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Challenges and Opportunities for Raising Agricultural Productivity in Malawi

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Abstract This paper gives a comprehensive exposé of key challenges and opportunities for agricultural productivity growth in Malawi. It has also raised a number of issues that define the current Research and Development landscape for Malawi. The paper is based on empirical evidence from data from national sources as well as secondary data from international source. The paper argues that unless government increases its financial contribution to Research and Development, research agenda in the country will remain donor driven creating a precarious situation for sustainable agricultural productivity growth.Among other things, this situation is compounded by the increasing budget allocation to the Input Subsidy Programme and the relatively weak extension delivery system in the country as well as other compounding factors discussed in the paper.There is an urgent need to consider strengthening the agricultural extension delivery system if technology development is to result in significant improvements in agricultural productivity. Furthermore, government should make deliberate efforts by creating a conducive environment and building capacity of smallholder farmers for the establishment of farmer producer and marketing associations.

Keywords Research and Development, Technology, Adoption, Productivity Growth

1. Introduction

Malawi is one of the least-developed countries in the world where the incidence of poverty is relatively high. The Human Development Index for 2010, which is a combination of three sub-indices covering wealth, health and education, ranks Malawi lowly at position 153 out of 169 countries surveyed[1]. On the other hand, the country estimates based on the national poverty line show that 40 percent of the populace earn/spend less than the threshold[2].Agriculture still remains the main engine for economic growth and development for the country. This means that poverty reduction efforts in Malawi have to put significant emphasis on improving agricultural productivity growth. Among other things, this entails increased investments in Agricultural Research and Development (AgR&D) to generate new technologies, the cutting edge for improving agricultural productivity. However, despite the pivotal role that agriculture plays in the economy, government investments in Research and Development (R&D) remain very low. Much of Malawi's agricultural research agenda is donor-funded, thereby creating a very precarious situation for sustainable technology generation. The key question that this paper raises is how can agricultural productivity growth be ensured without significant government investments in Research and Development?

While analyses of main crops production data (maize in particular) for the past five years show an improvement in yields, much of this has been achieved as a result of the much touted government Farm Input Subsidy Programme (FISP) implemented since 2005/2006 cropping season coupled with a relatively favourable rainfall pattern. Both locally and internationally, the FISP has been considered a huge success which has among others, resulted in Malawi being able to produce surplus food over and above the annual requirements breaking a long tradition of dependency on food ain and commercial imports[3]. This paper argues, however, that much as the Farm Input Subsidy Programme is producing positive results with regards to productivity gains, but this is not a sustainable policy option given the budgetary strain it creates on the meagre government resources. Therefore, there is a need to increase investments in AgR&D and strengthening of extension delivery to ensure sustainable generation and adoption of new technologies.

The paper uses information and data collected through qualitative and quantitative study tools. Qualitative information was gathered through Expert Opinion Interviews with various key informants and experts mainly from the Ministry of Agriculture and Food Security, Input

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Companies, and University of Malawi (particularly Bunda College of Agriculture). On the other hand, quantitative data was largely collected from secondary data sources available in the country.

The paper focuses on discussing the challenges and opportunities for raising agricultural productivity in Malawi within the scope of AgR&D. In this paper, we argue that despite the fact that agriculture still remains the main engine for economic growth and poverty reduction in Malawi, the sector has not received the necessary support in terms of investments for Research and Development. Much of the research has been donor-driven. In addition, while we acknowledge some technological breakthroughs, weak extension delivery systems coupled with unreliable or non-working markets have colluded to limit the potential gains translated through agricultural productivity. The fundamental condition for overall social and economic growth of many developing countries is a dynamic agricultural sector brought about by a steady increase in agricultural productivity[4].

1.1. Structure of the Agriculture Sector in Malawi

Agriculture sector is the backbone of Malawi's economy. The sector accounts for about 93 per cent of the total export earnings, provides more than 80 per cent of the total employment and contributes about 27 per cent of the country GDP[5]. Furthermore, the sector contributes 63.7 percent of total income for the rural poor. Agriculture occupies about 56 per cent of the land area covering 5.3 million hectares of the country's 9.4 million hectares and supplies at least 65 percent of the manufacturing sector's raw material requirements[6][7]. The agricultural sector in Malawi is dualistic, consisting of small-scale farmers and the estate sub-sector. These sub-sectors could be viewed as the key farm types in the country. The sub-sectors have been historically distinguished on the basis of legal and constitutional rules regulating land tenure, type of crops grown and marketing arrangements.

The smallholder sub-sector (smallholder farm type) is based on customary land tenure system and is primarily subsistence. Land tenure is the basis for land allocation and ownership. Land in Malawi can be divided into three main basic categories: (i) public land, (ii) private land, and (iv) customary land. The customary land law is quite variable in the country, but with the most important difference being expressed between matrilineal and patrilineal systems of inheritance. Under the matrilineal marriage system, access to land is through the female members of the clan while the opposite is the case in patrilineal system, most dominant in the northern part of the country. However, in both systems, some common basic principles apply: land which is in use can be held and inherited indefinitely; whereas land that is not used is considered to belong to the community, under the jurisdiction of the chief, rather than by individual[8]. The customary land which dominates the smallholder farm type is cultivated under usufructus right and ideally cannot be sold. On the other hand, the estate sub-sector comprises 14,700 estates occupying about 850,000 hectares of privately owned land under leasehold title. The commercial farm type primarily produces cash crops: burley and flue cured tobacco, sugar, coffee, tea and tree nuts.

Over 70 per cent of the cultivated area in Malawi is under the customary land tenure system and is utilized by 3.5 million smallholder farming families with land holdings ranging from 0.5 to 2.5 hectares. The smallholder farm type occupies about 76.4 percent of the total land by zone (ADD) while the commercial farm type (estate) occupies about 23.6 percent. But overall, 90 percent of cultivated land is under customary tenure system with only 10 percent in the estate-commercial farm type[9].

Smallholder farmers produce numerous crops with the main focus on food crops. The main crops grown by smallholder farmers are: tobacco, maize, Irish potatoes, groundnuts, pulses, sweet potatoes, cassava, sorghum, rice, sunflower, wheat, vegetables, fruits, coffee, macadamia, cashew and spices. Maize, as the staple food, is the most important crop to the Malawian population and occupies 65 per cent of the total land cultivated by smallholder farm types. The highest amount of land under maize is in Lilongwe Agriculture Development Division (ADD) the main food basket. (See Figure 1 below and Figure A1 in the Annexes[9]reports that "*Chimangandimoyo"* (maize is life) in Malawi, and the ideal of producing enough maize to meet household food needs "informs everyone's actions and rationales for their actions before, during and after the maize harvest." This has also driven the government's priority setting with regards to Agricultural Research and Development (AgR&D)[10].

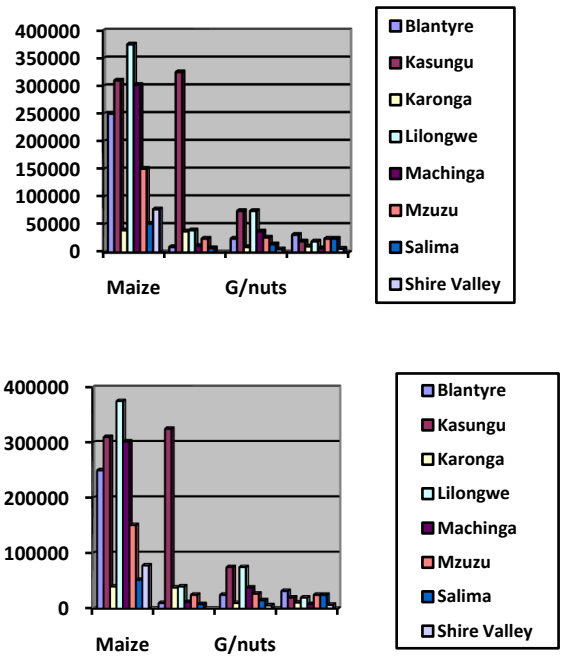


Figure 1. Land Allocation to Maize, Tobacco, Groundnuts and Cassava (2009/10)

It is noted that tobacco occupies more land than maize in Kasungu ADD – the main producing area for the crop. In all the Agricultural Development Divisions (ADD), however, smallholder farmers also keep some livestock with the main ones being cattle, sheep, poultry, goats, rabbits and pigs.

2. Technology Generation and Dissemination

Agricultural Research and Development programmes in Malawi are implemented through a number of research institutions. These are mainly public and international institutions. Public research in Malawi is carried out and coordinated through the Department of Agricultural Research Services (DARS) which is one of the seven technical departments of the Ministry of Agriculture and Food Security (MoAFS). DARS collaborates closely with some International Agricultural Research Centers (IARCs) such as ICRISAT who have some offices in the country. The department also worksin close collaboration with the University of Malawi particularly Bunda College of Agriculture and Chancellor College.

Agricultural Research and Development in Malawi establishes a strong linkage with the Agricultural Extension Delivery System. Much of the extension system in the country is public but operates in close collaboration with Non-Governmental Organizations and Farmer Organizations. The target client of all these activities is the farmer where it is assumed that adoption of improved technologies developed and disseminated through these systems will lead to increased crop productivity which will in turn contribute to overall economic growth and poverty reduction in the country.

The sections that follow describe the agricultural research and development system in the country and then examine the agricultural extension delivery system.

i. The Agricultural Research and Development in Malawi

The bulk of Agricultural Research and Development in Malawi is carried out and coordinated by the Department of Agricultural Research and Development (DARS). The DARS is one of the seven technical departments within the Ministry of Agriculture and Food Security. DARS is responsible for conducting research technology development and providing regulatory and specialist services on all crops and livestock, except tobacco, tea and sugarcane. The Department is headed by a Director and has a staff complement of about 60 professional scientists and 156 technical support staff. DARS conducts its work at a network of sixteen research centers that are strategically located in all agro-ecological zones of the country, covering a total land area of 2,731 ha. Every year, DARS scientists conduct some 500 on-station and on-farm trials and demonstrations throughout the country[11].

DARS has basic infrastructure that enable its scientists to perform their core functions. Some of these include: office space, two soils and plant analytical laboratories; a plant quarantine facility, a plant genetic resource conservation center; three main libraries; an internationally accredited seed technology laboratory; ten laboratories; three fruit tree nurseries; three for plant pathology, three crop storage, three for entomology and one for animal nutrition; farm machinery design workshop; and irrigation research infrastructure.

Vision

To be centre of excellence in agricultural research leading to the generation of cutting edge technologies and promotion of high quality regulatory and specialist services.

Mission

To conduct strategic and demand driven research and generate environmental friendly technologies and information; and to provide efficient regulatory and specialist services to meet the needs of smallholders, thereby alleviating poverty of the majority of Malawians.

Mandate

The mandate of DARS covers crops and livestock production, processing and regulatory and specialist services.

ii. Management and Institutional Setup for Public R&D

The Department of Agricultural and Research Services is part of the Ministry of Agriculture and Food Security (MoAFS). Since the department is a component of a ministry that has its own objectives, it performs functions in line with the Ministry and government obligations and policies. The headquarters of DARS is at Chitedze Research station.

The Department carries out its mandate and functions through a network of 16 Research Stations and seven Commodity Research Teams. The overall coordinator for public research is the Director of the Department of Agricultural Research Services. The Director has a team of four Deputy Directors who are charged with different thematic areas of research or commodities (also called Divisions). The four divisions are: i) Technology Development Division; ii) Technology Management Division; iii) Management Information Services Division and iv)

iii. Administration and Support Services Division.

The DARS has its administrative headquarters at Capital Hill in Lilongwe. It has four main research stations (Chitedze, Bvumbwe, Makoka and Lunyangwa), four experimental stations (Baka, Lifuwu, Chitala and Kasinthula) and eight trial sites (Meru, Ntchenachena, Bolero, Tsangano, Bembeke, Likangala, Ngabu and Makhanga). The research and experimental stations as well as trial sites differ in functional responsibilities and staff compliments. Each Research Station has a station manager who is the overall manager or research activities and administration matters at the station. DARS conducts collaborative research programmes with various partners. Such collaboration enables the Department to leverage expertise, funding and broadens coverage of its research activities and services. Some of the major partners are as follows:

Local research institutions (e.g. Tea Research Foundation, Forestry Research Institute of Malawi);

University of Malawi (e.g. Bunda College of Agriculture, Chancellor College; Mzuzu University);

●Regional Institutions (e.g. SADC Plant Genetic Resources Center, Commonwealth Agriculture Bureau)

●International Research Institutes (e.g. Natural Resources Institute)

●CGIAR Centers (e.g. ICRISAT, IITA, CIAT, CIMMYT, ICRAF)

●Farmer Organizations (Association of Small Seed Multiplication Action Group (ASSMAG); National Association of Smallholder Farmers in Malawi)

●Sister Departments in the Ministry of Agriculture and Food Security

●Donors (Rockefeller Foundation, McKnight Foundation, Irish Aid, NORAD, etc)

●Private Sector (Traders and manufacturers)

●Fisheries Research: Fisheries Research Institute, Bunda College, World Fish Center.

iv. Research Focus and Organization

Agricultural Research and Development (R&D) within the DARS is carried out through Technical Programs. Technical Programs in the department are organized into seven Commodity/ Technical Groups, each of which is sub-divided into appropriate Commodity Teams. Each Commodity Group is led by a National Research Coordinator. Commodity Teams are led by Team Leaders. The Commodity Groups and their teams are summarized in Table 1 below.

Table 1. Agricultural Research Organization

No	Commodity Group	Research Focus
1	Cereals Group	Maize, Rice and small grains (sorghum, millets, wheat and barley)
2	Horticulture Group	Fruits, Tree nuts, Flowers and Coffee Vegetables and spices; Roots and Tubers
3	Livestock and Pastures Group	Livestock and Pastures
4	Grain Legumes, Oilseeds and Fibre Groups Group	Groundnuts; Pulses and, Fibres and Oilseeds
5	Soils and Agricultural Engineering Group	Soil Fertility and agro-forestry Farm Machinery and agro-processing Irrigation and Drainage
6	Technical Services Group	Seed certification and quality control Plant Genetic Resources and Biotechnology; Library and Information Services, Agricultural Statistics and Economics Analytical Services
7	Plant Protection Group	Integrated Field Insect Pest Management Integrated Field Disease Management Storage Pest Management

v. Bunda College of Agriculture

Bunda College of Agriculture comprises three Faculties: Faculty of Agriculture; Faculty of Environmental Sciences and Faculty of Development Studies. The college has a total of 12 Departments. Each one of the departments has a Strategic Plan with a clear vision and mission. One of the key mandates of each one of these departments is to conduct research. For this study, three key departments were consulted. These are Crop Science Department one of the main partners of the Department of Agricultural Research Services; Animal Science Department which is the main player in livestock research in Malawi. The third department consulted was the Aquaculture and Fisheries Department.

The Livestock Commodity Team has a total of 12 active researchers with Masters Degrees and above. Of these, 10 are from Bunda. It is estimated that Bunda is contributing over 70 % of livestock research in the country. Much of the resources for research over the last five years have gone to pasture growing and conservation.

The Mission Statement of the Crop Science Department is provide high quality tertiary training and generate technologies for the industry and farming sector through teaching; collaborative research and consultancy in crop and soil sciences in order to contribute significantly to food security, health, poverty alleviation and environmental protection. It is the biggest department in the college that collaborates closely with DARS in agricultural research.

On the other hand, the Mission Statement for the Aquaculture and Fisheries Department is to advance and promote knowledge and skills in aquaculture, fisheries science, natural resources and the environment for increased and sustainable fish production and utilization through teaching, research, outreach and consultancies and conservation of biodiversity; natural resources and the environment in response to national and international needs. It is the main research unit on aquaculture fisheries in Malawi and is among the biggest in the SADC region.

These examples from Bunda and the roles played by International Research Centers (IARCs) highlight the type of collaboration and synergies that the Department of Agricultural Research has established to build a robust Agricultural Research and Development (AgR&D) system for the country[12].

2.1. Resources and Capacities for R&D

The assessment of resources and capacities in Research and Development in Malawi focused on three areas as follows:

●Human capacity

●Infrastructure capacity

●Financial capacity

i. Human Capacity

The capacity of the DARS to for Agricultural Research and Development varies quite widely across commodity groups. Surprisingly, it is noted that the highest number of PhDs is in management. This means that although these are

research professionals but they spend much of their time carrying out administrative tasks rather than research thereby reducing the actual research capacity of the department.

It is interesting to note that the total number of researchers with Masters and Bachelor of Science Degrees is almost the same. Out of the 12 PhDs in DARS, 9 of them are at Chitedze Research Station – the main agricultural research station in the country. It is worth noting also that since much of the research in the DARS is agricultural; focusing on crops and livestock, to these statistics the Crop Science Department at Bunda contributes 11 PhDs, 3 Bachelor of Science Degrees while the Department of Animal Science at Bunda Contributes 7 PhDs and 3 Masters Degrees. There is generally a very poor gender balance of the personnel in both Chitedze and Bunda.

ii. Human and Financial Capacity of Bunda College of Agriculture

The human capacity of Bunda College has greatly improved over the last decade in terms of both numbers as well as quality. In general, while the number of support staff in all the departments has decreased over the last decade, the number of academic staff has greatly increased. The move towards outsourcing of support services in the Universities of Malawi as a whole has resulted in significant retrenchments at this level. However, academic programmes have expanded with most options being upgraded to Bachelor of Science Degrees, establishment of several Masters Degree Programmes and more recently, PhD Programmes in Aquaculture and Fisheries, Agricultural and Resource Economics, Rural Development and Extension and in Livestock Production have necessitated strengthening of academic staff complement.

On the other hand, the financial capacity of the college is very weak as it largely depends on government subventions to run the institution and all research and development activities are donor funded. This means that continued research within the college including sustainability of Masters and PhD Degree Programmes is dependent on continued donor support.

iii. Financial Capacity of DARS

The Department of Agricultural Research Services (DARS) as a public science and technology institution depends on the Malawi Government for the bulk of its funding which currently accounts for over 80 percent of the Department's budget. The rest of the budget is made up of grants from various sources: donors, collaborative research partners and the private sector. The current Government funding level stands at 4 percent of the total budget of the Ministry of Agriculture and Food Security. It was reported through the Expert Opinion survey that much of the funding that goes to DARS is to finance Other Recurrent Transactions (ORT) with very little for research. Without donor funding, there is very little research, if any, taking place within the DARS. As pointed out below, the increasing percentage of the Agricultural budget that is allocated to support the government Input Subsidy Programme in recent years means that the rest of the sections in the Ministry share a smaller and smaller proportion on the total budget. All other things being equal, this entails reduced activity in these sections.

Similarly, almost 100 percent of the research taking place at Bunda College is donor funded. Government does not provide research funds to tertiary education institutions including supporting training at Masters and PhD levels. Only in isolated cases does government (with public funds) support their own staff to go for training at Masters and PhD Degree levels.

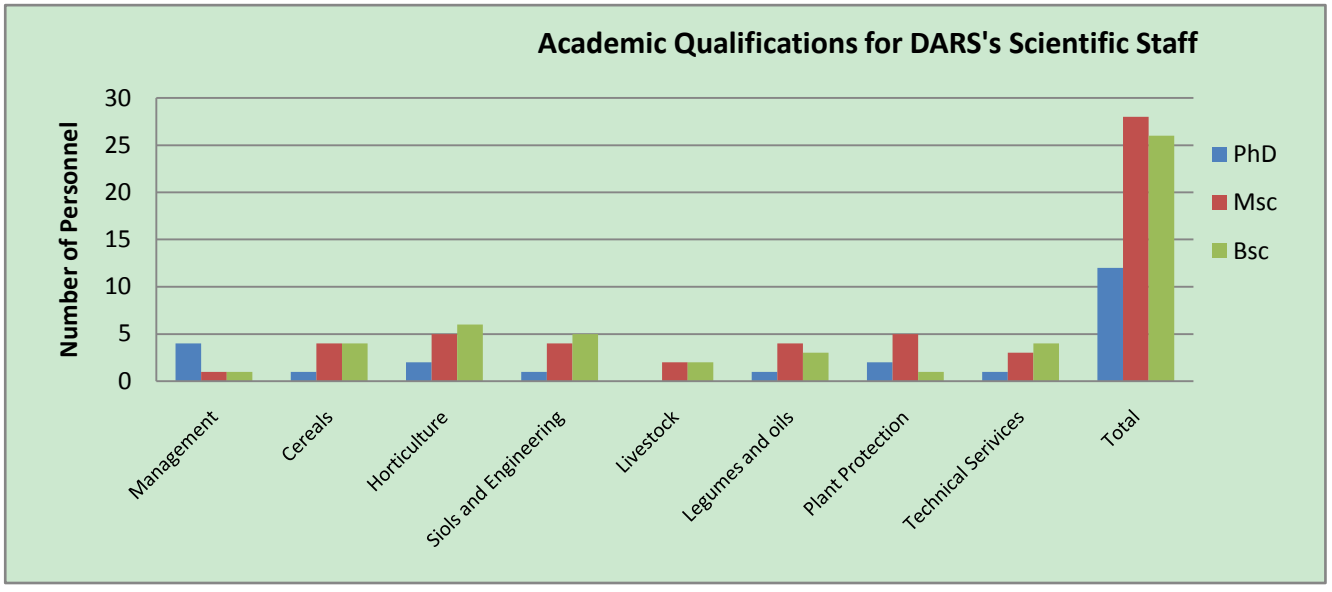


Figure 2. Summary of Academic Qualifications for DARS's Scientific Staff

iv. Infrastructural Capacity

The DARS has several research facilities ranging from laboratories, gene banks, border post quarantine testing units, farm workshops, libraries and many other facilities. As already pointed out, the DARS also relies on the facilities at Bunda College and Chancellor College as major partners in agricultural R&D in the country.

v. Funding of the CG Centres in Malawi

About 80-90 percent of funding of the CG centres comes from donors which normally includes European Union, USAID, African Development Bank (AfDB), World Bank, ASARECA, NORAD , countries like Germany, UK, Australia, Austria, Belgium and even from individuals like Bill & Melinda Gates and in the case of IITA Nigerian government also provides some funds for its activities. It is estimated that on average the CG centres spend about 65 percent of their funding on operations and about 25 percent on salaries and remunerations for their employees, with 10 percent considered as capital costs.

2.2. Extension Delivery System

Agricultural Extension Services in Malawi are coordinated by the Department of Agricultural Extension Services (DAES). The DAES formerly Department of Agriculture was instituted in 1907. Its mandate is to provide quality agricultural extension services in order to enhance adoption of improved technologies for farmers of all gender categories and vulnerable groups. Thus, the department translates agricultural innovations from research institutions, the private entrepreneurs to the farming communities.

The Policy of the department advocates a Pluralistic, decentralized and demand-driven agricultural extension service in Malawi. This policy was formulated in 2000 and operationalized in 2001 with the aim of responding to the growing demands from the farmers, based on commodity specialization. The policy also forms the basis for coordinating all players providing extension services in the agricultural sector.

2.3. The Vision

The Vision of the Department is that All Farmers demand and access high quality Agricultural Extension Service.

2.4. Mission Statement

To provide Demand Driven Agricultural Extension Services in partnership with civil, Non-Governmental Organization, private and farmer organizations and promote equalization and coordination in service provision in order to achieve food, nutrition and income security at household level thereby reducing poverty.

2.4.1. Institutional Structure and Strategic Functions

The department is headed by a Director of Extension Services. DAES has six sub-programmes namely:

i. Extension Direction and Management responsible for:

- Policy direction in harmonized planning and implementation of programmes.
- Providing guidelines for capacity building for Staff and farmers.
- Oversees management of financial and human resources.

ii. Extension Methodologies and Systems:

- The sub-programme uses innovative approaches, strategies and methodologies to reach out to farmers with agricultural technologies in order to improve food security and livelihoods. These are:
- Institutionalization of the District Agriculture Extension Services System (DAESS) - to improve coordination of service providers and bring service delivery closer to the clientele.
- Approaches -The model village approach – used as the entry, planning and implementation base for all programmes.
- Strategies for farmer mobilization - Farming clusters, ulimiwam'ndandanda and lead farmer are strategies for mobilizing farmers to collectively engage into group activities.
- Extension Methodologies - On farm demonstrations (with packaged technologies), field days, study tours and training are methodologies for information and knowledge sharing.
- Strengthen Research-Extension –Farmer Linkage mechanisms in agriculture.

iii. AgriculturalCommunication Services provides media services in the ministry and other stakeholders through:

- Production of farm radio programmes.
- Develop and print agricultural extension technical messages.
- Upgrade and maintain equipment in multi-media, mobile vans, Radio studio, and Video-graphics and Print workshop.
- Programme all media services in Agricultural Communications Branch.

iv. Agriculture Gender Roles Extension Support Services: Provide policy guidance and guidelines on mainstreaming gender and HIV and AIDS through:

- Promoting mainstreaming of Gender, HIV and AIDS in agricultural programs and the agriculture sector in general.
- Enhance male and female staff and farmer capacity in mainstreaming gender, HIV and AIDS in agricultural programmes and projects;
- Enhancing the participation of women in agriculture and food security programs and project activities.

v. Food and Nutrition:

- Promote Nutrition Education with emphasis on food processing, preservation, and utilization for diversified diets at household levels;
- Strengthening coordination and collaboration with other stakeholders;
- Capacity building forall nutrition programmes.

vi. Agribusiness Development and Management:

i. Promote business development and management through establishment of Farmer Based Organizations (FBOs):

- Improve marketing of agricultural produce
- Establishment of Farmer Business Schools

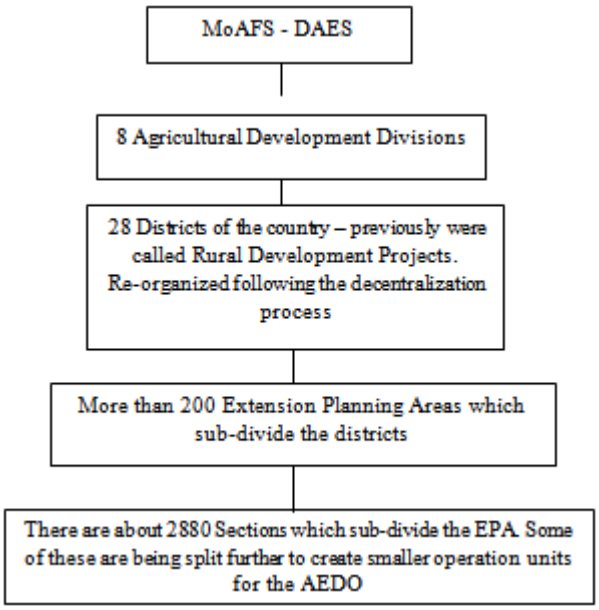
ii. The delivery of extension services to the farm level uses a comprehensive structure or extension delivery system which is structured as follows:

iii. 8 Agricultural Development Divisions (ADD) demarcated based on agro-ecological characteristics.

iv. 28 Districts (previously called Rural Development Projects) each headed by a District Agriculture Development Officer (DADO).

v. More than 200 Extension Planning Areas (EPA), each managed by an Agricultural Extension Development Coordinator (AEDC)

vi. About 2880 sections each manned by an Agricultural Extension Development Officer (AEDO) who is the frontline extension officer. He/she is that one who translates extension messages at the farm level (to the farmer). See Summary in Figure 2 below.



Extension delivery by DAES is carried out in collaboration with a number of collaborating partners at varying degrees. The main ones are the following:

Non-Governmental Organizations

Bunda through its outreach activities

Farmers' Organizations (FUM, NASFAM, ASSMAG etc)

Agro-dealers through demonstrations close to their shops

2.5. Summary of Research and Development and Extension Delivery System in Malawi

The preceding sections have discussed in a reasonable detail the research and development system in Malawi. This has been followed by a summary description of the extension delivery system in the country. The linkages between the two broad systems and the institutional linkages could be summarized by the Venn diagram below.

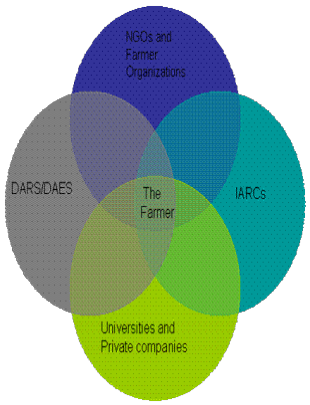
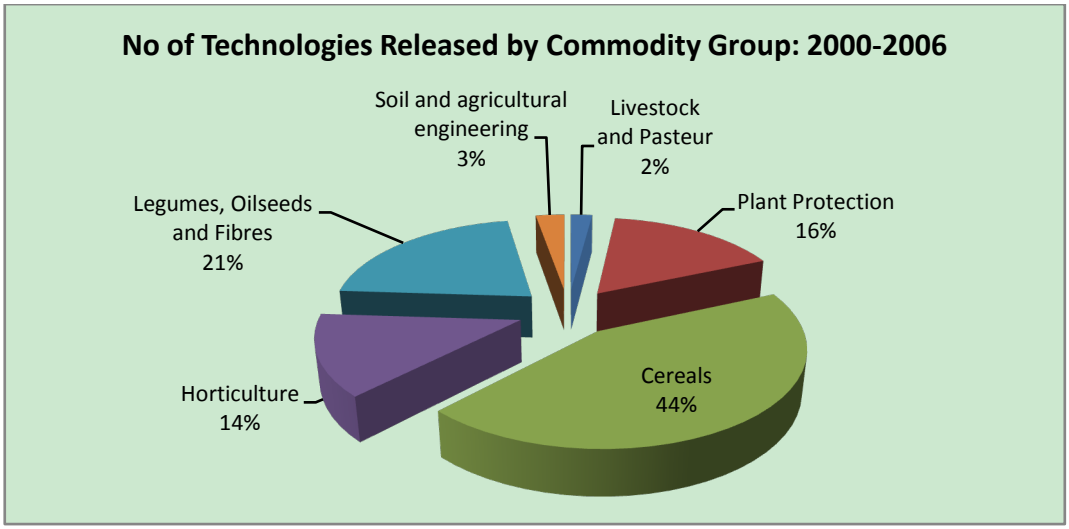


Figure 3: Linkages between R&D and Extension Delivery Systems

2.6. Technological breakthroughs and Agricultural Productivity Gains

The main technological advancements in various sub-sectors of agriculture vary quite widely. However, most of the technologies have been developed in the cereals commodity group. A total of 64 technologies have been developed in the cereal commodity group between 2000 and 2006 representing 44 percent of all technologies developed during this period. The least number of technologies developed has been recorded in soil and agricultural engineering and livestock and pastures. See Table 3 below. It is worth noting that the levels to which these technologies have been disseminated and subsequently adopted by farmers is not well documented and quantified. However, it is possible to assess the impact of these technologies with regards to increases in productivity[13].

Consultations with experts at Bunda indicated that with respect to livestock, no clearly known technologies have been developed. However, there are several promising technologies under this component with high potential of adoption among farmers. It was pointed out that on most of the livestock technologies, there was need for more work on the promising technologies in order to perfection them, including adaptation and modification based on local conditions.



Source: DARS 2010

Figure 3: Technology Developments

3. Productivity Gains in Crop Production

It is possible to assess the level to which AgR&D and Extension delivery systems have impacted on agricultural production over the years. Due to data limitations, however, assessment of increases in crop productivity was conducted only on selected crops.

Data summarized in Table 4 below show smallholder yield gaps and changes in crop productivity between 1988 and 2010. It is noted that for the majority of crops, despite the fact that the same base (1988) was used to calculate yield gaps, smallholder farmers are still producing more than 60 percent below the yield potential. However, significant yield gains have been achieved in cassava and tobacco. With regards to cassava, based on the 1988 research yield potential, it is noted that current cassava yield levels are about 25 percent higher than research potential in 1988. However, recent data (2005) show a yield potential range of 10 (Chitembwere variety) – 44 (Mkondezi variety) ton/ha depending on varieties. If the same calculations were done based on the maximum potential yield, it is noted cassava has 57.3 percent yield gap. Based on opinions from experts consulted, the impressive results for cassava have been attributed to the extensive research and promotional activities driven by government in close collaboration with IITA/SARRNET as means of reducing the over dependence on maize which is more prone to drought and can be grown in soils with relatively lower levels of fertility[13].

On the other hand, the relatively high improvements in the average yield of tobacco has been attributed to 1994 repeal of Special Crops Act which allowed smallholder farmers to grow high yielding and more lucrative tobacco types such as burley. Before then, smallholder farmers were restricted to the growing of Northern Division Dark Fired Tobacco, and Turkish tobacco which are far much lower yielding.

In general, however, if 1988 crop yields were compared with 2010 crop yields, it is noted that there are impressive improvements in yields with the highest in cassava (527.8 percent) followed by tobacco with 514.3 percent increase. The lowest yield increase between the two periods was recorded in rice (18.9 percent).

While crop yields are increasing for all the crops assessed in Table 4 below, and yield gaps between research and smallholder farms closing up, some questions still remains. What are the main challenges to improving agricultural productivity in Malawi? What could be done in order to accelerate the level of agricultural productivity in the country?

Table 4: Yield Gaps and Yield Improvements (1988 – 2010)

Crop	1988			2010		
	Research Yields (t/ha)	Smallholder Yields (t/ha)	Yield Gap (%)	Smallholder Yields (t/ha)	Yield Gap (%)	Yield increase (%)
Maize	6.0-10.0	1.03	89.2	1.43	85.7	38.8
Pulses	2.0-3.0	0.34	88.7	0.78	74.0	129.4
Cotton	2.0-3.0	0.70	76.7	1.04	65.3	48.6
Rice	3.0-6.0	1.64	72.7	1.95	67.5	18.9
Sorghums	2.0-3.0	0.61	79.7			
Cassava	10.0-15.0	2.99	80.1	18.77	- 25.1	527.8 *
Wheat	2.0-3.0	0.65	71.7	-	-	-
Sunflowers	1.5-3.0	0.42	86.0	-	-	-
Irish potatoes	10.0-15.0	3.60	75.0	-	-	-
Tobacco	2.0-3.0	0.42	85.9	2.58	14.0	514.3 **
Groundnuts	2.0-3.0	0.50	83.3	1.01	66.3	102.0

Source: Saka*et al* (2004) and Own calculations

Note:Percent yield gap is the difference between maximum yields obtained under research station conditions and the national smallholder average yields.

Yield increase is a percentage change between yields in 2010 and 1988. Yield gap for 2010 is based on the 1988 Research yield potential to show the yield improvements.

4. Challenges to Raising Agricultural Productivity

The major challenges to agricultural productivity include: (i) adverse weather conditions, (ii) poor and unimproved crop varieties, (iii) poor crop management practices, (iv) insects, pests and diseases, (v) technology barriers, (vi) environmental externalities and technology adoption, (vii) increasing population pressure on land, (viii) poor and declining soil fertility, and (ix) institutional challenges.

(i) *Adverse weather conditions:*Frequent droughts and floods; and erratic, unreliable and unpredictable rainfall have over the last two decades adversely affected crop production in Malawi with major repercussions on economic growth and development (RMSI, 2010). The frequency as well as the intensity of these hazards has tended to increase over the last two decades[14]. These are mainly caused by global climate changes, as a result of increasing greenhouse gas emissions, shifts in the global air circulation patterns, and disruptions of hydrological systems.

(ii) *Poor and unimproved crop varieties:* The continued use of low yielding crop varieties has led to low productivity, which has created a yield gap that ranges between 72% and 89% for different crops. However, following the implementation of Farm Input Subsidy Programme, use of improved technologies such as seeds and fertilizers have tended to improve as we shall demonstrate later in this paper.

(iii) *Poor crop management practices:* Even in cases where high yielding crop varieties have been adopted, there has been no remarkable increase in crop production under smallholder farm conditions. Part of the problem is due to poor crop husbandry and management practices, such as late land preparation, late planting, inappropriate plant population densities, late weeding, poor fertilizer management practices, and poor post-harvest handling and storage.

(iv) *Uncontrolled insect pests and diseases.* Insect pests and diseases adversely affect crop performance. Smallholder farmers do not have the capacity to control large-scale infestations of migratory insect pests, such as red locusts or armyworm; and/or new diseases, such as Gray Leaf Spot or Maize Streak Virus.

(v) *Technology adoption barriers:*For farm-level adoption, barriers include small farm size, widespread poverty and lack of capital, inadequate credit, risk aversion, lack of access to information, lack of human capital, inappropriate transportation infrastructure, inadequate incentives associated with tenure arrangements, poor linkages among various stakeholders, inappropriate government policies, and unreliable supplies of complementary inputs. Because strategies for new technologies are often imposed in top-down manner, implementation fails when local people are not consulted, or when local research and extension staff are not sufficiently trained in the specific techniques.

(vi) *Environmental externalities and technology adoption:* Technology adoption barriers arise from environmental externalities so that market prices do not reflect the true social costs and benefits of particular technology adoption choices. Environmental quality can be improved by internalizing externalities, and correcting market failures in the provision of information and infrastructure. Insufficient information constrains the adoption of new technologies by farmers.

(vii) *Increasing population pressure on land:* Increasing human population pressure on a limited land resource base is exerting enormous pressure on limited renewable natural resources (land, soils, water, fisheries, forests and wildlife). Land and soil degradation is exacerbated by many factors, including: (i) deforestation, (ii) overgrazing, (iii) continuous cultivation, (v) poor soil and water management practices, and

(iv) Unsustainable management of natural resources, a situation that has led to severe soil erosion and declining soil fertility, hence low crop and land productivity.

(viii) *Poor and declining soil fertility:* Presently, poor soil fertility is the biggest problem that greatly constrains agricultural productivity in Malawi. Malawi has over the years experienced excessive land degradation, thereby negatively affecting crop productivity, food security and income generation mainly among the smallholder farmers. Land degradation may be defined as the loss of utility or potential utility through the reduction of or damage to physical, chemical, social, cultural or economic features and/or reduction of ecosystem diversity. Reference[15] defines soil degradation more specifically as "any chemical, physical, or biological change in the soil's condition that lowers its agricultural productivity, defined as its contribution to the economic value of yields per unit of land area, holding other agricultural inputs the same."

4.1. Constraints for Technology Generation and Productivity Growth

Malawi's research and development initiatives are affected by several constraints which also limit the levels of adoption. Low levels of adoption of modern farming technologies also limit the rate of agricultural productivity growth. The main factors that constrain technology generation and productivity growth are summarized below.

4.1.1.*Limited Collaboration amongst Researchers and also with Extension Workers*

The general picture obtained from the expert opinions is that there is limited collaboration among scientists from different institutions (public, semi-public, international and private institutions). One fundamental cause of limited working relationships amongst research bodies is the

heterogeneity in resource endowment, mainly with regards to finances. In particular, public and semi-public institutions fail to effectively work with international and private bodies. The international and private research bodies do not appropriately extend their resources with the public and semi-public research institutions to boost their collaborative work.

Additionally, the problem arises from the fact that researchers fail to closely work with extension workers to jointly work on priority problem areas of the farmers. This limits the development of technologies that would be readily disseminated to farmers and with enhanced acceptability by these end users. This in turn limits the rate of agricultural productivity growth.

4.1.2. Limited Capacity in General which Includes Human Capacity

Several key areas of research have limited capacity in the country. For example livestock research is quite weak in Malawi. Biotechnology is just starting, agro processing key in Pillar 2 in ASWAp but is still lacking the necessary capacity to develop it further. On Human capacity, restrictions from donors mainly the International Monetary Fund in recruitment have affected the sector. This is because of the agreements between government and donors on what government can spend on salaries. As a result, there are many vacancies but government cannot recruit. The Ministry of Agriculture and Food Security is operating at 50 percent capacity in the Department of Agriculture Research Services[9].

4.1.3. Shortages of Germplasm/Breeding Materials

The shortage of breeding materials remains a challenge to technology development. The study revealed that good breeding materials are missing in some crops such as Irish potatoes. In some instances, some of the existing materials are so mixed that their purity is lost hence need to have new breeder seeds which are not readily available in the country. Some planting materials/seeds shortages arise due to outbreaks of diseases and pests which warrant development of resistant varieties such as outbreak of banana bunchy top disease. There are specific crops which are handled by the semi-public bodies which lack technological development support from the Ministry of Agriculture. In this regard, sugarcane research is not handled by the Ministry much as smallholder farmers are actively being involved in its production. Currently the technologies in use for sugarcane production are largely brought into the country from South Africa and Mauritius.

Similarly, the livestock sub-sector largely suffers from some serious shortages of breeding stock for a number of livestock types such as goats, cattle, pigs and others. This picture is more serious for the public sector hence research work in this area is impeded by this development. For instance in goats, the demand for improved bucks and dairy goats outstrip the supply from some limited breeders in the country.

4.1.4. Budgetary Allocation from own Resources Remains a Big Challenge

Research activities in the department still largely depend on donor funded projects. This is a major concern. It means that in the absence of donor support, ideally, there will be no research going on in public research institutions. As already pointed out, the government currently invests only 4% of the agricultural budget in research. This is compounded by the fact that in recent years, the Input Subsidy Programme (ISP) takes the "lion's share" of the agricultural budget as it can be noted in Table 5 below. A slight decline in world fertilizer prices in 2010 resulted in a reduced cash outlay to support the ISP for the 2010/11 growing season. But this did not entail a reduction in the amount of fertilizer procured for the programme.

Table 5: Percentage of Input Subsidies in the Agricultural Budget

Year	Total Agricultural Budget (MK)	Allocation to Input Subsidies (MK)	% of Subsidies in Total Agricultural Budget
2005/06	15,171,761,156	-	-
2006/07	18,537,262,837	10,205,000,000	55.1
2007/08	20,970,392,640	13,500,000,000	64.4
2008/09	32,234,211,526	21,965,000,000	68.1
2009/10	33,537,080,432	24,995,130,717	74.5
2010/11	35,476,498,315	20,056,583,963	56.5

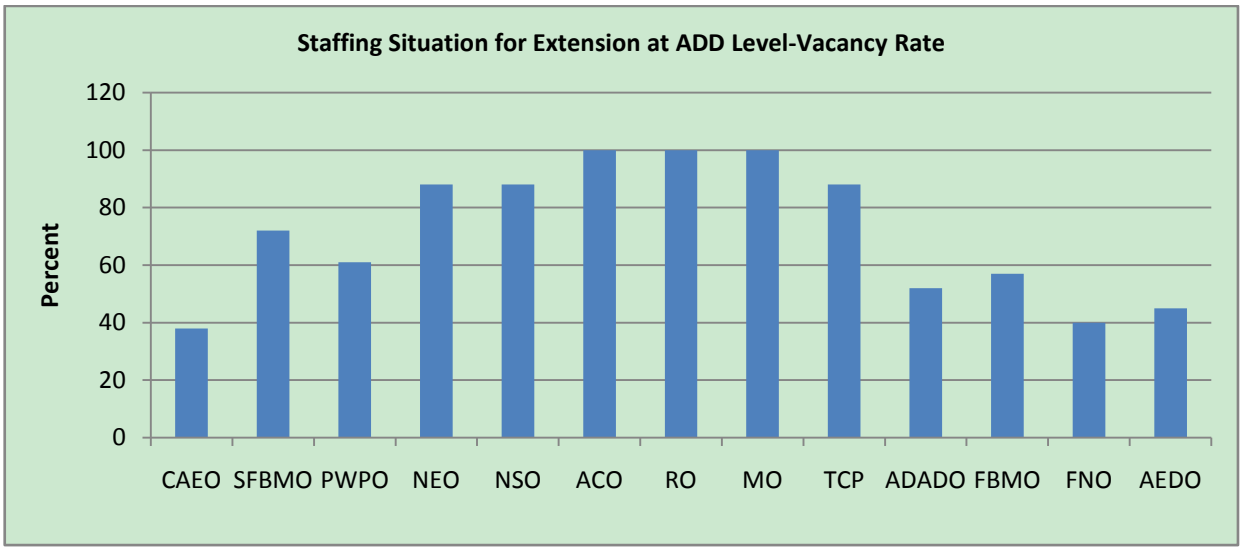
Source: Ministry of Agriculture and Food Security and Own calculations

4.1.*5. Limited Infrastructure in General Including Lab Equipment for Research*

Despite the fact that all research stations have various types of laboratories; most of these have old or outdated equipment. It is expected however that donors are supposed to support the ASWAp through ASWAP-Support Project which is supported by the World Bank and Norwegian Embassy. It is aimed at building capacity in support of the ASWAp[12]. A lot of trials are being run through this project.

4.1.6. Skewedness of Technologies towards some Specific Areas

It has been pointed out that some of the commodities enjoy more technology generation than others. This was found to be the case for cereals more than other crops. For instance, Irish potatoes have received less attention than cereal crops. And within the cereals, maize has been the main beneficiary of research support. This skewdness also exists within the same crop types for instance beans have received more focus than chick peas and soy beans. Irrigation and mechanization are other areas that has had limited number of developed technologies despite being considered important.



Source: DAES Staff Rationalization Report – 2008

Figure 4: Staffing Situation for Extension at ADD Level

4.2. Technology Dissemination Constraints and Adoption

Fundamentally, technology dissemination is constrained by the existence of two main factors in the country. These mainly relate to the extension delivery system and the market systems for both input and output markets. It is noted that constraints in technology dissemination and adoption ultimately affect the rate at which agricultural productivity increases. The two main constraints are briefly discussed below.

4.2.1. Weak Extension Delivery Services

Effectiveness of the Department of Agricultural Extension Services (DAES) towards improving agricultural development has been reduced over the recent past owing to low staffing levels and lowly - trained personnel in the department. Figure 4 below shows an analysis of the staffing situation in the Department of Agricultural Extension Services at national level. It shows that most of the posts at various levels are vacant. The situation is more critical at ADD level where 45% of the posts are vacant.

It is worth noting that the highest vacancy rate is 100% for the posts of Agricultural Communications Officer, Radio Officers, Maintenance Officer, and Principals for Residential Training Centers followed by posts of NEO and NSO which are 88%. In general, this situation greatly affects the delivery of quality extension services in the country. Effective extension delivery is key to ensuring technology transfer to farmers leading to high levels of technology adoption which in turn will lead to improving crop productivity. Weak linkages between research and extension services as already discussed above exacerbate the problem of capacity.

Other major constraints and challenges which negatively affect effective delivery of extension services in the country could be summarized as follows:

- Transport problems at all levels, at headquarters, ADD level, and district level which affects supervision of field activities
- Poor state of frontline staff houses which negatively affects staff motivation leading to high staff turn-over; mostly taken up by NGOs. This has ultimately negatively contributed to weakening the extension delivery system
- Low motivation to staff in terms of training plan not many junior staff are sent for training to upgrade their skills.
- There is no proper succession plan therefore people remain at the same position for a long time without being promoted.
- Insufficient capacities in junior staff since most of them never go for refresher courses.
- Too many *ad hoc* programs, so this affects the implementation of annual work plans leading partial implementation of core activities within the department.

4.3. Binding Constraints for Productivity and Commercialization

The binding constraints for productivity and commercialization are both internal and external to the smallholder. These are discussed below.

4.3.1. Internal Constraints

Capital and land constraints: The majority of smallholder farmers are poor. As a result they are limited in term of investing in improved technologies which could lead to raising agricultural productivity. Smallholder farm types do not have enough arable land (on average 0.5hactare) to produce at a scale that justifies high cost and investments in much of the improved technologies and practices. The smallholder farm type faces cash constraints in form of capital. Although microfinance services are available in the rural areas, access to credit is limited due to stringent requirements in terms of assets, income, high interest rates among other things. Most smallholder farmers do not have the necessary collateral to enable them access formal credit sources.

Quality of natural resources: Declining soil fertility is

considered as one of the most binding constraints to improving crop productivity and hence commercialization. This problem is compounded by the fact that the majority of smallholder farmers cannot access improved inputs without support from the government (subsidy) or through free input distribution programmes implemented by NGOs.

Labor constraints: The availability of labour may be limiting adoption of technologies in some smallholder families. It is understood that male headed households have relatively lower provision of labour than male headed households. The labour supply levels have in some cases been low due to HIV/AIDS impact which has led to many household members attending to the sick person or reduction in household members due to HIV/AIDS related deaths. This therefore means that labour intensive technologies may not be widely adopted in the smallholder farm types.

Education Level: Low education levels among smallholder farmers affects agricultural productivity due to limited drive to adopt improved technologies.

4.3.2. External Constraints

Several external constraints to the smallholder farm type have been identified, which constrain productivity improvements and commercialization.

Technology availability: There is limited access to some of the technologies developed due to inherent weaknesses of the extension delivery system. As a result not only are farmers not aware of the technologies, but these are also not available within the communities.

Location of Output markets: With respect to output markets, poor transport infrastructure limits their access to markets. This makes them travel long distances to access markets also affecting their marketing margins.

Input market constraints: Access to inputs is limited by lack of infrastructure (roads, markets) in the rural areas which similarly results in high transportation costs. Apart from infrastructure, input market access is also limited by inefficiencies among input suppliers due to poor logistic arrangements, importing processes which usually make inputs available at a wrong time.

Inadequate marketing institutions: Commercialization of agriculture in Malawi is also being bounded by inadequate cooperatives and stronger farmers' associations which can lobby effectively for better prices and other producer incentives.

4.4. Opportunities to Raising Agricultural Productivity

The main opportunities to raising agricultural productivity in Malawi include: i) favourable policy environment; ii) a lot of technologies available and ready for scaling up; iii) supportive donor community; and iv) existing well organized extension delivery system.

a. *Favourable policy environment:*The government is committed to improving agricultural productivity through various policy initiatives such as the Input Subsidy Programme, the Green belt initiative and the comprehensive policy support provided through the Agriculture Sector Wide Approach (ASWAp).

b. Alot of technologies available and ready for scaling up: A lot of technologies have been identified in Malawi defined as "best-bet". These are technologies that have very high potential of being adopted mainly because of their characteristics and adaptation to farmers' conditions. Appropriate strategies need to be designed for scaling-up these technologies which have already been identified.

*c. Supportive donor community:*It has been noted over the last five years or so that donor confidence has been reestablished due to the fiscal discipline of the current government and the conducive policy environment. Several donors are now willing to support the government of Malawi in its various development programmes including the Input Subsidy Programme.

d. Existing well organized extension delivery system: Malawi has a well organized extension delivery system despite its human capacity problems. This is coordinated through the Department of Agricultural Extension Services (DAES). Its mandate is to provide quality agricultural extension services in order to enhance adoption of improved technologies for farmers of all gender categories and vulnerable groups.

The Policy of the department advocates a Pluralistic, decentralized and demand-driven agricultural extension service in Malawi. This policy was formulated in 2000 and operationalized in 2001 with the aim of responding to the growing demands from the farmers, based on commodity specialization. The policy also forms a basis for coordinating all players providing extension services in the agricultural sector.

4.5. Diagnostic Analysis for Accelerating Agricultural Productivity Growth

The diagnostic analysis for accelerating agricultural productivity growth in Malawi builds on the information that has been provided in preceding sections of this paper. The aim of this section therefore is to provide a general discussion of the strengths and weaknesses (binding constraints) to raising agricultural productivity, along the following chain and provide a basis for suggesting key drivers to agricultural productivity growth:

R&D system → extension system → adoption (profitability – factors including environmental, natural resource base / markets / gender/ other)

The preceding analysis has shown that Malawi's R&D system is quite strong in many ways. Firstly, Malawi has a well-established network of institutions that are involved in different types of research. Each research institution has clear mandates and strategic plans which guide their research focus and direction. There is a relatively strong staff complement to each organization involved in research. It is also important to note that the distribution and diversity of research centres in the country also takes into account the agro-climatic diversity of the country. This means that

adapted or appropriate research is conducted for each zone of the country.

Secondly, to this complex research development network is linked a comprehensive agricultural extension delivery system. A pluralistic – demand driven extension delivery system ensures that all farmers in the country are reached with extension messages. The Agricultural Extension Development Officer (AEDO) is the frontline extension worker whose role is to expose farmers to all newtechnolog ies being generated through research within the country.

Thirdly, market liberalization has created a more conducive environment that enables competitive pricing for both input and output markets. Thus a number of players have now entered these markets to the benefit of the farmers. Access to markets that offers competitive market prices offers incentives to farmers to invest in more productive technologies.

Fourthly, experience in Malawi over the last few years has shown that there is strong government commitment to ensuring improved agricultural productivity through various policy initiatives including those that take into account equitable participation of all gender groups in economic activities besides ensuring their access to productivity enhancing technologies.

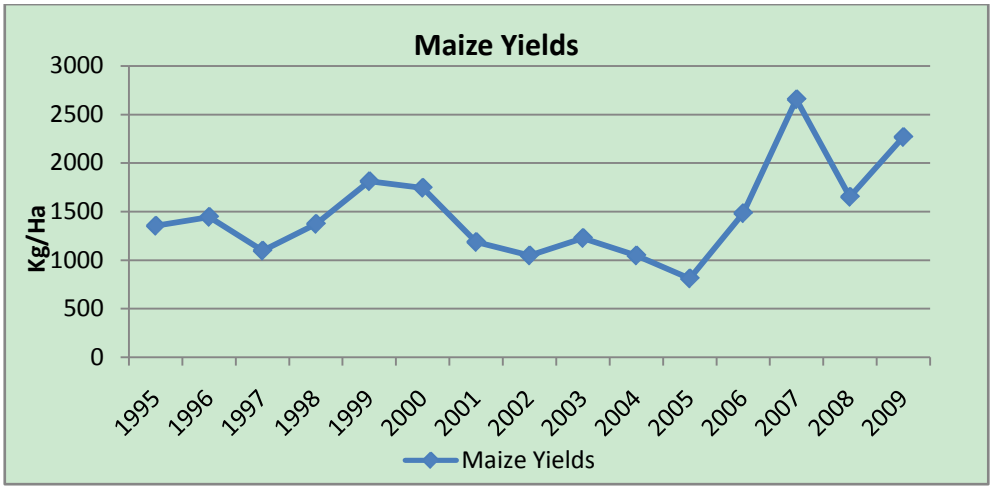
However, despite the existence of a strong R&D system in general, several weaknesses affect the level to which this system could fully contribute to enhancing agricultural productivity in the country. Firstly, cognizant of the fact that agriculture is the engine for economic growth for Malawi, it is paradoxical to note that the sector does not receive the necessary budgetary support that it deserves from government coffers. The current 4 percent investment in research and development is too low to drive new technology generation in the country. It has already been noted that research in Malawi is donor driven. This is not a healthy situation if Malawi is to effectively define and drive its own research agenda. Secondly, it is not surprising that most of the technologies developed by research do not reach the target beneficiaries – the farmers- due to the very high vacancy rate in the Department of Agricultural Extension Services – defining a relatively well-organized but very weak institutional network. It is understood that HIV and AIDS, retirements or indeed resignations converge to create such a high vacancy rate, but this is relatively the same situation in all other sectors of the economy. Thirdly, it has been noted with concern that the situation of gender at all levels is skewed towards men. Except in some cases, technical staffing is relatively gender sensitive, but most of the senior research positions are held by men. Fourthly, the limited competitive market environment arising from poor transport and road networks is a major hindrance to improving agricultural productivity in the country. This is exacerbated by the fact that the majority of smallholder farmers sell their crop produce on an individual basis hence have very limited bargaining power for better prices. Finally, but not least, declining soil fertility and failure of the majority of farmers to manage the decline in fertility is a major threat to long term sustainability of agricultural productivity.

4.6. Suggested Drivers for Accelerating Agricultural Productivity Growth

The strengths and weaknesses of the Research and Development system in Malawi provide fertile ground for policy and institutional reforms that would lead to improved agricultural productivity. A few strategies or drivers have been suggested that would lead to doubling yields for example in the next decade or so.

Not much headway would be achieved in terms of agricultural productivity (adoption) with a weak extension delivery system. The government of Malawi should embark on massive training of frontline extension workers to drive the technology diffusion process. Technologies will continue to gather dust on the shelves with 50 percent vacancy rates in the extension delivery system particularly at the farmer level where technologies are translated into improved crop productivity. This strategy should also take advantage of the existence of multiple players (e.g. private sector, NGOs, Farmer Organizations) in agricultural extension delivery by establishing strong synergies with such organizations. Strong Public – Private Partnerships (PPPs) would assist in dissipating inherent weaknesses in public institutions in the delivery of extension services.

Malawi's research agenda should be supported first and foremost with local resources. Thus research funding should significantly reflect the importance of the sector to the economy. Indeed subsidies are important in supporting the poor to access crop productivity enhancing technologies but this strategy is not sustainable in view of the intense stress it puts on budgetary resources of the country. Figure 5 below shows the significant improvements in maize yields in almost all the ADDs since 2004 following reintroduction of the Input Subsidy Programme. But such a strategy in a resource constrained economy such as Malawi needs to be a temporal measure for demonstrating yield gains if farmers adopt as a package a combination of improved maize seed and inorganic fertilizers. It is worth noting that several organic *'best-bet'* technologies have been developed and are ready for scaling up. The government of Malawi should consider investing in promoting Integrated Soil Fertility Management Technologies where inorganic and organic soil fertility enhancing technologies should be promoted together. Studies have shown that adoption of Integrated Soil Fertility Management Technologies (ISFMT) leads to higher crop productivity gains than if organic and inorganic fertilizers were used separately[16]. All other things being equal, this will lead to a decline in the overall cost of the crop production system particularly if this leads to a reduction in the demand for inorganic fertilizers. Promotion of such a strategy will also lead to significant reduction in the amount of financial resources needed to support the input subsidy programme[17].



Source: Authors' calculations based on FAOSTAT (2011)

Figure 5. Improvement in Maize Productivity following Input Subsidies

Unless farmers have access to stable output markets, there will be little incentive to generate a surplus beyond subsistence needs. Many programmes in the country have tended to emphasize on productivity without putting in place strategies, *a priori,* of how to manage the surpluses once they are generated leading to farmers' frustrations. Investing in farmer cooperatives and linking them to stable markets through contract farming arrangements for example is one way of ensuring a win-win situation for the farmers as well as agricultural produce processors. This will require significant capacity building to ensure establishment of effective relationships between buyers on the one hand and sellers on the other.

5. Conclusionsand Recommendations

This paper has given a comprehensive exposé of key challenges and opportunities for agricultural productivity growth in Malawi. It has also raised a number of issues that define the current R&D landscape for Malawi. Firstly, despite the fact that agriculture is the engine for economic growth for Malawi's economy, R&D seems not to be a key priority area of emphasis in terms of research funding. Much of the research carried out by the DARS as well as the Universities is donor funded. This does not depict a healthy R&D situation for the country. Discontinuity of donor support entails no research for the well organized R&D system in the country. It is also noted that since 2004, the Input Subsidy Programme is taking a "lion's share" from the agricultural budget rising to three quarters in 2009/10. This means that the rest of the other components of the sector have to share only 25 percent of the agricultural budget raising major worries on sustainability of activities in these areas including Research and Development. Nevertheless, through collaborative effort, Malawi has a critical mass of researchers in different areas of agriculture. On the other hand, there is a weak link between agricultural research and extension largely because of the relatively weak extension delivery system. This means that unless this situation changes, it will be very difficult to speed up technology adoption in Malawi. As a result, agricultural productivity growth will continue at the current slow pace leaving a huge gap between actual and potential crop yields.

Some key recommendations have been made based on the findings from this study. These are summarized as follows:

The Government of Malawi with support from its development partners should include R&D funding in every annual budget that it passes in parliament. There is enough research capacity in the country but this can only be translated into meaningful returns if there is funding to conduct more research and disseminate results through adoption of farmer friendly strategies.

There is an urgent need to consider strengthening the agricultural extension delivery system if technology development is to result in significant improvements in agricultural productivity. Among others, government should lobby with donors (IMF, World Bank) to relax the employment controls so that both research and extension could be strengthened through increased numbers of people on the ground. Frontline extension staffs are key to driving technology adoption that would in turn result in accelerated agricultural productivity growth.

Government should make deliberate efforts by creating a conducive environment and building capacity of smallholder farmers for the establishment of farmer producer and marketing associations which are preconditions for contract farming with agri-processors.

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