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The impact of investment in smallholder irrigation schemes on irrigation expansion and crop productivity in Malawi

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Abstract

Reliance on rainfall for agriculture and increased climate change and variability pose growing production risks in developing countries. Agriculture in Sub-Saharan Africa is dominated by smallholder farmers who depend mainly on rain-fed agriculture, putting food security at both household and national levels at risk, especially in the event of drought. Investment in smallholder irrigation becomes a priority in developing countries if food security and national development goals are to be met, as their economies are agro-based. This study evaluates the impact of investment in smallholder irrigation schemes in Malawi on improving crop production and productivity in comparison with rain-fed agriculture. The area under smallholder irrigation schemes increased from 15 988 ha in 2003 to about 42 986 ha in 2011, contributing immensely to national food production. Irrigated maize production increased from 78 159 tons in 2000 to 544 378 tons in 2013.

Key words: agriculture; irrigation; smallholder farmers; crop productivity; water resources

1. Introduction

Irrigation has been found to be one of the key solutions to the problem of food insecurity in the face of recurring droughts and floods, rapid population growth and climate change (Nkhoma 2011; Shah *et al*. 2002). Agriculture in Malawi, like in most countries in Sub-Saharan Africa (SSA), is heavily dependent on rainfall, yet it is the mainstay of the economy. In normal years, agriculture contributes more than one-third of GDP and over 90% of export earnings, employs almost half of those in paid employment and supports at least 85% of the population (Chirwa 2008; Harrigan 2008; Tchale 2009). Agriculture, therefore, determines the pace and direction of the overall economic growth of Malawi and, consequently, productivity in the sector is of great concern to policy makers.

However, dependence on rain-fed agriculture has caused food insecurity at both the household and national level, as the rainy seasons have become unpredictable and shorter, while the recurrence of floods and droughts have been more frequent in the last decades due to climate change and variability (AGRA 2014). This is compounded by other stressors, such as poor soil fertility and low input use. For example, the 1992 drought resulted in a fall of approximately 7.9% in real GDP, as the country's economy depends heavily on agriculture. Food deficits therefore have dire consequences in Malawi,

as the country is exposed to the high costs in foreign exchange of importing grain, and to the risks associated with dependence on world markets or aid donors (Devereux 1997; Lea & Hanmer 2009).

Like in other Sub-Saharan African countries, smallholder farming in Malawi dominates the agriculture sector, as it is the primary producer of agricultural outputs. But it is vulnerable to the impacts of climate change and variability, as the smallholder farmers lack the necessary resources to adapt (AGRA 2014; Lemos *et al*. 2013). The vulnerability of smallholder farmers to the impacts of climate change exposes the national economy and food security to climate-induced shocks, as Malawi's economy is agro-based.

Considering the important role played by smallholder farming in Malawi, it becomes imperative to invest in the sector, and especially in smallholder irrigation. Malawi is a country endowed with abundant freshwater resources, covering about 21% of the total land area, but despite this vast water resource, only 3.5% of agricultural land is irrigated (MoAIWD 2012b). Malawi therefore has the potential to expand its irrigated land and improve agricultural performance, especially the 3.5% of land under irrigation, which is well below the Southern Africa Development Community (SADC)'s Regional Indicative Strategic Development Plan (RISDP) target of 7%.

Investment in irrigation is one of the key factors required to increase agricultural productivity in Malawi. Irrigation has the potential to maintain reliable crop production that is enough to meet the national food requirements, as crops can still be produced even if there is drought. Reliance on rain-fed agriculture will continue to stagnate crop production, with the consequence that net food imports to the country will continue to increase as the population continues to grow rapidly. According to the population census undertaken in 2008, the Malawi population stood at about 13 077 160, an increase of 32% from the census undertaken in 1998 and an increase of 64% from that taken in 1987, just after the completion of the last national water resources assessment and the National Water Resources Master Plan (NSO 2009). The population is currently estimated at more than 16 million (World Bank 2015). If the average economic growth of 5% achieved during the period from 2003 to 2009 (Chilonda *et al*. 2010; Domenech & Ringler 2013; World Bank 2015) continues, together with the current rapid population growth, pressure on food and natural resources will grow significantly, increasing the demand for irrigated agriculture.

Faced with the challenge of meeting the food requirements of a rapidly growing population, and with the need to reduce food imports, the government of Malawi has, since 2004, prioritised investment in irrigation development at the smallholder level. As the result, there has been an increase in yields through the provision of at least two harvests per year. The prioritisation of irrigation investment at smallholder level has had the benefits of ensuring food security, promoting economic development and improving the livelihoods of people. Some of the agriculture programmes targeting smallholder farmers that the government has been implementing and that stimulate crop production include (MoAIWD 2013):

a) Malawi Irrigation Support Programme
b) Small Farms Irrigation Project
c) Smallholder Crop Production and Marketing Project
d) Development of Medium-scale Irrigation Schemes (MIDP)
e) Climate Adaptation for Rural Livelihood Advancement and Agriculture Project (CARLAP)
f) Strengthening the Water Sector Monitoring and Evaluation Project (SWSM&EP)

The government also implemented other projects that were administered by ministries other than the Ministry of Agriculture, yet had an impact on smallholder irrigation, and these include:

a) Agriculture Infrastructure Support Project (AISP)
b) Irrigation Rural Livelihoods and Agriculture Development Project (IRLADP)
c) Green Belt Initiative (GBI), administratively implemented in the Office of the President and Cabinet (OPC)
d) Smallholder Irrigation and Value Addition Project (SIVAP)
e) Shire River Basin Management Programme Project (SRBMP)

This study assesses how investment in smallholder irrigation is affecting the expansion of smallholder irrigated area and improving crop production and productivity in Malawi. A comparison is drawn of the changes experienced in irrigated area, crop production and productivity between smallholder irrigation schemes and privately owned smallholder estates, as well as between irrigated and rain-fed systems, between 2000 and 2013. The analysis enables the appreciation of the impact of smallholder irrigation on economic development, food security and the livelihoods of the rural majority.

2. Geography, climate and population of Malawi

Malawi is located between latitudes 9°22′S and 17°03′S and longitudes 33°40′′E and 35°55′E, with a surface area of 118 480 km^2, of which the land area is 94 276 km^2, with the rest of the area being comprised of water, mainly Lake Malawi. As a result of these vast water resources, the government of Malawi has realised the importance of spearheading economic growth through the utilisation of its water resources, and has embarked on a programme to expand irrigation. Malawi is a landlocked country bordered by Tanzania to the north and northeast, by Mozambique to the south and southwest, and by Zambia to the west.

Figure 1 is a map showing the location of Malawi and its altitude. Malawi has four recognised main physiographic zones, and these are the Highland, the Plateau, the Escarpment and the Rift valley floor. As shown in Figure 1, the Highland areas range from 1 500 to 3 000 m above sea level, whilst the Plateau areas range from 900 to 1 500 m. The Rift valley floor ranges from about 500 m at the lakeshore to about 50 m in the lower Shire Valley. About 94% of the land area in Malawi, as well as parts of two neighbouring countries (Zambia and Mozambique), forms part of the Zambezi River Basin, which drains into the Indian Ocean. The remaining 6% falls within the small internal drainage basin of Lake Chilwa. Eight percent of the Zambezi River Basin falls within Malawi. The country's population is currently estimated at more than 16 million (World Bank 2015), and it is spread across three regions, namely Northern, Central and Southern, which are comprised of 28 districts in total.

The country has a sub-tropical climate, which is relatively dry and strongly seasonal. The warm-wet season stretches from November to April, during which 95% of the annual precipitation takes place. Annual average rainfall varies from 725 mm to 2 500 mm. Low-lying areas like the lower Shire Valley and some areas in Salima and Karonga are more vulnerable to floods than higher grounds (Chipofya *et al*. 2012). A cool, dry winter season stretches from May to August, when the mean daily temperatures vary between 17 and 27°C, with night-time temperatures falling to between 4 and 10°C. In addition, frost may occur in isolated areas in June and July. A hot, dry season lasts from September to October, with average temperatures varying between 25 and 37°C. Humidity ranges from 50% to 87% during the drier months of September/October and the wetter months of January/February respectively. The period from December to March is characterised by hunger, as food reserves from the previous season decline.

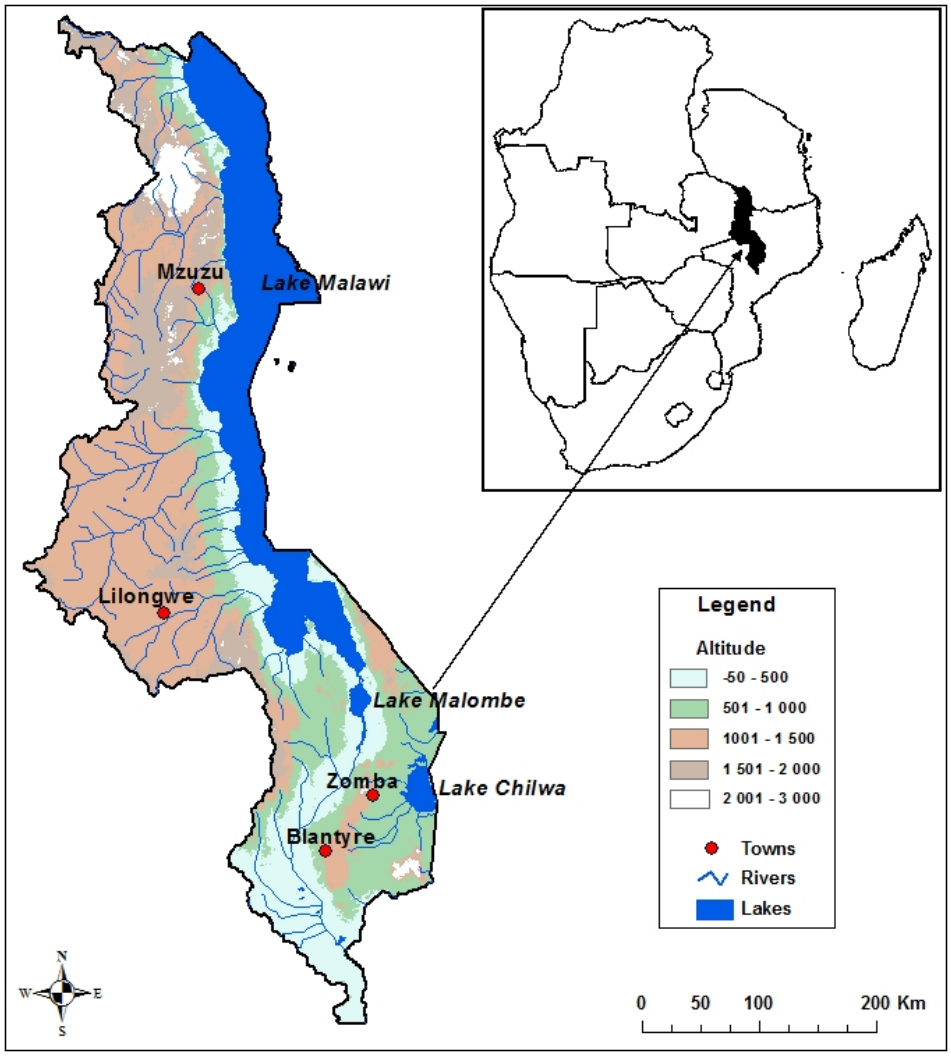

Figure 1: Map of Malawi, showing its elevation and location in Southern Africa

3. Investment in the water sector in Malawi, including the performance of the national budget in this sector

Investment in the water sector in Malawi, of which irrigation forms part, has been increasing over the past years. The investment has been bearing fruit, notably in the irrigated sector, where the land under smallholder irrigation (both smallholder irrigation schemes and private estates) has increased from about 53 000 ha in 2003 to about 102 000 ha in 2014. The government of Malawi has prioritised irrigation as a means to ensure food security in the country. The expansion of land under irrigation is in line with the objectives of the Comprehensive Africa Agriculture Development Programme (CAADP) of increasing the area under irrigation by 7% and investment in agriculture by 10% of the national budget. Malawi is one of the few countries on the continent to have reached the target of agricultural investment of a minimum of 10% of the national budget (MoAIWD 2012a). According to Matchaya *et al*. (2014), the agricultural sector has been receiving more than 10% of the national budget in recent years and, in 2013, this amount increased to 21%. Investments that went into smallholder farming resulted in an increase in the acreage of smallholder irrigation schemes, from about 3 000 ha in 2003 to over 50 000 ha in 2014, representing an increase of over 1 560%. However, the acreage of smallholder private estate irrigation remained almost stagnant in the same period, increasing from about 50 000 to 55 000 ha, representing an insignificant increase of less than 10%.

Financial support for the water sector has come mainly from public funding through the national budget, and also from development partners. Non-governmental organisations and the private sector play a complementary role in the overall financing of the sector. Figure 2 shows financing trends for the water sector from 2009 and 2014. The trend line for the total budget shows substantial fluctuation with respect to resources going to the sector over the years. The trends reveal retrogressive funding between 2009 and 2011, with funding increasing sharply thereafter to the highest funding level of about MK7 billion in 2012, representing 2.3% of the overall national budget. The influencing trend line is the development of the foreign budget, largely from donor funding through the National Water Development Programme. In the 2012/2013 financial year, the sector was allocated 5% fewer resources compared to the 2011/2012 fiscal year (MoDPC 2012). This was largely as a result of the reduction in funding levels from development partners in the year. In terms of expenditure, the sector spent the whole amount that was received from the approved funding.

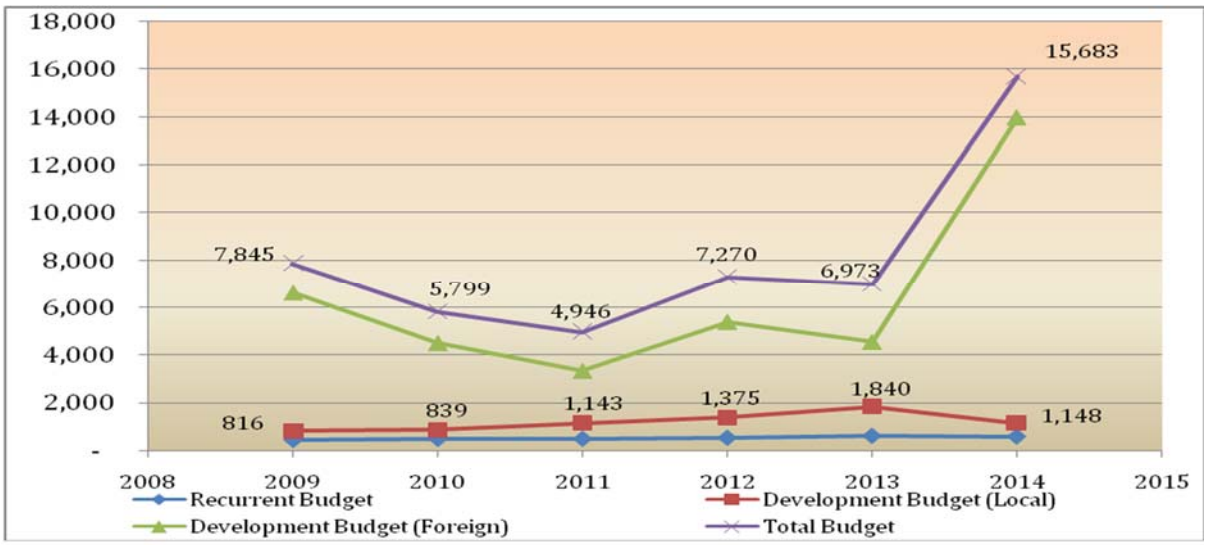

Figure 2: Financing trends for the water sector budget (in MK million)
Source: MoAIWD 2014

The government of Malawi has continued supporting and investing in agriculture. For example, during the five-year Malawi Growth and Development Strategy (MGDS) (2006 to 2011), the average budget of the agriculture and food security sector was 11% of the national budget (MoAIWD 2012a). This was in line with the Maputo Declaration, which stipulated that SADC governments should allocate at least 10% of their budget to agriculture. With this government spending, the sector's average growth rate reached 6.4% in 2011 and 7.3% in 2012 (MoDPC 2012), which was above the CAADP target of 6%. The average public spending on agriculture before the MGDS was around 6.1%. In the period before 2005, about five million Malawians were at risk of hunger. This number dropped to about 500 000 in 2008. Furthermore, maize production increased from 1.22 million metric tons in 2005 to 3.6 million metric tons in 2012. (MoAIWD 2012a).

4. Changes in Malawi's smallholder irrigated area

Over the years, there have been significant increases in the acreage of smallholder irrigation schemes in Malawi compared to acreage in privately owned smallholder irrigation estates, as indicated in Table 1. Old irrigation schemes that had been operating below capacity are being rehabilitated and revitalised, and new ones are being developed. However, the overall growth rate of 2% for both privately owned irrigation estates and irrigation schemes for the 2010/2011 season is too small. The small overall growth rate is the result of too much focus on the smallholder irrigation schemes and too little focus on the privately owned smallholder estates, which have not been receiving much

support. In 2005, the irrigated area of smallholder irrigation schemes was 15 988 ha, but this increased to 42 986 ha in 2011. In the same period, the irrigated area of privately owned smallholder estates grew from 48 360 ha to 49 340 ha, resembling almost stagnant growth. The stagnation in growth of privately owned estates is due mainly to (a) inadequate funding of the sector, resulting in some activities not being implemented, (b) non-repair and non-renovation of irrigation equipment and infrastructure, resulting in non-functionality of water supply systems, and (c) theft and vandalism of equipment, which also affect access to water. More emphasis is being put on smallholder irrigation, as the country's main crop producers are smallholder farmers, who occupy 70% of the country's arable land but depend mainly on rainwater.

Table 1: Changes in the acreage of smallholder irrigation systems over time

Season	Area (ha)			Percentage increase		
	Private estates	Smallholder irrigation	Annual totals	Private estates	Smallholder irrigation	Annual increase
2004/2005	48 360	15 988	64 348			
2005/2006	48 360	18 210	66 570	0	12	3
2006/2007	48 360	25 114	77 083	0	27	14
2007/2008	48 360	29 640	78 000	0	15	1
2008/2009	48 360	33 249	81 609	0	11	4
2009/2010	48 382	39 000	90 563	0	15	10
2010/2011	49 340	42 986	92 326	2	9	2

Source: MoAIWD (2012c)

As indicated in Table 1, the area under smallholder irrigation schemes in the 2004/2005 season was almost a third of the privately owned smallholder estates, but in the 2010/2011 season, the areas of both systems were almost the same in size. The most outstanding growth in smallholder irrigation schemes happened in the 2006/2007 season, when it recorded an increase of 27%. This was due to government policies that promoted huge investment in smallholder agriculture, resulting in a boom in the revitalisation of old irrigation schemes and the development of new ones. An example of such policies is the Malawi Agricultural Input Subsidy Programme (MAISP), now called the Farm Input Subsidy Programme (FISP) (Dorward & Chirwa 2011), which allowed smallholder farmers to purchase fertilisers and other chemicals at highly subsidised prices, enabling them to produce more crops than they usually did, as they were able to add nutrients to the soil and combat crop diseases and weeds. Smallholder farmers improved on agronomic practices which nullified the negative effects of crop stresses like soil nutrient deficiency, weeds and diseases as they were able to access subsidised fertilisers and chemicals. During the period under study, namely 2005 to 2011, the area under smallholder irrigation schemes grew by 63%, and this was consistent with the increase in land under smallholder irrigation schemes. The total crop production from irrigated area increased from 443 715 to 1 693 920 tons over the period.

5. Changes in rain-fed and irrigated productivity of maize and rice crops

A comparison was done between the total crop area, crop production and productivity of two important cereals in Malawi, namely maize and rice, in irrigated and rain-fed agricultural systems. This was done to detect changes that took place from 2000 to 2013, as shown in Tables 2 and 3. The actual total rain-fed area under maize in 2013 stood at 1 491 930 ha, producing 3 097 062 tons of maize, which represented 2.08 t/ha of maize productivity. In contrast, the total irrigated area under maize in the same year was only 181 246 ha, but this still produced 544 378 tons of maize, which represented 3 t/ha of crop productivity. In the same year, 2013, the actual rain-fed area under rice was 60 878 ha, producing 106 694 tons of rice, which represented 1.75 t/ha of rice productivity. The actual irrigated area under rice in the same year was only 3 988 ha, producing 15 567 tons of rice, which represented 3.9 t/ha of rice productivity. In rain-fed agriculture, both cereals failed to reach the national crop productivity target of 2.3 t/ha, as they oscillated between 1 and 2 t/ha. However, in

irrigated agriculture crop productivity for the studied period, cereals grew steadily, from 1.5 to 4.4 t/ha. These differences in crop productivity between irrigated and rain-fed systems indicate that, by doubling the area under irrigation, producing crops throughout the year, crop production would also double or even triple, as crop productivity per unit area of irrigated agriculture is more effective than that of rain-fed agriculture.

Crop productivity from irrigated agriculture was more effective, as it was almost twice as much as the productivity from rain-fed agriculture. This is despite the fact that the actual irrigated area was six times less than the rain-fed cultivated area under crop. Increasing land under irrigation therefore would go a long way in ensuring food security and improving the livelihoods of the rural majority.

Table 2: Changes in the area under maize and its production and productivity in Malawi

	Irrigated maize			Rain-fed maize		
Year	Area under maize (ha)	Total production (tons)	Productivity (t/ha)	Area under maize (ha)	Total production (tons)	Productivity (t/ha)
2000	45 690	78 159	1.71	1 461 398	2 423 152	1.66
2001	56 396	93 973	1.67	1 450 132	1 619 091	1.12
2002	94 837	166 228	1.75	1 404 817	1 437 043	1.02
2003	123 204	224 752	1.82	1 445 775	1 758 688	1.22
2004	129 364	225 543	1.74	1 349 386	1 382 806	1.02
2005	103 858	158 446	1.53	1 410 071	1 066 788	0.76
2006	138 809	291 999	2.10	1 485 221	2 319 487	1.56
2007	154 510	369 720	2.39	1 531 932	3 074 935	2.01
2008	162 319	361 949	2.23	1 484 895	2 415 489	1.63
2009	166 768	496 419	2.98	1 495 787	3 270 989	2.19
2010	165 260	468 035	2.83	1 531 010	2 951 374	1.93
2011	174 828	505 803	2.89	1 557 543	3 389 378	2.18
2012	181 514	537 371	2.96	1 552 178	3 086 553	1.99
2013	181 246	544 378	3.00	1 491 930	3 097 062	2.08

Source: MoAIWD (2014)

Table 3: Changes in the area under rice and its production and productivity in Malawi

	Irrigated rice			Rain-fed rice		
Year	Area under rice (ha)	Total production (tons)	Productivity (t/ha)	Area under rice (ha)	Total production (tons)	Productivity (t/ha)
2000	1 297	4 517	3.48	42 245	67 116	1.59
2001	1 812	7 046	3.89	48 334	86 104	1.78
2002	1 823	6 735	3.69	54 654	87 480	1.60
2003	1 864	6 855	3.68	52 543	81 329	1.55
2004	1 800	5 596	3.11	40 754	44 096	1.08
2005	1 386	5 230	3.77	36 040	36 040	1.00
2006	2 005	7 475	3.73	83 975	83 975	1.00
2007	2 101	8 035	3.82	55 990	105 131	1.88
2008	3 305	13 272	4.02	59 825	101 633	1.70
2009	3 076	13 404	4.36	60 892	122 584	2.01
2010	3 444	14 239	4.13	55 654	95 877	1.72
2011	3 894	15 516	3.98	57 665	102 217	1.77
2012	4 243	15 773	3.72	55 889	94 632	1.69
2013	3 988	15 567	3.90	60 878	106 694	1.75

Source: MoAIWD (2014)

Although maize and rice production from rain-fed agriculture is almost six times higher than production from irrigated agriculture, as shown in Tables 2 and 3, crop productivity from irrigated agriculture is double that of productivity from rain-fed agriculture. This data classifies Malawi as a country of which its agriculture is predominantly rain-fed, dominated by small-scale rural farmers cultivating small plots of land. The practice at times causes dire consequences due to climate

variability, as the rainy season has become unpredictable, while at the same time floods and drought have become common occurrences. If there is flooding or drought, there will be a total crop failure for that whole season because of the dependence on rainfall for agriculture. As a consequence, Malawi is affected by food insecurity and retarded economic growth, as the economy depends on agriculture.

6. Irrigation technology used by smallholder farmers

Another contributing factor to smallholder irrigation expansion is the use of simple and low-cost irrigation technologies, such as gravity fed, motorised pumps, treadle pumps and watering cans. Table 4 shows trends in the area under smallholder irrigation by technology type from 2004 to 2011. There is a general increase in the area using each technology, except for the motorised pump, which varies over time. The factors contributing to the increase of the area under smallholder irrigation therefore are threefold: (a) the success of existing schemes, (b) the committed investment in irrigation and (c) the use of affordable technologies.

Table 4: Trends in the acreage of smallholder irrigation schemes by technology

Irrigation technology	Area under smallholder irrigation by technology, ha						
	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Gravity fed	7 365	7 881	8 517	10 551	13 535	17 206	21 987
Motorised	1 280	936	2 080	1 611	2 236	4 004	3 093
Treadle pump	6 052	6 732	11 180	12 254	12 254	13 994	12 757
Watering cans	1 291	2 661	3 337	5 224	5 224	3 796	5 149
Annual totals	**15 988**	**18 210**	**25 114**	**29 640**	**33 249**	**39 000**	**42 986**

Source: MoAIWD (2010; 2011; 2012c)

Table 4 shows that the gravity-fed technology is the most popular, followed by the treadle pump and then watering cans. The fluctuating trend in the area under motorised pumps is caused mainly by the non-availability of diesel/power to run the pumps and, in some cases, smallholder farmers cannot afford to pay for electricity or purchase fuel.

As shown in Table 5, 55.8% of the total number of irrigation schemes used watering cans in 2011, yet they occupied only 12% of the total irrigated area. This implies that irrigation schemes that use watering cans are very small, about 0.3 ha in size, as they are labour intensive. The largest schemes are those using the gravity technology (about 7.5 ha in size), as they are only 8.7% of the total number of schemes yet they occupy 51% of the irrigated area. A total of 33% of the irrigation schemes use the treadle pump, and they occupy 30% of the irrigated area, implying that it is a popular technology used on relatively larger schemes. The motorised pump is the least used technology, as it represents only 2.6% of the total number of schemes and occupies only 7% of the smallholder irrigated area. Their average size is about 3.6 ha. The gravity and motorised pump technologies are very effective but still not fully accessible to the majority of the smallholder farmers.

Table 5: Cumulative area of smallholder irrigation schemes broken down per technology (2011)

Technology	Number of schemes	Proportion (%)	Total area (ha)	Av. area (ha)	% of total area	Number of beneficiaries		
						Male	Female	Total
Gravity	2 916	8.7	21 987	7.54	51	43 898	37 260	86 164
Motorised pump	870	2.6	3 093	3.56	7	13 962	11 946	26 039
Treadle pumps	11 106	33.0	12 757	1.15	30	71 491	54 050	125 471
Watering can	18 810	55.8	5 149	0.27	12	75 769	52 401	128 170
Total	**33 702**	**100**	**42 986**	1.28	**100**	**205 120**	**155 657**	**365 844**

Source: MoAIWD (2012c)

Table 5 also shows that, although men still dominate the smallholder irrigation sector, the number of women using irrigation technology is increasing. The total number of beneficiaries of these technologies add up to 365 844 working in 33 702 schemes countrywide.

7. Impact of improved crop production on food security and nutrition

The expansion of smallholder irrigation in Malawi has been having a positive impact on food security and nutrition levels due to increased crop production. The Farm Input Subsidy Programme (FISP), which was implemented by the government in 2005, combined with the investment in irrigation, has boosted incomes and food security and alleviated poverty at the household level (MFDP 2011). These two factors contributed significantly to the increase in maize production, which rose from 1.2 million metric tons in 2004/2005 to 3.6 million metric tons in 2012/2013, as indicated in Table 2. The renewed emphasis on irrigated agriculture has transformed Malawi from a net importer to a net exporter of maize, and has allowed the majority of households to attain food security since 2006. This has led to low and stable maize prices, an important achievement in a country in which the majority of households are net consumers, and food accounts for over 60% of household income (MAFS 2011). Since then, the country has managed to have a food surplus every year, as indicated in Table 6.

Table 6: Food surplus/deficit, 2006 to 2011

Season	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Surplus (Metric tons)	1.3	0.3	1.3	0.8	1.1

Source: MAFS (2011)

As a result of the food surplus from 2006 to 2011, nutrition indicators have been improving significantly, although the figures remain high. Table 7 shows changes in the nutrition indicators in Malawi between 2004 and 2010.

Table 7: Changes in the nutrition indicators in Malawi from 2004 to 2010

Year	**2004**	**2010**
Prevalence of stunting among children under 5 (0 to 59 months)	52.50%	47%
Prevalence of underweight among children under 5 (0 to 59 months)	17.30%	13%
Prevalence of wasting among children under 5 (0 to 59 months)	6.00%	4%
Prevalence of anaemia among children aged 6 to 59 months	73%	63%
Prevalence of anaemia among women of reproductive age (15 to 49 years)	44%	28%
Prevalence of thinness among women of reproductive age (15 to 49 years)	9%	9%
Prevalence of breastfed children aged 6 to 23 months receiving a minimum acceptable diet	22%	19%

Source: DHS (2004; 2010)

8. Malawi's potential for irrigation expansion

Although the area under smallholder irrigation schemes has been on the increase, agriculture in Malawi remains predominantly rain-fed. Since there are limited opportunities under rain-fed agriculture to produce sufficient food, crop production has been intensified through a number of interventions, including investing in small-scale irrigation using low-cost technologies. To date, 77% of the land with irrigation potential remains unused. Eleven percent of irrigable land is under smallholder irrigation, and 12% forms part of private estates.

Smallholder farming remains important in the production of food crops in Malawi, making smallholder irrigation development a priority for ensuring food security, improving nutrition levels and promoting economic development. More investment in the irrigation sector will result in further increases in land under irrigation, allowing more agricultural land to produce crops throughout the year, thus increasing crop production. Malawi has great potential to produce more crops from irrigation due to its vast water resources. Irrigation has the advantage that crop productivity per unit

area of irrigated agriculture is double that of rain-fed agriculture, as shown in Tables 2 and 3. Furthermore, most of Malawi's water resources are not used, as the total renewable water resources are estimated at 1 728 km^3/year, yet the total freshwater water withdrawal is estimated at 1.48 km^3/year, representing only 7.9% (World Bank 2015). Agriculture uses the bulk of the water withdrawn annually, which stands at 1.166 km^3/year, representing 79% of the water withdrawn annually. The rest (21%) goes to domestic and industrial use.

Figure 3 is a graph highlighting the relationship between total crop production and the productivity of rain-fed and irrigated crops in Malawi from 2000 to 2014 (includes cereals, legumes, oil seeds, roots, tubers and fruits). Although the total irrigated crop production has remained lower than the total crop production from rain-fed agriculture, its crop productivity is higher than that of the rain-fed area. Irrigation is more efficient in crop production per unit area when compared to the rain-fed area. Therefore, increasing land under irrigation will boost crop production. Figure 3 indicates that the crop productivity gap between irrigated and rain-fed agriculture systems has continued to widen over the years as more cultivated land is opened for irrigation. The rain-fed crop production graph shows a high degree of fluctuation and variability because it is dependent on rainfall patterns and is subjected to floods and drought. However, irrigated crop production has risen constantly over the years, as it generally is not affected by climatic conditions. Irrigation agriculture therefore is more reliable and produces more crops per unit area, hence the need to increase land under irrigation.

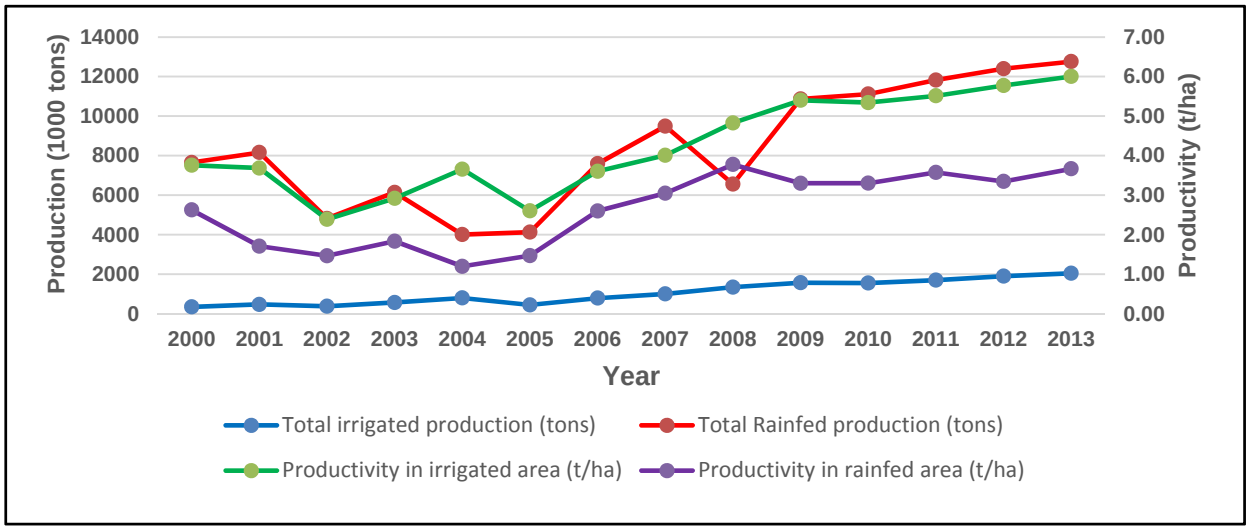

Figure 3: Relationship between crop productivity and production in rain-fed and irrgated agriculture systems

9. Discussion and conclusions

Malawi's population is growing at a rate of 2.8% per annum, and it currently is estimated to be over 16 million (World Bank 2015) and that it could double by 2025 (Tchale 2009). The high population growth rate demands agriculture to grow at levels sufficient to feed the growing population. Given the declining land-holding sizes of smallholder farmers (currently averaging at 0.3 ha), which is caused by the increasing population, one plausible way to improve crop production and productivity is to enhance efficiency through irrigation. To maintain high productivity in the face of declining land-holding sizes there is a particular need to improve the efficiency of the smallholder subsector, which is by far the largest and remains the main crop producer in Malawi. According to Tchale (2009), over three million small-scale farmers cultivate over 70% of Malawi's arable land held under customary tenure. The expansion of the smallholder irrigated area will not only increase crop production and productivity, but will result in improved crop water productivity in the sector and prevent water losses.

At present, the irrigation technologies available to the majority of smallholder farmers are so rudimentary that they have little or no capacity to counter the effects of erratic rainfall and dry spells. This could result in total crop failure when rain fails, creating problems in the national economy, as it is agro-based. Continued irrigation development therefore is necessary to fully achieve the targets for economic development, and also to ensure food security and to improve nutrition levels. There are several reasons for irrigation development in Malawi and they include: (a) the vulnerability of the country to droughts; Malawi has experienced severe droughts in the past, with notable ones being in 1948/1949 and 1991/1992, and more recently from the 2002 to 2005 seasons, (b) the country's vulnerability to flooding; the most recent flood took place in the 2014/2015 season, (c) that irrigation offers the opportunity to achieve the much publicised crop diversification programme, (d) that, as an agro-based economy, there is a need to grow crops throughout the year to boost the much-needed revenue, and (e) that irrigation expansion will go a long way to ensuring food security, achieving the economic growth targets and improving the livelihoods of the rural population. Sustained investment in smallholder irrigation continues to be important in increasing land under irrigation, growing crops throughout the year and avoiding redundancy during the dry season, as well as increasing crop production.

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