana and pineapple.
	4)	Promote the production of fruits by both commercial and smallholder farmers for export through concentrated production in specific areas e.g., Tangerines in Mwanza; pineapples in Mulanje; oranges, grapefruit and mangoes in the Shire Valley and lakeshore areas.
	5)	Encourage the processing and use of fruits through cottage industries for the processing of juices, pickles and other products.
	6)	Ensure an effective and economic control of insect pests and diseases in orchards through chemical sprays, biological control, and other IPM strategies.
Spices	1)	Promote the production of chillies, paprika, ginger and turmeric by smallholders on contract to buyers and encourage the formation of co-operatives by farmers and strengthen MASH so as to accumulate adequate tonnage for the penetration of the export market.
	2)	Promote the use of improved high yielding varieties and improved production technologies including time of planting, fertiliser use, harvesting, and better post harvest handling procedures including grading, packaging and the setting up of handling sheds in targeted production areas.
	3)	Encourage the development of cottage industries to add value to spices through processing into various products and by products.
Ornamental crops	1)	Promote the ornamental plants industry and formulate policy guidelines on the use of open space in the urban and district centres in Malawi.
	2)	Organise and train smallholder farmer cooperatives to cultivate cut flowers for the export market.
	3)	Develop nurseries for supply of ornamental plants to the communities.

Root and Tuber crops	1)	Promote the consumption of cassava and potatoes as food security crops in all parts of Malawi.
	2)	Encourage the multiplication of recommended varieties of cassava and potatoes by farmers, NGOs and the commercial sector to ensure the availability and accessibility of planting materials to farmers.
	3)	Promote the processing of cassava and potatoes into various value added products and encourage their utilisation at household level. Emphasis should be on developing technologies for processing into flour and other recipes as by products.
	4)	Promote IPM control measures for major insect pests and diseases, especially CMVD, mealy bug, and green spider mite in cassava and the weevil in potatoes.
Livestock *Monogastric animals*	1)	Revitalise the programme to improve local chickens by introducing the Black Australorp and encourage farmers to keep improved breeds, eg., Large White or crossbreeds at village level.
	2)	Expand capacities of incubators and breeding centres for chickens and pigs respectively to ensure adequate supply of day old chicks, pullets and piglets by encouraging farmer-based hatcheries or incubators and breeding centres.
	3)	Encourage the formation of co-operatives for easy accessing of loans for monogastrics.
	4)	Encourage the estate sector to expand chicken and pig production for eggs, meat and pork, respectively.
Ruminant animals	1)	Upgrade indigenous breeds by crossing with Brahman, Holsteins, Dorper and Boer to improve the size, meat and milk production potential.
	2)	Improve pasture and forage conservation techniques to maintain quality and for extended feed supply.
	3)	Improve the management of parasites and diseases.
	4)	Encourage the establishment of co-operative mini-dairies and meat processing plants in rural areas for improved marketing of ruminant by-products.
	5)	Encourage the private sector, in general, to get involved in commercial animal production.
	6)	Facilitate the efficient delivery of animal health and husbandry services.
Fisheries *Capture fisheries*	1)	Introduce and enforce co-management of fish resources in all communal water bodies for sustainable use and conservation of fish.
	2)	Ensure strict observation of the closed season and other management practices that involve the private sector and community participation for proper policing to avoid over exploitation of fish resources.
	3)	Promote proper environmental conservation practices to reduce the destruction of spawning habitats and introduce farmer based handling and processing technologies.
Aquaculture Fisheries	1)	Improve education and extension services for fish pond sites selection, and management of fish ponds and pond fish including feeding regimes.
	2)	Empower aquaculture farmers financially and promote farmer based fingerling production within communities.
	3)	Propose integrated agriculture/aquaculture farming techniques through optimum use of small water bodies.
	4)	Construct community dams on major rivers for stocking fish.

Forestry	1)	Improve the conservation and control of woodlands on private and customary land, national parks, forest, game reserves and protected hillslopes.
	2)	Provide incentives to local communities, NGOs and the private sector to afforest specific bare or fragile soils including eradable areas and make efficient use of available forestry resources.
	3)	Introduce appropriate technologies for silviculture management and multiple land-use system for sustained wood production by the private sector and local communities.
	4)	Initiate policy reforms to reduce the price of electricity and paraffin so that these are used as source of energy for cooking instead of firewood.

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ANNEXES

ANNEX 1 TERMS OF REFERENCE FOR THE PREPARATION OF THE MALAWI AGRICULTURAL AND NATURAL RESOURCES RESEARCH MASTER PLAN

1.0 INTRODUCTION

1.1 One of the mandates of the Agricultural Sciences Committee is to prepare a National Agricultural and Natural Resources Research Master Plan. This master plan should outline strategies to meet the challenges in the Agricultural and Natural Resources Sectors. The Master Plan would also ensure that Agricultural and Natural Research priorities on all commodities are set and are consistent with the country's development policies, that they are demand driven, address the needs of the resource poor farmers and that it ensures sustainable utilisation of the country's natural, financial and human resources.

1.2 Several institutional research programmes will be part of this master plan and these include the following institutions:-

(a) Department of Agricultural Research (DAR)
(b) Department of Animal Health and Industry (DAHI)
(c) Dept. of Agricultural Extension and Training (DAET)
(d) Human Food and Nutrition Unit (DAET)
(e) Land Resources Conservation Branch (LRCB)
(f) Forestry Research Institute of Malawi (Forestry Department) (FRIM)
(g) Department of Irrigation
(h) Department of Fisheries
(i) Department of Meteorology
(j) Centre for Social Studies
(k) University of Malawi
(l) Malawi Industrial Research and Technology Development Centre (MIRTDC)
(m) Tea Research Foundation (TRF)
(n) Agricultural Research and Extension Trust (ARET)
(o) Sugar Industry (SUCOMA and DWANGWA)
(p) Environmental Affairs Department of MOREA
(q) National Herbarium and Botanical Gardens

1.3 Most of these institutions have action plans while others have master plans which will be used for the preparation of the National Research Master Plan. The National Research Master Plan should reflect the ideas and priorities contained in the institutional or departmental master plans and action plans but reflecting national goals.

2.0 NAME OF THE RESEARCH MASTER PLAN

2.1 It is recommended that the plan should be called the **"Malawi Agricultural and Natural Resources Research Master Plan"** and the final printed document should be 90-120 pages long.

3.0 OBJECTIVES OF THE PLAN

The overall objectives of the plan will be to set out the strategy for research in the agricultural and natural resources sectors over the next 5 to 10 years period.

3.1 It should set out priorities at institutional/departmental and national level. These priorities should reflect the national priorities including those established by the Ministry of Agriculture and Livestock Development in "The Agricultural and Livestock Development Strategy and Action Plan".

3.2 Funding mechanisms for core research, specific priority areas, and contract research will be shown in the plan.

4.0 ISSUES TO BE CONSIDERED IN THE PREPARATION OF THE PLAN

4.1 The future roles of government and private sectors in research including potentials for increasing contributions from end-users of the research technologies.

4.2 The establishment and role of a coordinating body for all research activities and also as a lobby group making the case for agricultural research to influence political masters, Ministry of Finance (Treasury), the private sector and donor agencies for their moral and financial support.

4.3 Making provision for the establishment of a sustainable Contract Research Programme with peer-reviewed research projects at adequately funded levels and adjusted for inflation.

4.4 Establishment of management systems including the monitoring of both public and privately funded agricultural research to ensure that national priorities are being adequately addressed and to report on the quality of output and advise government on serious gaps in coverage or performance.

4.5 The institutional arrangements for links between scientists, within institutions, between institutions and with regional and international research systems. This may involve establishing a mechanism that brings together complementary skills of the Research Institutions and facilitate full utilisation of research facilities.

4.6 The promotion of an effective extension delivery system infrastructure to ensure effective linkage systems between Policy makers - Researchers - Extensionists - Farmers - Processors. This should also include how farmers, processors and other end-users may

participate at all stages of the technology generation process and also at all levels of the decision-making process.

5.0 IMPORTANT PRINCIPLES AND GUIDELINES TO BE CONSIDERED WHEN DEVELOPING THE PLAN

5.1 In developing the framework, format, methodology and time-frame for design of the Plan, a number of important considerations have had to be taken into account. These include the following:-

5.1.1 **The substantial number of organisations** in both the public and private sector, and in several Ministries, that are involved in research for agriculture and natural resources. Some of these have already produced plans for future work. Thus the Department of Agricultural Research has prepared a draft Research Master Plan (March, 1995); the Forest Research Institute of Malawi has a Strategy, 1995 to 1998. ARET plans to produce a strategy by September, 1996. Several other groups, e.g. Veterinary Services have also drawn up their plans for future research.

5.1.2 **The role of multi-lateral and bi-lateral donors** in agricultural research in Malawi. The donors are involved not only in financing research *but also in determining what research should be done and how it should be done.* Thus donor policies in farming systems research, client-oriented research, low-input agricultural systems, research priorities for the poorest groups, non-subsidised inputs, private seed suppliers, etc, all influence the present research agenda.

5.1.3 **The activities of several international agricultural research centres** in Malawi. Although their programmes have mainly a regional mandate, they have a substantial influence on research in the host country and thus on the priorities for research. At the same time, their collaborative research has produced new technology which is suitable for Malawi.

5.1.4 **The view, apparently widely held by researchers, is that there are technologies available,** which are economically and socially viable for small farmers, but which remain unused. The DAR Master Plan, for example, shows that the research yields are several times higher than the average yields on farmers' fields. On the other hand, the extension staff emphasise the shortage of suitable technologies. Since the rate at which research results are applied by farmers has a major influence on the returns to investment in research, this question will need to be examined in the design of the Plan.

5.1.5 **Government policies** The government's Agricultural and Livestock Development Strategy and Action Plan sets out a series of goals for the sector and a large number of research, extension and provision of services strategies to achieve these goals. At the same time, it is clear that there are major problem areas, which involve several sub-sectors and dominate the approaches to agricultural development. These include the effects of the apparently more frequent droughts, the need for diversification, the inexorable decline in soil fertility, the growing impoverishment of the rural community

due to decreasing farm size, the continued deterioration of the environment. The research strategies will be designed to define the role of research in dealing with these problems.

5.1.6 **The financing of research in the long term**. In the short term (which might be the next ten years) the research system in Malawi will have to depend to a considerable degree on donor financing for operational costs and for capital investments. The system must plan for this form of financing in the near term but plan as well for a decreasing dependence on it and eventually complete national financing. If this approach is accepted, then it has important implications for the eventual size and scope of the system, for the manner in which donor financing should be handled in the near term and for the planning of a national system, eventually financed from national public and private resources. Thus, the size of the system would have to be based on what the country is likely to be able to afford. This is obviously a political decision which will be greatly influenced by the impact of research over the next ten years. Varying guidelines have been described, mainly based on the value of the AGDP. Thus the DAR Master Plan states that the present public expenditure on agricultural research is equivalent to 0.5% of AGDP and suggests that it should be raised to 1%. At present tea research spends 1.4% of the value of the crop on research. These may provide useful target figures.

5.1.7 **The management of donor financing.** As noted in (ii) donors have a major role not only in financing research but also in determining its direction. This is not a satisfactory way in which to build a national research system, which must move towards some kind of consolidated funding mechanism, whereby the sources and application of funds are clearly stated but which support a coherent programme, which is, however, **managed by the Malawian national research system**. Donors, for a variety of reasons, are very reluctant to move to any kind of consolidated funding; in the near-term, however, they may support defined activities within an agreed plan. Hopefully they will phase out their involvement in the detailed design of these activities and will accept a system-wide monitoring and evaluation system which will report to both government and donors. At the same time, an accounting and financial management system, which can be readily used by all those involved, will need to be designed and installed.

6.0 METHODOLOGY FOR DEVELOPING THE PLAN

Involvement of individual scientists and institutions

6.1 As noted earlier, there are many organisations and groups dealing with agriculture and natural resources research in Malawi. The guide to the ASC lists 10 agricultural research stations of the DAR and 16 public, private, international and regional research organisations working in research in the country; in addition, there are at least eight bi-lateral and multi-lateral donors involved in the agricultural and natural resources field.

6.2 In the past, in Malawi as in other countries, research planning has tended to be "top down" in that the interested parties have been asked to react to drafts rather than fully participating in the preparation of the drafts. The reasons for this have not been wholly

the desire to proceed in this fashion but rather to the problem of getting individual scientists and groups to be proactive and provide ideas rather than react to draft plans. There has been a tendency for scientists to wait and see how they will benefit from a plan rather than a desire to see how they can contribute to it. Consequently, the work pattern will ensure that all of those with an interest in the outcome of the planning exercise will be involved from the start of the work.

6.3 Thus the institutions involved in livestock, forestry, fisheries and irrigation are being requested to prepare research strategies, showing their priorities, for discussion at a workshop and eventual incorporation in the Plan. Where applicable they will set priorities on a *commodity* rather than on a *disciplinary* basis. Thus the research programme on cattle, for example, would cover health, nutrition, breeding, etc. It would define the problems by examining what is happening at the farm level and set out a programme, including details of financial and professional staff requirements. It is expected that fisheries will be able to use the same kinds of approach. Forestry research may be able to use a similar commodity based approach e.g. industrial plantations, indigenous woodland. This commodity approach would be in line with that used by the DAR in developing its plan.

6.4 Not all research can be prioritised on a commodity basis. Some aspects of soil fertility, for example fertiliser trials on maize can be prioritised within the commodity. However, there are many *factors of production* that cut across many or all commodities and need a different approach. Irrigation and water management would be regarded as factors of production, as would agricultural machinery; cattle are a commodity but also a factor of production in that they provide traction. Agro-forestry would be considered a production factor in its contribution to soil fertility but it is also a commodity in providing fuel or timber. Pest and disease research can mostly be done as part of commodity research but weed control usually involves cropping systems.

6.5 One question that often emerges in using the commodity approach is how to handle mixed cropping, a feature of many production systems. Clearly this requires commodity teams to collaborate, but this has to be a factor for any research to succeed.

6.6 The involvement of the *universities* in the research system needs to be considered. They will be able to contribute to several of the commodity and factor based programmes; they may also have special expertise which can be called upon in the social sciences. Thus they could contribute in the area of policy analyses where the various research organisations are weak. This would involve the analysis of policy options or strategies for research directed at the solution of specific problems. As an example, approaches to improving soil fertility might include research and/or policy changes. Social science expertise will also be needed in developing impact studies and in examining costs and benefits of research.

6.7 Another group which will continue to have an important role in agricultural development are the organisations in the *private research sector.* These include ARET (tobacco), TRF (tea) and SUCOMA (sugar). As industry financed operations, they can be expected to follow their industry's priorities though some are prepared to undertake contract

research, for example, TRF on coffee. Because of the policy for diversification, there may be a special case for ARET to have a special role in research for improving production of non-tobacco crops on tobacco farms.

6.8 The research programmes of the *international research centres* should be taken into account when developing the Plan. Apart from the technology which they are generating and will continue to generate, they have also substantial experience in planning and developing research programmes, in assessing the resources needed for successful research and in defining farmers' problems.

6.9 Finally the *post-farm aspects* of agriculture must be taken into account. The research programmes of the public sector institutions appear to focus mostly on the on-farm production processes yet farmers have to market their produce and agro-processing gives added value. Some post-harvest research can be done within the commodity programmes, e.g., storage and small scale processing. Other aspects cut across commodity groups and the ideas and needs of the agro-processing industries will require attention in the Plan.

6.10 In summary then, the various institutions involved in any aspect of public sector financed agricultural and natural resources research will be invited to submit prioritised research plans, together with an estimate of the financial and staff resources that would be needed to carry out these plans

7.0 PRIORITY SETTING

7.1 Priority setting is essentially an attempt to estimate the contributions that research can make to the different objectives of a research system. Thus it sets out, on an *a priori basis,* where investments in research are likely to have the highest pay-off. There is, of course, nothing new in the idea of setting priorities; every scientist has to make choices on how he plans to spend his time and resources. However formal priority setting, by basing decisions on a number of selected criteria which extend beyond the scientist's own interests, introduces a degree of objectivity into the process. Such a process helps to remove the bias of many scientists of wanting to continue their current research. Such resistance to change is to be expected as scientists see such changes as a threat to their informal relationships, if not to their livelihoods. For this reason the scientists doing research should also have an involvement in setting priorities. This process will usually take more time to reach agreement but it will ensure that once agreement is reached, implementation will be easier. There are several approaches and methodologies to priority setting but ultimately they all have a substantial degree of subjectivity and personal judgement. For the purposes of setting priorities for Malawi's research plan, it is suggested that this should be done at five levels.

Level 1: Priorities among commodity groups, e.g., cereals, vegetables, monogastric animals, aquaculture, indigenous forests.

Level 2: Priorities among commodities and factors of production, e.g., the priority

between maize and horticultural crops, or between groundnuts and cattle. It is at this strategic level that scoring or weighted objective methods of priority setting are most useful.

Level 3: Constraints to production, e.g., pests and diseases, declining soil fertility, deforestation.

Level 4: Priorities for research programmes or themes within the selected commodities and factors; an example would be the relative priorities for breeding, disease control and nutrition in a ruminant programme. Decisions on priorities at this level are best made by peer review, although simple checklists can be useful in ensuring that all programmes take account of the same kinds of factors.

Level 5: Research Focus: Research projects to be undertaken to solve the problems identified at Level 2, e.g., the kinds of experiments or surveys that need to be undertaken in the laboratory, research station or farmers' fields

7.2 Level 4 is the level at which the Plan will make decisions in setting out research priorities for Malawi's research system. Once the priorities and resource allocations are decided for these then the scientists involved in these commodities or factors will be responsible for decisions on Level 5 priorities.

7.3 It is proposed that weighted objectives or scoring methods be used in setting the priorities. The DAR has already used some of these and they are described in detail in the Ghana National Plan and in ISNAR publications. It is suggested that the ASC Secretariat meet with some of the scientists from DAR and the other institutions and with its consultants and agree a detailed procedure. It should be pointed that these methods are not, in themselves, particularly time consuming but the collection of the data necessary to operate the techniques can take a considerable amount of time. The sooner a decision is taken on which information to collect, the sooner collection can start.

8.0 CONSULTANCY INPUT

8.1 The operations for the development of the Plan, as set out above, will require a core team of consultants. The core team would consist of three members, (a biological scientist, an agricultural economist and an extension expert) and the ASC Secretariat. All would need to be experienced in the field of agricultural research and development but at least one or two should be from outside the national research system.

8.2 In addition, there will be eight Working Groups dealing with the following topics: **Agricultural Mechanisation; Post-harvest Handling and Utilisation; Field Crops; Fisheries; Forestry; Horticultural and Plantation Crops; Livestock;** and **Management of Natural Resource Base** (Soil Fertility, Water Management, Environmental Factors, etc). The working groups will consist of 2-4 specialists drawn from various organisations or institutions based on their specialisation and professional competence.

9.0 CONTENT AND FORMAT OF THE PLAN

The layout of the plan will emerge more clearly as the various components are provided by the research organisations and working groups involved. However, it is desirable to start work soon on a draft layout which will guide the collection of information and the appointment of teams to carry forward the work. The outline of the chapters and their contents is, therefore, somewhat tentative at the moment but should form the basis for a first draft.

9.1 Chapter I: Background

This chapter would summarise the information about agriculture and natural resources in the country. It would describe the nature of the natural resource base - soils, climate, vegetation - and the changes that are taking place. It would outline the nature of the major farming systems, how these are changing with time and the technical problems that are presented by these changes. Measures of the performance of agriculture including crop yields, growth in production and productivity would be included.

9.2 Chapter II: Government Policies and Goals.

This chapter would summarise the government's policies on agriculture concentrating on those areas where government expects technology to make an impact. It would also examine the policies which would be most likely to help or hinder technology development and its use by farmers.

9.3 Chapter III: The Structure, Programmes and Human and Financial Resources of the Existing Research Institutions and Research Systems

This chapter would describe the mandates of the various organisations that are presently engaged in research. It would summarise their research programmes, describe how these programmes are developed and managed, how they are financed and the professional staff at their disposal. This chapter would give a clear picture of the total resources presently available for agricultural and natural resources research in Malawi.

9.4 Chapter IV: Lessons from past Successes and Failures of Agricultural Research and Impact of Research

This chapter would give an objective assessment of the impact of past agricultural research. It would analyse the reasons for successes and failures so that the lessons from these could influence the shape of future research programmes. There would be less emphasis on the output of past research, e.g., lists of new varieties and on the failures of current research structures and more on the research strategies which have achieved success. There would also be a discussion on how government policies encouraged or inhibited the impacts of research. Examples could be drawn from both the public and the private sector.

9.5 Chapter V: The National Agricultural and Natural Resources Research Priorities

This chapter would describe the approach to planning including a brief review of the priority setting methodology and its advantages and limitations. The chapter would set out the priorities for commodities and factors of production at Level 1 and would show how financial and staffing resources would be allocated. It would identify those areas with high priority which needed additional resources and also those areas of low priority from which resources could be moved.

9.6 Chapter VI: The Structure of Research Programmes and Development of a Management System

This chapter would set out the research programmes for the next five years. Essentially, it would be a medium term action plan which would describe the main research programmes for each of the priority commodity and factor oriented research groups. Thus, it would set out the Level 2 priorities in each of these groups. It would be desirable for the research system to develop a common format for formulating these programmes; logical frameworks are a useful tool for this as they develop a standard of presentation that allows comparison of different research programmes. Their use as a management tool is discussed further in Chapter VIII.

Regardless of where responsibilities for management are placed, the research system will need to develop a series of management tools so that the system works efficiently and effectively. These include financial management, research programme management, human resource management and management of the equipment and infrastrucure. These tools include a management information system, a transparent accounting system that will satisfy donors, a financial management system, including programme budgeting, a human resources development plan that deals particularly with short-term training and a monitoring and evaluation system. Staff management would form part of the overall management system. Consideration should also be given to the introduction of logical frameworks for research programme planning. This system is already in use in some of the donor funded projects and is an excellent basis for introducing a Monitoring and Evaluation system.

9.7 Chapter VII: The Role of the ASC in the Structure and Management of the Research System

Restructuring research systems has been a popular approach by donors; there are many reasons for this, amongst them the pressures to show that something is happening. The planned functions of the ASC are comprehensive, but its guide does not indicate how these will be managed or whether any restructuring of Malawi's agricultural and natural resources research system will be needed. A recent ISNAR review of restructured research systems suggests that it is often of limited value. In this chapter, the ASC will need to set out its objectives in managing the system and its strategy for doing so. Its objectives, and thus, its functions might be largely limited to the preparation of the Plan with only an administrative role in reporting to government whether it was being

implemented. A further step would be the monitoring of implementation with powers to enforce timetables. With more authority (and resources) it could undertake a more active management role in monitoring quality of research, efficiency of the use of financial resources and timeliness of outputs. This chapter will thus describe what the ASC proposes to do, the resources that will be needed; and how the various monitoring and control systems will be introduced.

9.9 **Chapter VIII: Technology Transfer, Production Strategies, Scope and Implementation**

Some of the decisions on implementation must await the outcome of the Plan. Others will be circumscribed by the existing linkages with extension, with the international agricultural research centres and with donors. If new management systems are to be introduced, then thought will need to be given as to how these are to be phased in and the existing systems phased out. It should be emphasised that managing change is recognised to be a time-consuming and challenging undertaking and consequently planning for it should start as soon as possible.

10.0 TIMETABLE FOR PREPARATION OF THE PLAN

10.1 Clearly the time taken to prepare such a Plan depends to a considerable degree on the staff and financial resources that can be made available to the ASC Secretariat. Nevertheless, there are important parts of the process that will depend on people outside the Secretariat; unless they can be motivated to make their contributions in a timely fashion the process can encounter substantial delays.

10.2 Many national research plans have taken a considerable amount of time - up to three years in some instances. There are various reasons for such extended timetables; but such lengthy delays exasperate both scientists and donors as well as the government. It is proposed that the target date for completion of this Plan be 30th September 1998.

ANNEX 2 LIST OF CONSULTANTS AND TASK FORCE MEMBERS

2.1 CONSULTANTS

(i) Dr. E.H.C. Chilembwe, ASC Coordinator, NRCM

(ii) Dr. I.M.G. Phiri, ASC Research Officer, NRCM

(iii) Dr. J. Coulter, International Advisor, United Kingdom

(iv) Dr. J.T. Munthali, Head of the Core Team of Local Consultants, ARET

(v) Prof. V.W. Saka, Member of the core team of local consultants, Bunda College of Agriculture, University of Malawi.

(vi) Dr. C. Mataya, Member of the core team of local consultants, Bunda College of Agriculture, University of Malawi.

2.2 TASK FORCE TEAMS AND MEMBERS

2.2.1 Agricultural Mechanisation

(i) Mr. W.F Kumwenda, Farm Mechanisation Research Engineer, Department of Agricultural Research and Technical Services (DARTS), Ministry of Agriculture and Irrigation (MoAID)
(ii) Mr. E. Kunkwenzu, Farm Mechanisation Research Engineer, DARTS, MoAID
(iii) Mr. S. Ngwira, Farm Machinery Engineer, Bunda College, UNIMA
(iv) Mr. A. Mbeza, Post Harvest Engineer, Bunda College, UNIMA

2.2.2 Post Harvest Handling, Utilisation and Nutrition

(i) Dr. M. Ngwira, Chairperson, Food Scientist, Bunda College, UNIMA
(ii) Mrs. R. Ayoade, Food Nutritionist - Nutrition Unit, MoAID
(iii) Mr. S. Munthali, Post Harvest Technologist, DARTS, MoAID

2.2.3 Field Crops (Cereals, Legumes)

(i) Dr. J.D.T. Kumwenda, Chairman, Research Agronomist, DARTS, MoAID,
(ii) Dr. A.J. Chiyembekeza, Groundnut Breeder, DARTS, MoAID
(iii) Dr. J.H.C. Luhanga, Seed Technologist, DARTS, MoAID
(iv) Dr. A.T. Daudi, Nematologist, DARTS, MoAID

2.2.4 Fisheries

(i) Mr. S.A. Mapila (Chairman), Deputy Director, Capture Fisheries, Fisheries Dept, Ministry of Forestry, Fisheries and Environmental Affairs (MoNREA)

(ii) Mr. A.O. Maluwa, Fish Breeder, Aquaculture, Fisheries Dept, MoNREA
(iii) Dr. J.S. Likongwe, Aquaculture, Bunda College, UNIMA
(iv) Mr. O. Kachinjika, Capture Fisheries Researcher, Fisheries Dept, MoNREA

2.2.5 Forestry

(i) Mr. M.W.M. Shaba, MoNREA
(ii) Mr. C. Masamba, Forestry Institute of Malawi (FRIM), MoNREA

2.2.6 Horticultural and Plantation Crops (Vegetables, Fruits, Tree nuts, Spices, Tea, Coffee, Tobacco)

(i) Dr. W.T. Gondwe, Research Horticulturist, DARTS, MoAID
(ii) Dr. M. Kwapata, Horticulturist, Bunda College, UNIMA
(iii) Mr. N.M. Nsanjama, Agronomist, DARTS, MoAID
(iv) Mr. L.E. Ngwata, Extension Horticulturist, MoAID
(v) Dr. C.T. Kisyombe, Plant Pathologist, DARTS, MoAID

2.2.7 Livestock

(i) Dr. J.P. Mtimuni, Animal Nutritionist, Bunda College, UNIMA
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(iii) Dr. S. Ndaomba, Veterinarian, DAHI, MoAID
(iv) Dr. R. Phoya, Livestock Physiologist, Bunda College, UNIMA

2.2.8 Natural Resources and the Environment

(i) Mr. G. K. Munthali, Meteorologist, Department of Meteorology, Ministry of Transport and Communications
(ii) Dr. A.R. Saka, Soil Physist, DARTS, MoAID
(iii) Dr. Z.M. Vokhiwa, Environmental Specialist, Environmental Affairs Department, MoNREA

2.3 EDITORIAL

(i) Mr. J.B Chuma, Chief Documentation Officer, National Research Council of Malawi (NRCM)
(ii) Dr. G. Matita, Veterinarian, Department of Animal Health and Industry(DAHI), MoAID
(iii) Dr. A. Chiyembekeza, Groundnut Breeder, DARTS. MoAID
(iv) Dr. A.R. Saka, Soil Physist, DARTS, MoAID
(v) Mr C. Kharapuwa, Communications Officer, ARET

ANNEX 3 LIST OF TASK FORCE COMMODITY REPORTS

(i) Production strategies and research action plan for field crops.

(ii) Production strategies and research action plan for horticultural and plantation crops.

(iii) Development strategies and research action plan for forestry.

(iv) Strategies and research action plan for animal production and health.

(v) Production strategies and research action plan for aquaculture and capture fisheries

(vi) Strategies and research action plan for agricultural mechanisation

(vii) Strategies and research action plan for post harvest handling, processing, utilisation and nutrition.

(viii) Strategies and research action plan for sustainable management and utilisation of renewable natural resources including the environment.

ANNEX 4 STAKEHOLDERS CONSULTED DURING THE RESEARCH MASTER PLAN PREPARATION PROCESS

NAME	INSTITUTION
A.O. Maluwa	Fisheries Dept. Domasi
E.P.M. Ng'oma	Board Member, Farmer
A.F.T. Kumwenda	Blantyre ADD
A.W.J Kisebe	Smallholder Sugar Authority
H.D.C. Msiska	DARTS
A.J. Kaunda	Shire Valley ADD
B.F.R. Mtika	Karonga ADD
A.M. Chirembo	Chitedze Research Station
R. Phoya	Bunda College
V.W. Saka	Bunda College
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P.W. Chirwa	FRIM
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T.Z. Chunga	Natural Resources College
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Dr. A.T. Daudi	Bvumbwe Research Station
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G.J. Kamba	Ministry of Finance
Dr. G.B. Matita	Department of Animal Health Industry
C.C. Khonje	Kasungu ADD
E.P.H. Kunkwenzu	Chitedze Research Station
E. Mwendo - Phiri	World Vision
R.M. Chirwa	Chitedze Research Station
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D.R. Madise	Natural Resources College
G.K. Munthali	Metereology Department
F.C. Munthali	ARET
A. Bulirani	Fisheries Dept
Pala Subnahmanyam	ICRISAT
J. Luhanga	DARTS
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T.Z. Chunga	Natural Resources College
Dr. C. Mwiyeriwa	National Research Council
Dr. E Chilembwe	" " "
Dr. I. Phiri	" " "
Mr. U. Mtokoma	" " "
Mr. E. Nyondo	" " "
Mr H. Gausi	" " "
Mr A. Manda	" " "
Mr J. Manda	" " "
Mr M. Kachedwa	" " "
Mr. P. Chinyang'anya	" " "
Mr M. Kakatera	" " "
Mr. Mwale	Lilongwe ADD
Mr. D. Kamputa	MoAID
Mrs G. Thaulo	MoAID
Mr. K. Chabvula	MoAID
Mr. E. Chongwe	MoAID
Dr. D. Kampani	MoAID
Dr. C. Kisyombe	Chitedze Research Station
Dr. H. Thindwa	Bvumbwe Research Station
Dr. M. Lowole	MoAID
Dr. A. Chiyembekeza	Chitedze Research Station

Mr. Chisenga	Mzuzu ADD
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Mr. M. Kasowanjete	DAHI
Mr. M. Shaba	Forestry Hqrs
Mr. C. Masamba	FRIM
Dr. N. Ngulube	FRIM
Mr. F. Kulapani	FRIM
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Mr. H. Mbedza	Bunda College
Dr. M. Ngwira	Bunda College
Mr. S. Munthali	Chitedze Research Station
Dr. A. Saka	Chitedze Research Station
Mr. Kanyinji	Principal - Natural Resources College
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Mr. M. Sibande	Ministry of Finance
Mr. M.K. Tonde	Farmer, Machinga ADD
Dr. E. Sambo	Chancellor College
Dr. E. Minofu-Sibale	EU Food Security programme
Mr. V.H. Chipofya	Polytechnic
Mr. A.A. Mangwele	Ministry of Natural Resources
Dr. C. Mataya	APRU, Bunda College
Dr. Dan Chimwenje	Mzuzu University
Mr. Kamphambe Nkhoma	Deputy SPC
Dr. G.Y. Kanyama-Phiri	Bunda College
Dr. Opio	Bunda/IFPRI
Mr. Ellos Lodzeni	Ministry of Natural Resources
Dr. Francis Moto	Chancellor College
Mr. F. Mbuka	World Bank
Resident Representative, UNDP	
Mission Director, USAID	
Director, DANIDA	
Country Representative, Rockefeller	
Country Representative, DFID	
Resident Representative, JICA	
Secretary for Human Resource Management and Development	
Principal, Bunda College	
Mr. Kazembe	Parks and Recreation Manager, Lilongwe City Council
Mr. Chanika	Smallholder Coffee Authority
Mr. C. Chikopa & Mr A. Njikho	Kawalazi Tea Estate
Mr. A. Tongo	Viply

Dr. Bunderson	Malawi Agroforestry Extension Project
Mr. Mpila, Mr. Chamangono & Mrs J. Ngwira	ICRAF, Makoka
Mr. Mwase	Mzuzu City Council
Mr. V. Msiska	Regional Forestry Office, Mzuzu
Mr. W. Simwela	Regional Forestry Office, Lilongwe
Mr. B. Chamba	Viphya Plantations
Mtondo Village Forest Committee in T.A. Mduwa, Mchinji	
Mgaline village Forest Committee	
Chikazinga Village Forest Committee, T.A. Chikulamayembe	
Mr. Sadyalunda	Kasungu Flue Cured Tobacco Authority
Mr. M. Selenje	Agricultural Research and Extension Trust
Mr. Kawiya	City of Blantyre
Mr. Botha	Press Agriculture (Kasungu)
Mr. Mauambeta	Wild Life Society of Malawi
Mr. Chipezeani	Regional Forestry Office (South)
Mr. Hara	Smallholder Tea Authority
Mr. Chidumayo	Naming'omba Tea Estates
Mr. Nthiwatiwa	Tea Research Foundation
Mr. Clark	Sugar Research Foundation
Mr. Barratt	Leopard Match Company
Mr. Kunje	Wood Industries Coorporation
Mr. Patel	Shire Limited
Mr. Cristal	Imperial Timbers Ltd.

ANNEX 5 DETERMINATION OF PRIORITIES AMONG COMMODITY GROUPS AND COMMODITIES IN CROPS, LIVESTOCK, FISHERIES AND FORESTRY

Annex 5.1 Determination of priorities among commodity groups

Commodity	Production Value		Intuition	Final priority rank
	Malawi Kwacha	Priority rank (Weight in brackets)	Priority rank (Weight in brackets)	(Weight in brackets)
Cereals	5,099,915	2 (90)	1 (90)	1 (180)
Cash crops	8,849,337	1 (100)	3 (72)	2 (172)
Root and tubers	1,940,426	3 (80)	5 (54)	3 (134)
Vegetables	1,365,768	4 (70)	4 (63)	4 (133)
Legumes & oilseeds	848,360	7 (40)	2 (81)	5 (121)
Fisheries	1,270,483	5 (60)	8 (27)	6 (87)
Livestock	800,332	8 (30)	6 (45)	7 (75)
Fruits	1,161,065	6 (50)	9 (18)	8 (63)
Spices	232,120	10 (10)	7 (36)	9 (46)
Forestry	602,100	9 (20)	10 (9)	10 (29)

Annex 5.2a Determination of priorities among commodities - Cereals

Commodity	Quantitative Criteria for Priority Setting							
	Quantity (Tonnes)	Production value (MK'000)	Food value (Calories)	Comparative advantage (DRC ratio)	Gross margins (MK)	Ranking by intuition	Total score	Priority rank
Maize	1,560,663	476,002	362	0.37	502	1	98.3	1
Rice	55,851	252,447	354	0.50	1,019	2	91.7	2
Sorghum	37,000	55,500	353	0.62	239	3	80.0	3
Millet	16,761	25,142	336	0.62	239	4	70.0	4
Wheat	1,944	6,804	243	1.14	204	5	60.0	5

Annex 5.2b Determination of priorities among commodities - Legumes and oilseeds

Commodity	Quantitative Criteria for Priority Setting								
	Quantity (Tonnes)	Production value (MK'000)	Food value (Calories)	Comparative advantage (DRC ratio)	Gross margins (MK)	Export value (MK'000)	Ranking by intuition	Total score	Priority rank
Beans	40,235	315,040	22	0.33	902	133,000	1	92.9	1
Pigeon peas	70,241	151,018	20	0.30	489	35,100	2	84.3	2
Groundnut	20,859	166,872	27	0.35	2,075	7,600	3	71.7	3
Soyabeans	28,693	124,528	35	0.89	342	-	4	64.3	4
Sunflower	34,093	85,233	13	0.43	287	21,900	6	58	5
Cow peas	2,620	5,669	22	0.53	-	-	5		6

Annex 5.2c Determination of priorities among commodities - Industrial and cash crops

Commodity	Quantitative Criteria for Priority Setting							
	Quantity (Tonnes)	Production value (MK'000)	Comparative advantage (DRC ratio)	Gross margins (MK)	Export value (MK'000)	Ranking by intuition	Total score	Priority rank
Tobacco	135,920	4,417,400	0.32	6,699	5,549,30	1	91.70	1
Sugar	216,800	2,655,800	0.23	759	528,700	3	83.30	2
Tea	35,707	1,119,300	0.54	1,600	1,119,30	2	75.00	3
Coffee	4,797	209,149	0.27	2,085	162,300	4	70.00	4
Cotton	53,894	393,965	0.29	404	257,600	5	65.00	5
Macadamia	131	8,018	0.38	1,200	30,000	6	48.30	6
Cashew	1,487	5,205	0.25	1,000	-	7	46.00	7
Rubber	-	40,500	-	-	40,500	8	43.30	8
Palms	-		-	-	-	9	40.00	9

Annex 5.2d Determination of priorities among commodities - Root and tuber crops

Commodity	Quantitative Criteria for Priority Setting							
	Quantity (Tonnes)	Production value (MK'000)	Food value (Calories)	Comparative advantage (DRC ratio)	Gross margins (MK)	Ranking by intuition	Total score	Priority rank
Sweet potato	596,409	894,614	121	0.19	350	1		1
Cassava	431,487	755,102	140	0.23	1,203	2		2
Potato	116,284	290,710	75	0.39	-	3		3

Annex 5.2e Determination of priorities among commodities - Spices

Commodity	Quantitative Criteria for Priority Setting							
	Quantity (Tonnes)	Production value (MK'000)	Comparative advantage (DRC ratio)	Gross margins (MK)	Export value (MK'000)	Ranking by intuition	Total score	Priority rank
Chillies	4,232	148,120	0.32	1,400	116,100	1	96.70	1
Paprika	2,400	84,000	0.23	8,892	17,200	2	91.70	2
Ginger	-	-	-	-	-	3	70.00	3
Tumeric	-	-	-	-	-	4	60.00	4

Annex 5.2f Determination of priorities among commodities - Vegetables

Commodity	Quantitative Criteria for Priority Setting							
	Quantity (Tonnes)	Production value (MK'000)	Food value (Calories)	Comparative advantage (DRC ratio)	Gross margins (MK)	Ranking by intuition	Total score	Priority rank
Tomato	335,360	1,005,180	510	0.11	112,350	1	90	1
Pumpkins	-	-	720	-	-	3	85	2
Cabbage	85,319	298,617	540	0.14	3,000	2	83	3
Onion	17,706	61,971	570	0.08	1,900	4	80	4
Amaranthus	-	-	830	-	-	6	75	5
Carrot	-	-	60	-	-	7	60	6
Mushroom	-	-	460	-	-	5	50	7

Annex 5.2g Determination of priorities among commodities - Fruits

Commodity	Quantitative Criteria for Priority Setting					
	Quantity (Tonnes)	Production value (MK'000)	Food value (Calories)	Ranking by intuition	Total score	Priority rank
Banana	53,7549	546,936	560	1	90	1
Mango	23,4180	351,270	610	2	90	2
Flowers	-	53,100	-	3	83	3
Citrus	23,8339	207,509	540	4	75	4
Guava	-	-	650	5	75	5
Avocado	-	-	610	6	60	6
Pineapple	450	2,250	370	7	55	7
Pawpaw	-	-	440	8	45	8
Paach & Apples	-	-	380	9	35	9
Masuku	-	-	-	10	10	10

Annex 5.2h Determination of priorities among commodities - Forestry

Commodity	Quantitative Criteria for Priority Setting				
	Quantity (Cubic meters)	Production value (MK'000)	Ranking by intuition	Total score	Priority rank
Indigenous	17,400,000	822,000	1		1
Plantation	2,540,000	76,200	2		2
Woodlots	130,000	3,900	3		3

Annex 5.2i Determination of priorities among commodities - Livestock

Commodity	Quantitative Criteria for Priority Setting				
	Quantity (Cubic meters)	Production value (MK'000)	Ranking by intuition	Total score	Priority rank
Chickens	103,366,40	233,244	1	96	1
Cattle	618,747	435,600	1	93	2
Goats	1,597,536	3,853	2	86	3
Pigs	481,563	2,927	2	76	4
Sheep	102,671	800,684	3	66	5

Annex 5.2j Determination of priorities among commodities - Fisheries

Commodity	Quantitative Criteria for Priority Setting				
	Quantity (Cubic meters)	Production value (MK'000)	Ranking by intuition	Total score	Priority rank
Capture	46,854	1,257,199	1	100	1
Aquaculture	300	13,284	2	90	2