# ZAMBIA SOCIAL SCIENCE JOURNAL



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# Zambia Social Science Journal

## Indaba Agricultural Policy Research Institute (IAPRI) Special Issue

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## Articles

# Agriculture in a Transformative Policy Space: An Introduction

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## Introduction

The agricultural sector landscape in Zambia has been inundated with policies designed and implemented by successive governments to enhance broad-based agricultural development. Since 1964, each policy adopted for the sector has had its own set of objectives and with time, new goals have been identified and incorporated in subsequent policies in response to changes in the socio-economic environment. To assess the effectiveness of the myriad policies in achieving intended objectives, agricultural policy analysts (those in academia, line government ministries, the national agricultural research system, civil society and independent policy think tanks) have been on hand to provide evidenced-based analysis. Therefore, as we began discussions about putting together a special issue on agriculture, it became clear that the issue had to focus on emerging topics in the Zambian agricultural policy analysis space that are supported by empirical evidence. Ultimately, we envisaged that our platform would also contribute to widening the audience exposed to current policy debates and options for an improved agricultural sector, through the articles included in this special issue.

The papers presented in this special issue are those selected from a number of excellent working papers written by researchers at the Indaba Agricultural Policy Research Institute (IAPRI) and their collaborators[1] Papers for publication were selected after a writers' workshop conducted by the Southern African Institute for Policy and Research (SAIPAR) with support from Michigan State University (MSU) and IAPRI. The workshop brought together 23 participants from IAPRI including researchers, interns and recipients of Student Competitive Grants for master's research. Through the various presentations and group activities facilitated by SAIPAR resource persons, the workshop surveyed participants' research interests and motivated them to publish their work in peer-reviewed journals. Thus, this special issue is an outcome of the writers' workshop that comprises a set of papers with a strong emphasis on policy, organised around three themes: (i) political economy and agricultural policy, (ii) agricultural technology and productivity, and (iii) emerging issues in agricultural development. In addition, there are two book reviews at the end of this issue that speak directly to the three identified themes.

**Political economy and agricultural policy**

The political economy framework has been used by development scholars to understand government interventions in the production and marketing of agricultural goods. Political economy theorists focus on the allocation of public resources in the political market and have emphasised the behaviour of politicians, voters, pressure groups, and bureaucrats motivated by self-interest. (Swinnen and Van Der Zee, 1993).

The first paper in this issue written from the political economy and agricultural policy perspective by Chapoto and a team of other experts within and outside IAPRI, interrogates the policy-making process with respect to Zambia's so-called political crop: maize. The paper aims to elicit an understanding of who holds the keys to change and how to influence agricultural policy changes within the maize subsector. The paper unpacks three main issues pertaining to the politics of maize. Firstly, the executive branch of government (Cabinet/State House) is identified as the most powerful player in commanding other actors in the subsector. Secondly, powerful lobby groups with links to the executive have been influential by either advocating for high maize prices (in particular, producer lobby groups) or low prices of the commodity (mainly millers) irrespective of the market conditions in a given season. The food price dilemma, producers wanting higher food prices while consumers demand low food prices, mposed by the aforementioned competing interests has a negative effect on maize and the whole agricultural sector. Thirdly, the authors identify what they describe as a "Command Triangle" consisting of the president, Minister of Finance and Minister of Agriculture and submit that this triangle holds the keys for sustainable policy changes in the maize sector. The paper concludes that in order to bring about long-lasting changes to maize marketing policies in Zambia, there is a need for strong collective action within the command triangle, as they possess the most influence.

The second paper authored by Chapoto and others, using the political economy framework proposes reforms to the country's signature farming input and output subsidy programmes, providing alternative approaches that will work better for both individual Zambians who rely on the state for support, and the country as a whole. Over the years, the Farmer Input Support Programme (FISP) and the Food Reserve Agency (FRA) have not addressed the challenges they were intended to tackle. For both subsidy programmes, the authors contrast the objectives with reality, eality which is informed by empirical evidence,to demonstrate that the two programmes have been ineffective. The paper submits a number of proposals to transform the subsidy programmes, among them, specific ways that spending on the subsidy programmes can be scaled back and funds redirected to support economic growth and social development. In conclusion, the authors caution that, "maintaining the *status quo* is likely to be very costly politically given that the country can no longer afford the continued financial haemorrhage from the current operations of the FISP and FRA".

**Agricultural technology and productivity**

The second theme focusses on appropriate use of land-saving agricultural technology,inorganic fertilisers,to enhance smallholder farmer productivity. Only one paper authored by Chapoto, Chabala and Lungu is presented in this section. Their study evaluated the continued promotion of blanket recommendations of inorganic fertiliser application, a practice that is common across Africa (Kaizzi et al. 2017; Rware et al. 2014) despite widespread recognition that improved productivity is best achieved when recommendations are informed by conditions specific to a location. Using a multidisciplinary approach to address this complex issue, the paper augments household survey data analysis with soil analysis techniques to show which approach between location specific fertiliser application and blanket recommendation has potential to raise crop productivity. The ,authors discuss two main findings. Firstly, they show that soil fertility, as expected, varies across the country based on soil analysis results of key parameters such as soil pH, soil organic carbon and soil phosphorus. Secondly, the soil testing results point to the need for Zambia to promote location specific fertiliser recommendations and do away with blanket fertiliser recommendations not best suited across the entire country. The paper builds a case for promotion of mobile soil testing as part of extension service provision and goes a step further to propose inclusion of soil testing as a requirement to access inputs through the FISP.

**Emerging issues in agricultural development**

The final paper in this issue, written by Zulu-Mbata and Chapoto, examines the gender dynamics associated with adoption of conservation agriculture and the impacts on several livelihood outcomes of smallholder households in Zambia. Analysed at plot level, the study shows that conservation agriculture adoption has a positive effect on households' ability to diversify crop production decisions which in turn has a positive effect on dietary diversity. But, the results indicate that the impact of conservation agriculture on either crop diversification or household dietary diversity diminishes if the farmer is a female household head or the farmer (male or female) is in a female headed household. The authors conclude that promotion of conservation agriculture should consider "the gender differences at household level and within the household, as well as female farmer's access to productive resources".

## Final remarks

This IAPRI special issue presents four papers that provide insights into a range of issues of policy relevance along three thematic areas. The policy debates and proposals submitted in the papers have widespread applicability given the similarity in agricultural policies implemented in Zambia and other countries in the sub-Saharan African region. Intervention in agriculture production and marketing by governments, extension messages that continue to promote blanket recommendation of fertiliser application, and promotion of nationwide input subsidies constitute policy positions that are not unique to Zambia. In sum, this special issue packages papers that are both accessible and insightful regarding policy options relevant to stimulating agricultural growth in a context similar to Zambia. We highly recommend them to those interested in the topics covered.

## Endnotes

[1] IAPRI is an agricultural policy research think tank whose mandate is to utilise empirical evidence to advise and guide the Zambian government and other stakeholders on agricultural investments and policies.

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# The Politics of Maize in Zambia: Who holds the Keys to Change the Status Quo?

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*As both the national staple food and primary smallholder crop, maize occupies a central position in Zambia's agricultural political economy. Despite the government's large subsidies, maize productivity levels remain way below global averages, maize commercialisation in the smallholder sector remains highly concentrated, maize meal prices are highly volatile, and rural poverty remains high. This study uses a political economy framework to better understand the policy-making process, power structures and dynamics involved in the maize sector in order to get a better understanding of who holds the keys to change, and how to influence agricultural policy changes. Net-Map procedure was used to map the linkages of key players in order to determine critical nodes of policy change. The Executive (Cabinet/State House) was found to wield the most power in commanding the other actors in the sector. However, powerful lobby groups with links to the Executive have often opposed changes to the sector to maintain large rents to their constituency with disregard to the negative effects on the whole sector. In addition, a "Command Triangle" which holds the keys for sustainable policy changes in the maize sector was identified. This command triangle consists of thePresident, Minister of Finance and Minister of Agriculture. Hence, in order to bring about long-lasting changes to maize marketing policies in Zambia, there is a need for strong collective action within the command triangle, as it possesses the most influence.*

**Key words:**
Zambia, maize politics, Net-Map procedure, lobbying linkages, command linkages, VisualLyzer software

## Introduction

For decades, maize has occupied a central position in Zambia's agricultural political economy. The political importance of maize can be traced back to the early colonial period, with maize input and output price subsidies being the hallmarks of the country's policy approach. The food riots experienced when supplies ran short in 1986 and again in 1989 have not been easily forgotten by either the people or political leaders. Nevertheless, is it just because politicians fear shortages in the basic foodstuff that the commodity is politicised, or are there other underlying factors? The answer to this question is complex.

Maize and other basic food staples are rain fed, thus their production is susceptible to variations in weather. This means that production volumes tend to fluctuate not just with changes in the market, but also with fluctuations in the weather, and this in turn means that their prices tend to fluctuate alarmingly if left unregulated.Also, basic foods are quite inelastic in their demand, and consumers usually find it difficult to shift to alternatives in most developing economies including Zambia. For these reasons alone, politicians often become nervous about the prospects of either low prices (too many farmers will suffer) or high prices (fear of consumer rage), the usual food price dilemma. Therefore, they tend to advocate for subsidies when perhaps it might be wiser if they did not. However, despite the evidence that the intervention programmes—the Food Reserve Agency (FRA) and Farmer Input Support Programme (FISP)—do not manage to effectively reach the poor, it is probable that most people still believe that they do. This is because once the government becomes involved in food market opportunities, certain operators take advantage of the subsidies and, hence, the incentive to sustain government interventions beyond what makes technical sense becomes stronger.

Discretionary and unpredictable FRA intervention continues to be the greatest policy problem plaguing the maize marketing system and food security in Zambia. Generally, the actual and potential government interventions by the FRA generate private sector uncertainties and inaction leading to a cycle of recurrent need for government intervention. All this comes at a huge expense to the treasury and causes headaches for politicians who are concerned about the country's budget deficit. The high government expenditure on maize production and market subsidies stifles broad-based agricultural growth because little money is going to key drivers of agricultural growth such as rural infrastructure (roads, rail, and telecommunication), agricultural research and development, market information, irrigation, institutions that foster the development of effective markets, and complementary services such as agricultural extension and credit (Chapoto et al., 2015).

Apart from the politicised maize policies, Zambia's trade policy has also been highly unstable. Stop-go trade policies have led to skyrocketing consumer prices and increased informal trade, suggesting that Zambia is failing to take advantage of regional markets and opportunities to increase tax collection. Chapoto and Jayne (2009) show that countries (including Zambia) that had unpredictable maize marketing and trade policies had the highest price variability and unpredictability compared to countries that had an open border maize policy. The latter took advantage of trade in both deficit and surplus years whereas countries like Zambia continued to be in panic mode resulting in 'knee-jerk' policies that curtail meaningful agriculture growth.

As a result of the deeply political nature of maize in Zambia, and the extensive use of inefficient subsidies to promote production and manage food prices, the private sector has tended to take a cautious approach to investing in the sector. At the same time, maize productivity levels remain way below global averages, maize commercialisation in the smallholder sector is highly concentrated, maize meal prices are highly volatile, and rural poverty remains high. The combination of these factors suggests an urgent need for policy change. Therefore, the main question is how the government can help unlock the potential of the Zambian agriculture sector to achieve meaningful pro-poor agricultural growth.

Behind this backdrop, this study explores the political economy networks that have maintained maize as the primary focus of Zambian agricultural policy and how these networks can be influenced to change the *status quo*. We utilised a participatory interview-based mapping method called Net-Map (Schiffer and Hauck, 2010) to help understand and visualise the political dynamics of maize in Zambia, and identify the main key forces of change, their primary policy objectives, how they are linked, and their ability to influence policy outcomes.

The rest of the paper is organised as follows: Section 2 discusses the evolution of the maize marketing and trade policies in Zambia; Section 3 presents the data and methods; Section 4 uses the Net-map procedure to help understand the political economy issues in the maize sector in order to identify the key levers for policy change; and Section 5 concludes and presents some recommendations on how to reform the maize sector.

## The History of Maize in Zambia

### *Pre-Independence period*

In order to fully understand Zambia's maize-centric policies since gaining independence in 1964, we need to start by understanding what the maize product is and how it came to be popular in Zambia. Maize in all of its varieties has its origins in the Americas, specifically Mexico, and was progressively brought to African shores from about 1500 onwards. At that time, millet and sorghum were the cereal subsistence staples of African populations, and were not replaced by maize for many centuries. What led to an expansion in maize production was its relative suitability to commercial production. It was easily cropped, came with a series of variety improvements developed in America and Australia, and matured relatively quickly compared with sorghum and millet, thus requiring less labour and producing better value productivity (McCann, 2001).

These physical attributes made maize suitable from two perspectives. Firstly, while it did not lend itself especially well to subsistence farming (though some African farmers did produce the crop with success) it suited commercial farming, and therefore, almost exclusively maize was produced by white commercial farmers. Secondly, it produced a basic food that lent itself to the growing demand from migrant labourers working in the expanding mines of South Africa, as well as from the then Northern Rhodesia (now Zambia). Maize was provided on contract to the mines, who distributed it as rations to their employees.

Maize, a crop which had been referred to as food for Europeans in the 1930s, was the food of choice for most Zambians by the time of independence in 1964 (McCann, 2001). Independent Zambia was, therefore, heavily reliant upon maize as a staple food; according to JAICAF (2008) over 60% of land planted to major crops at this time was under maize. But the way in which this expansion was achieved was highly favourable to white commercial farmers.

The great depression of 1933 did not spare the mining sector in Northern Rhodesia. Many new mines on the growing Copperbelt were closed at precisely the time good weather yielded a bumper harvest. This was also exacerbated (for the whites that is) by an expansion in African production on the Tonga Plateau, where ox-drawn plough technology was enhancing production and productivity. Prices plummeted and commercial farmers' profitability in particular was threatened. The solution was to introduce market controls. The Agricultural Advisory Board established a Maize Control Board. Farmers were required to sell to this Board, which would then be responsible for onward sale, including exports and imports when necessary. In addition, the Board stipulated that a minimum of three parts of total maize bought (by farmer revenue) and a maximum of one part would go to white commercial farmers and African farmers respectively. Effectively, the white commercial farmers were legislating against any expanded competition from African competitors (Vickery, 1985). In fact, at this time Africans were not even defined as farmers, and could therefore not join cooperatives established for the purpose of expanding markets.[1]

Between 1940 and 1964, fortunes fluctuated. During the liberation war years, Northern Rhodesia failed to produce enough to satisfy urban demand, and imports were required, mainly from the South. Prices to the mining companies rose, and they lobbied hard for reductions, and from this point on the Board began to subsidise consumers, and so operated at a loss. By the late 1950s and early 1960s production was in surplus again, but a political culture of support for white farmers and subsidies for the operation of the mines had been established as part of the expected political landscape. Preferential treatment of the white farmers continued more or less right up to the end of the colonial period.

***Post-Independence period***

After independence, the political objectives changed. The *Frontline States*, a loose coalition of African countries from the 1960s to the early 1990s committed to ending apartheid and white minority rule in South Africa and Rhodesia,imposed sanctions against the Smith Regime in Southern Rhodesia that made it politically unpalatable for members to commercially source maize in years of shortage. Zambia now became relatively dependent upon smaller farmers to provide what had become its basic food, and was in any case politically committed to supporting indigenous smallholder farmers, and redressing their discriminatory exclusion from markets.

In this environment, Zambia started to establish rural crop-buying stations, which were formed under the National Agricultural Marketing Board (NAMBOARD) in 1969. Maize as a staple continued to receive major government support and maize self-sufficiency became a key government policy. Cooperatives were established with a view (initially) towards improving access for smallholder farmers, both to inputs and to the market outlets according to the willingness and ability to supply, unrestricted by quota. Import and other controls were also imposed as a means of encouraging domestic growth. By 1970, these measures were beginning to have an impact. Whereas, up until that year, domestic production had run at about 600,000 to 800,000 tonnes, by 1976 it was up to around 1,600,000 tonnes (Figure1).

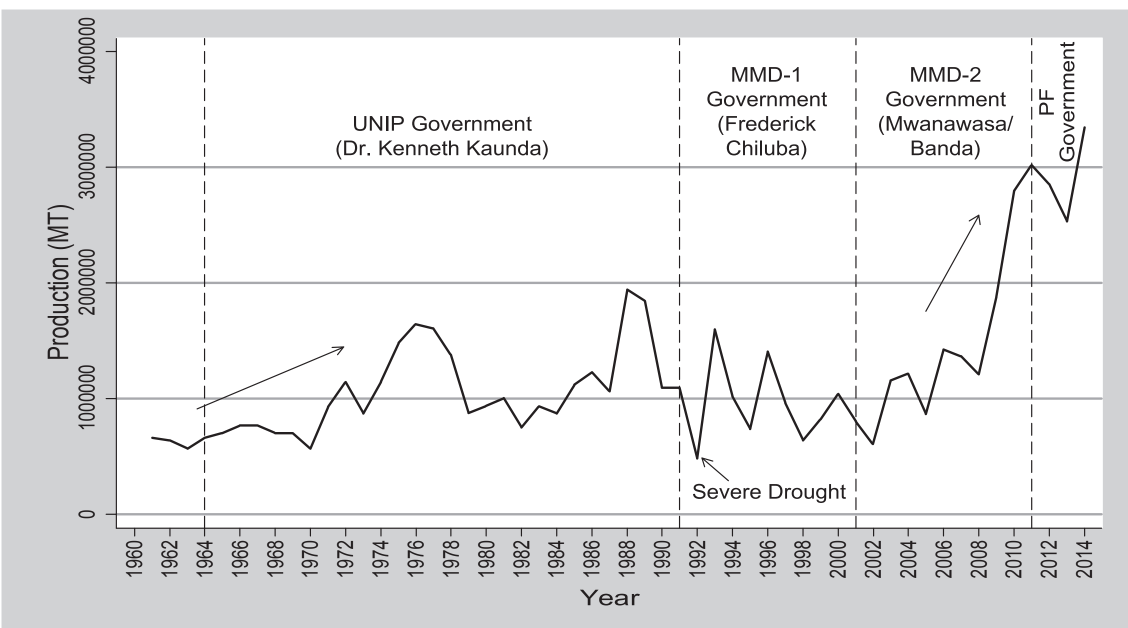


*Figure 1: Zambia's Maize Production from 1961 to 2014*

Source: FAOSTAT 2013; CSO/MAL Crop Forecast Survey.

The approach to maize subsidies in general hardly changed. The practice of supporting farmer prices and subsidising urban populations previously used by the colonial government was merely continued. What changed was the withdrawal of pro-white discrimination, and Zambia now had a new government devoted to promoting the interests of African farmers.

The approach to supporting production improvements was heavily state-centric. The political philosophy propounded by the United National Independence Party (UNIP) and its leader, Kenneth Kaunda, was socialist and humanist, partly owing to the historical, anti-western position taken by UNIP's predecessor, the Zambian African National Congress (ZANC) and their approach to building a broad social future for the mass of poor Africans, together with the non-aligned or somewhat pro-Soviet position chosen by the liberation movements. In this era, cooperatives were seen as potentially important contributors to overall rural mobilisation and agricultural development rather than just as member-based business organisations (Öjermark and Chabala, 1994).

***Economic decline and political change***

The early years of independence were reasonably successful, with annual real Gross Domestic Product (GDP) growth rates averaging 3.9% between 1965 and 1974, although this was only 0.6% per capita (Sousa and Fedec, 2015). But subsequent nationalisation of various sectors, including the mainstay copper mining, contributed to a decline in the efficiency of these industries. This, coupled with the decline in the global copper price and the rise in the price of oil undermined economic growth and government revenue.

The expanded recurrent expenditures by the government parastatals, especially on maize subsidies through NAMBOARD and subsidies on mealie meal prices, exacerbated national debt and contributed to increasingly uncontrollable inflation. From 1975 right through until 1998, GDP growth was largely stagnant, with GDP per capita running annually at around minus 2.5%. Food shortages and price increases, as subsidies had to be rescinded in the face of structural adjustment conditions, led to riots in 1986 and again in 1989. Under these various pressures, but also apparently under the clear impression that he could not lose an election, Kaunda permitted the registration of political parties, and an election was called in 1991. In this election, Kaunda lost to the Movement for Multiparty Democracy (MMD) under the leadership of Chiluba.

The approach to the economy adopted by the MMD was starkly at odds with that of UNIP. Indeed, injecting change in this respect was a key part of its agenda and appeal. MMD embarked upon a radical programme of privatisations centred on the copper mines but also involving the wide range of state-owned parastatals under the Industrial Development Corporation (INDECO). Subsidies and controls were removed, not just from maize, but from other markets as well (Howard and Mungoma, 1996). The private traders and millers were expected to fill the void left by NAMBOARD, but the environment was not yet conducive for them to meet the challenge. Interest rates rose to above 200% through the early 1990s, and so the required investments in new business infrastructure were not forthcoming.

Meanwhile demand for maize continued to grow, and the food shortages and price hikes of 1986 and 1990 could only be repeated. This was exacerbated by a severe drought in 1991, which caused production to fall to just over 500,000 tonnes, its lowest levels since independence. Throughout the 1990s, production fluctuated wildly, partly as farmers reacted to market instability and in response to weather changes. Many people concluded that the market had failed to yield any kind of stability, or self-sufficiency in the staple crop.

After failing in his bid for a third term in 2001, Chiluba was replaced by another MMD candidate, Levy Patrick Mwanawasa who dubbed his government the New Deal Government. With the economy reeling from the effects of market reforms, the Mwanawasa government decided to re-establish maize input and output support programmes. Coincidentally, Zambia like some other countries in Africa had her debt forgiven, making it possible for the government to implement these programmes without putting a lot of strain on the national budget. Maize production began to recover and indeed, expand. Therefore, the history both of food riots in the 1980s and of continuing poor harvests through the 1990s imprinted on successive governments the need to intervene. The subsidy programmes were ramped up under Rupiah Banda but could not secure him the election against Michael Sata. Table A1 in the Appendix summarises the key features of the five republics as they apply to the development of the maize sector.

## Data and Methods

To address the objectives, the study uses a qualitative research method. The key research tool utilised is a participatory mapping method called Net-Map (Schiffer and Hauck, 2010), which allows for the collection of qualitative data using a semi-structured interview approach. Net-Map, an interview-based mapping tool, was used to help understand, visualise, discuss, and improve situations in which many different actors influence outcomes[2]. The tool can be adapted to any situation, and in our case, was applied to gain an understanding of the political dynamics of the maize sector in Zambia, identifying the main key levers of change, their primary policy objectives, how they are linked, and their ability to influence policy outcomes.

Semi-structured interviews were conducted with nine key informants knowledgeable about the Zambian maize sector. The key informants were drawn from public institutions, private institution, civil societies, regional bodies, and some influential individuals in the maize sector. The informants were asked to identify the main actors in the maize sub-sector who are influential in changing or maintaining the current maize policies. They were also asked to identify the linkages that exist among the actors and to rate how much power/influence each actor had in blocking or supporting policy change. From this analysis, and in combination with our knowledge of the sector, we make recommendations of who, and how, to change the current *status quo* in the maize sub-sector.

Twenty-five actors from the public and private sector were identified by key informants as being influential in the agricultural policy-making process. The main actors identified included the State House/Cabinet (hereinafter referred to as the Executive), Ministry of Agriculture and Livestock (MAL), Ministry of Finance and National Planning (MoFNP), Zambia National Farmers Union (ZNFU), Millers Association of Zambia (MAZ), and Grain Traders Association of Zambia (GTAZ). These actors interacted in various ways, how they interacted influenced how, and which policies are made in the maize sector. Two main linkages under which they interact were identified as lobbying and command. The lobbying linkage is when one actor tries to influence another actor for policy change, while the command linkage is when one actor instructs another actor to perform or carry out certain duties/activities. To show these linkages between the actors, social network analysis was undertaken on the aggregated network data from the interviews with key stakeholders. The different perspectives of the various informants were aggregated using VisualLyzer software to control against potential bias (Schiffer and Hauck, 2010).

## Results and Discussion

### *Key actors and the agricultural policy formulation process*

**Government:** The agricultural policy planning process in Zambia involves several different levels of government including the MAL, MoFNP, and the Ministry of Justice. Any agricultural policy changes or new policies are communicated to the Cabinet through a Cabinet memo. The Policy Analysis and Coordination (PAC) division in the Cabinet office then sends the memo to relevant ministries for review before the relevant Cabinet Committee makes recommendations to the full cabinet for approval, and the policy decision is communicated back to the ministry for implementation (Koenen-Grant and Garnett, 1996).[3] Policies that are approved by cabinet for implementation are usually administrative policies. Policies that require enactment of new laws are taken to parliament for debate and vote on the proposed bill. However, it is very rare that Cabinet recommendations fail to pass through parliament because debates and voting is done along party lines.

The Executive plays a very significant role in agricultural policies especially the maize sector. Most of the agricultural stakeholders interviewed said that any change in policy would need to start from the top. The rural smallholder farming community is of great interest to politicians because they constitute the largest voting bloc in the country. Hence, to win the rural vote, the politician must win over the hearts of smallholder farmers by having programmes and/or policies targeted at them. The fear of losing elections has contributed, in many ways, to the high level of ad hoc maize marketing and trade decisions made by the government. As an arm of government, the Ministry of Agriculture and Livestock has often been forced to justify and implement decisions announced from the top. , Maize sector policies can be formulated at technical level but decisions are made at political level.

**Zambia National Farmers' Union:** ZNFU was founded in 1905, and consisted of large-scale farmers. Before independence in 1964, the ZNFU was called Rhodesia National Farmers' Union. After independence, the name became Commercial Farmers Bureau. In 1992, the name was changed to ZNFU, to represent the inclusion of smallholder farmers as members. Currently, it represents small- and large-scale farmers and agribusinesses. Its members are categorised into district famers' associations, commodity specialized associations, corporate farming businesses, the agribusiness chamber, and association members. Some of the union's objectives are to promote and safeguard the interest of members, to support the conduct and the development of the agriculture industry in Zambia, and to make representations to the government or to any competent authority with regard to matters directly or indirectly affecting agriculture (in its broadest sense). One of the union's core functions is to lobby and advocate on behalf of its members. In terms of maize policies, the union has a lot of influence when it comes to lobbying for change/no change due to its large membership base.

**Millers Association of Zambia:** MAZ comprises more than 30 members who are engaged in commercial milling of maize meal, flour, and stock feeds. These members are located across the country though concentrated along the line of rail. These milling companies tend to service mostly urban consumers. Small-scale millers are not members of the association. MAZ tends to advocate for cheap maize grain prices, and has been shown to have a lot of power in influencing policy shifts by using consumer prices of maize meal as bargaining chips. Government is usually caught in a dilemma of trying to offer affordable maize meal prices and offer farmers a good price for their produce.

**Grain Traders Association of Zambia:** GTAZ was established in 2005 mainly to promote commodity trading, develop sound trading rules and regulations, to encourage the development of small and medium traders and to work with the government and other stakeholders to improve the agriculture sector in Zambia. GTAZ comprises a diverse membership base of both Zambian and international companies, some of which are multinational and regional players. Currently they are more than 20 members trading in a number of other products apart from maize. However, when it comes to influencing policies surrounding maize, GTAZ seems to lack political influence, mainly stemming from a historically embedded distrust of private trade in general and in agricultural products in particular.

***Lobbying network***

Figure 2 summarises the lobbying network. The network shows that ZNFU has the largest influence as they have access to numerous actors in the sector including the Executive. MAZ, due to its large membership base, is also influential as they are seen to control consumer maize meal prices and, therefore, are able to leverage politicians' fears of escalating maize meal prices in order to lobby for cheap maize grain from FRA, either directly to the Minister and/or the Executive. Fertiliser companies have a lobby power almost equal to the millers because they also have access to the Executive. Because fertiliser is big business in Zambia, substantial campaign contributions by large fertiliser companies are likely to enable these companies to have direct access to State House. Key informants indicated that some fertiliser firms, especially those that have been winning the FISP tenders, have this access whilst others do not, suggesting an uneven playing field. GTAZ has the least influence compared to the other three actors as there is a long-standing distrust of private maize buyers, hence the grain traders' advocacy efforts tend not to matter as much as those of MAZ or ZNFU.

MAZ normally lobbies for cheap maize grain from FRA directly to the Minister and/or the Executive. One informant pointed out that, "the ones that benefit from the current policies are millers, as they use consumers as a bargaining chip". They tend to push the government to subsidise maize grain by making FRA sell cheaper maize to selected large millers (MAZ members) with the promise to reduce mealie meal prices. On the other hand, Grain Traders represented by GTAZ support and lobby for an open maize market policy, which is opposed by some large-scale millers who have in the past benefited from cheap FRA maize.

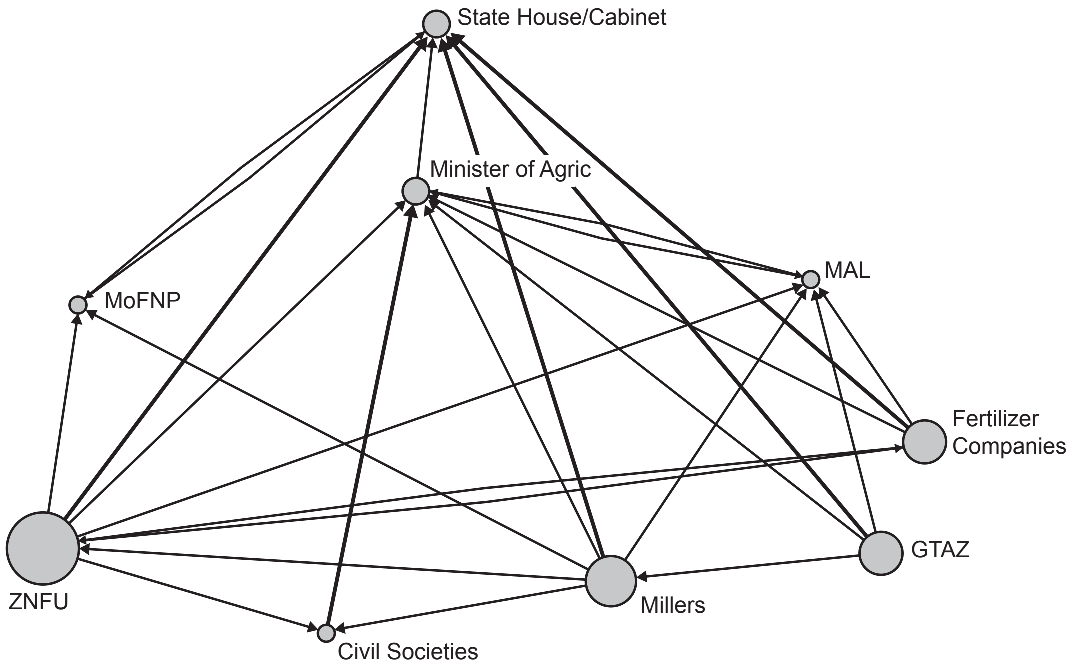


*Figure 2. Lobbying Network*
Source: Authors' calculations with VisualLyzer from interview data. Actors sized according to influence level.[4]

The actors identified in Figure 2 have varying interests and goals and each one of them lobbies to reach their association'sl goals. In terms of the maize sector, ZNFU tries to serve the interest of the smallholder farmers by lobbying for input provision and higher output price from the government. However, in most instances their lobbying has ignored empirical evidence that suggests that the majority of the beneficiaries have not been the smallholder farmer (Mason et al, 2013).

The fact that the interests of these key players do not overlap on a number of issues makes it difficult to reach a consensus when it comes to agriculture policy. ZNFU has in the past, been able to single-handedly lobby for FRA producer maize price increases, putting them at odds with traders and millers, who would rather have access to cheaper maize grain. However, as powerful as the union is, there are times when things do not go its way. For instance, on 17 March 2015, the Minister of Agriculture announced the importation of wheat, which the millers saw as a welcome move. However, this did not sit very well with ZNFU which went to the extent of calling the minister, "minister of millers" in an article posted on the union's website expressing dissatisfaction on the way things were going (ZNFU, 2015).

Within the milling industry, members of MAZ are seen to have unfair competitive advantage as they are usually the ones who are able to access cheaper maize from FRA. However, the MAZ lobby success is usually mixed. For instance, after the removal of the maize grain subsidy in 2013, it has not been successful with its lobby effort to fully bring back the subsidy. The continued tug of war among the different stakeholders makes policy changes in the maize sector much more difficult.

There are some areas of consensus amongst these players, for instance ZNFU depending on the crop, can also work in tandem with the millers and MAL. ZNFU, GTAZ, and some fertiliser and seed companies seem to have aligned interests when it comes to lobbying policy change concerning FISP and for Zambia to have a functional commodity exchange. Such areas of consensus can be used as a starting point for pushing for policy changes in the agricultural sector.

***Command network***

The results in Figure 3 show that the power to command actors in the maize sector is centralised around the Executive. For instance, although FRA reports to MAL, the Executive seem to have more power to influence the direction of the policies by formally and/or informally commanding both MAL and FRA to implement certain policies. For example, during the 2014/2015 marketing session, the ice resident at a political rally announced that FRA was going to buy all the surplus maize from the smallholder farmers and immediately FRA started buying more maize, exceeding the strategic reserve of 500,000-mt target. In addition, in August 2015, we saw the resident announcing a higher FRA maize price (K75 from K70 per 50kg bag) than announced by the agency a week before.

MoFNP is the second most powerful, followed by MAL in terms of the number of actors it can command. Thus, the Executive, MoFNP, and MAL form a command triangle, which according to the various stakeholder interviews possesses the keys to changing the current maize sector policies. At the centre of the triangle is the Minister of Agriculture who has command over MAL and FRA. However, the Ministry of Agriculture has been and is a revolving door, with an informant pointing out that “no single minister has been able to last long enough to gain sufficient control of the inistry to understand the challenges and advocate for change”. Since 2010, the inistry has had six inisters of Agriculture. Given the status quo, the only way policies can change is if the Minister of Agriculture, Minister of Finance, and the resident agree on policy issues. Together, these three hold the keys for change in the maize sector.

Stakeholders also pointed out that currently the Executive makes politically motivated policy pronouncements without consultation and these actions leave no budgetary accountability to either parliament or the Ministry of Finance.

Parliament on the other hand seems unwilling to hold the Executive accountable for decisions that affect the approved budget. It was also noted that the actual lines of command especially with the actors in the triangle are extremely convoluted and unclear, which makes it hard to determine where an order comes from and to hold particular actors and institutions accountable for actions.

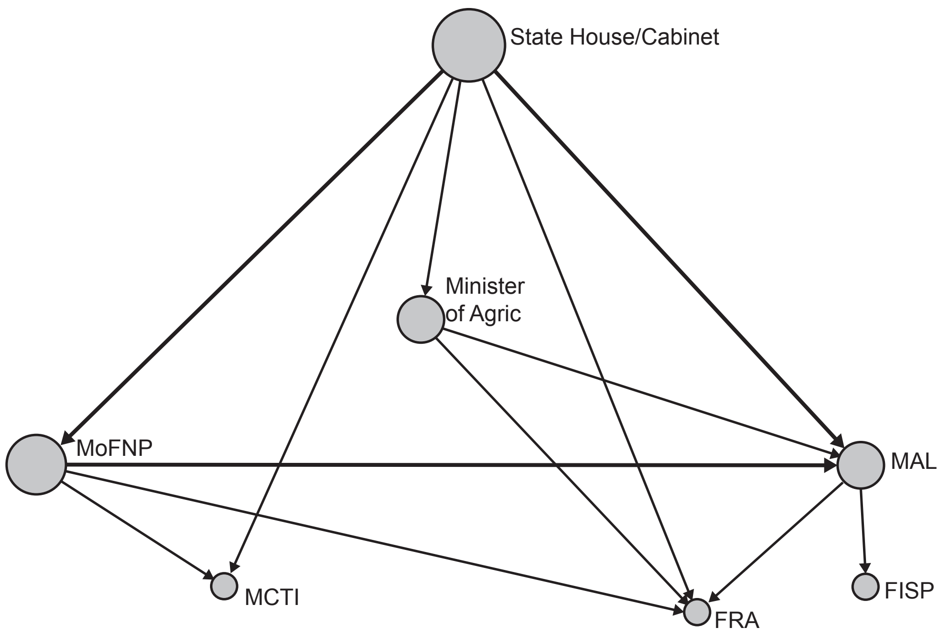


*Figure 3. Command Network*
Source: Authors' calculations with VisualLyzer from interview data. Actors sized according to Influence Level.

***Who and how to change the system***

The current maize system has remained unresponsive to policy change despite numerous policy recommendations. In order to change the system, the main actors that need to be targeted for policy change are those actors with the highest influence levels in the policy making process. Using information from the aggregated interview results from both the lobbying and command networks, actors that support, block, or are undecided about policy change were identified by key informants (Figure 4). Actors that support policy change are indicated in green, those that block policy change are indicated in red, while those that are undecided are indicated in yellow. The size of each actor's node shows the influence level that the actor has. As mentioned earlier, the results from key informant interviews indicated that the major actors identified to have the power to change the system are those that are undecided in terms of the policy direction they need to take. The actors who want to have the maize policies revamped (MoFNP, GTAZ, and civil societies) were found to be not very influential.

From this triangle of actors, MoFNP fully supports policy changes in both input and output markets due to the huge financial strain on the national budget caused by the large unbudgeted expenditures on FRA and FISP, however, it depends on the actual line ministry (MAL) to indicate which policies need to change. The Executive and MAL seem to be undecided when it comes to changing policy on FRA and FISP, as we continue to witness these programmes becoming larger and more ineffective. The Executive was said to remain undecided, as some of its members believe that FRA and FISP are key to winning the electoral rural vote.

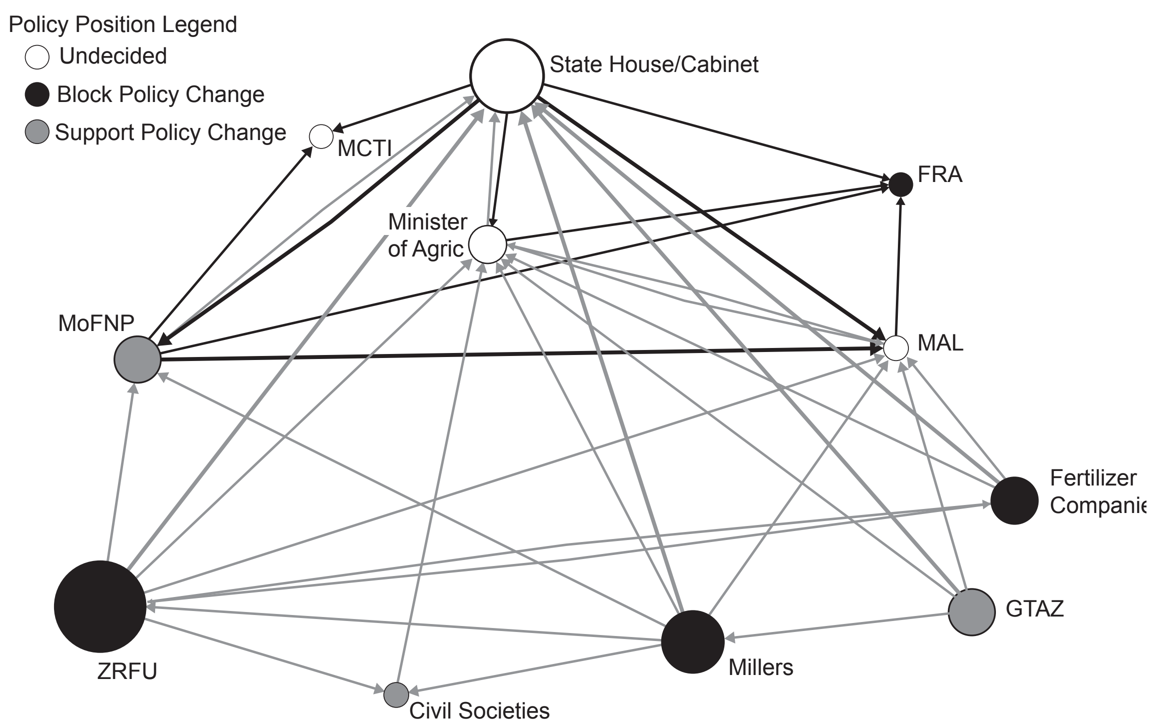


*Figure 4. Aggregated Network on Support, Undecided, and Blocking Policy Change*
Source: Authors' calculations with VisualLyzer from interview data. Actors sized according to influence level.

The majority of those interviewed indicated that there were opposing forces within MAL; hence, it was difficult for the ministry to push for change unequivocally. They said that as long as there is something to be gained from the *status quo*, people tend to protect it. This rent seeking behaviour is said to be obstructing change. The consensus view of those interviewed suggested that some of MAL's technical officers seem to advocate for policy choices that benefit them personally as opposed to what benefits the agricultural sector. For instance, the stalling of the implementation of the e-voucher in preference for the traditional FISP was ascribed to a small group within MAL protecting their interest in the FISP tendering, transportation, and distribution processes. The enactment of the Agricultural Marketing Bill has also stalled because the stakeholders advocated for the inclusion of the Agricultural Marketing Council to deal with marketing issues. However, some of MAL's technical staff perceived this as a threat to their jobs and ability to control the agricultural sector, hence, the bill has not been finalised.

The critical question is how we can change this way of thinking. Without full cooperation of the ministry's technical staff, it would prove difficult to change the maize policies because they are crucial in the policy formulation process. Any hesitation on their part tends to delay or derail the implementation of good policies. It was noted by some respondents that as long as the message from the technical staff is mixed, the minister would not be confident to carry it to Cabinet.

The analysis of the responses from the key informants also show that the millers, big fertiliser companies, and ZNFU seem to be the main actors blocking policy change (see Figure 4.) because they tend to lobby for policies that have short-term benefits for their constituents disregarding the long-term impact on the sector. In addition, with access to both the resident and Minister of Agriculture their voices tend to be heard over others.

**Conclusion**

The consistent interference in the market means that the expansion in production is economically ineffective. The productivity level achieved as a result of encouraging maize production by small farmers and by paying above market prices means that it would be more efficient, and most of the time cheaper, to buy maize on the international futures markets rather than to produce it domestically. Similarly, the practice of subsidising fertiliser – especially by importing the product or producing it inefficiently in government-run plant such as Nitrogen Chemicals of Zambia – would continue to undermine the potential for the expansion of domestic input industries and burden the national treasury.

In order to bring about long-lasting changes to the maize marketing policies in Zambia, there is a need for strong collective action at the highest level, especially with the command triangle. The Executive need to make a deliberate effort to depoliticise the maize sector in order to achieve broad-based growth in the agricultural sector. This is because any random pronouncement by the Executive at any fora usually becomes policy; Ministries of Agriculture and Finance are then forced to implement such *ad hoc* policies which often defy empirical evidence. In addition, the sector requires consistency, beginning with the minister's position. The current situation where ministers are frequently reshuffled does not promote stability because in most cases, the appointments are more political rather than based on the experience and contribution the person would bring to the sector.

Currently, actors are seen to push their agendas independently and decisions affecting the different actors are not coordinated. This lack of coordination perpetuates the *status quo*. Thus, to have meaningful progress in policy changes, there is need for sector actors to come together and push for policy reform in a coordinated fashion especially in areas where their interests align. For instance, we found that there was some consensus regarding the urgent need to reform FISP by adopting an e-voucher system in order to include more players and reduce government expenditure on the programme while at the same time reaching more beneficiaries. Also, we have seen ZNFU, MAZ, and GTAZ come together and agree on the need for the creation of a commodity exchange, an innovation that the government can use to meet the country's food security and poverty reduction objectives without disbanding FRA. Together they managed to convince the government to issue the Statutory Instrument (SI 59) required making the exchange operational. What remains is to demonstrate that FRA can be a big player in the commodity exchange because instead of procuring maize grain directly from farmers, the agency can do it through the private sector. This greatly reduces some of the financial losses currently incurred by the agency due to storage losses, transport logistics, and some of the inefficiencies associated with running a parastatal.

Finally, the decisions in agriculture are made with what are perceived as immediate benefit of winning political support. Providing options of how to gain immediate political mileage through other instruments has not been done sufficiently. FRA and FISP are being used as a form, albeit ineffective form, of social protection. Therefore, if the government would like to provide effective social protection, then part of the solution lies in putting more of FISP and FRA resources to alternative but more effective forms of social protection programmes. For instance, evidence in other countries has shown that giving people cash (social cash transfers) that does not distort the market has greater multiplier effects than distributing a commodity, which crowds out private sector investment. Therefore, there is need to have farmers who are the main actors affected by these policies understand the massive costs of the current programmes at the expense of them seeing tangible benefit; they could then assist in pushing for policy reform. In addition, the need for a well informed, strong, and independent civil society cannot be over emphasized.

## Endnotes

[1] Under the Farmers Licensing Ordinance Number 30 of 1946, a farmer was defined as any person other than: (a) An African or; (b) Any company or body of persons where the controlling interest was held by Africans. With this background and the continued obstacles to the formation of cooperatives by Africans, it was not surprising that the Northern Rhodesia Farmers' Union (NRF.U) at Independence in 1964 was essentially a union for the European commercial farmers. It was recognised as the only representative organisation for the farming community in the country (see Öjermark and Chabala, 1994).

[2] Net-Map has been applied on studies in International Trade and Policy Reform and Governance (see for example, Aberman and Edelman (2014); Raabe et al. (2010)).

[3] The communication structure remains the same to date, only that the line ministry in charge of the policy proposal contacts the relevant ministry as opposed to it being done by PAC. The role of the now PAC is to take the final memo to cabinet.

[4] The size of the influence level is determined by how many other actors a particular actor can lobby when it comes to policy shifts and changes.

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**Appendix**

*Table A1. List of Identified Actors in the Agricultural Policy Making Process*

| | |
|---|---|
| Public Institutions | 1. Food Reserve Agency (FRA) |
| | 2. Fertiliser Input Support Programme (FISP) |
| | 3. Ministry of Agriculture and Livestock (MAL) |
| | 4. Ministry of Agriculture and Livestock Stock Monitoring Committee |
| | 5. Minister of Agriculture |
| | 6. Ministry of Commerce Trade and Industry (MCTI) |
| | 7. Ministry of Finance and National Planning (MoFNP) |
| | 8. Parliamentary Committee on Agriculture and Lands |
| | 9. Parliament |
| | 10. Cabinet |
| | 11. State House |

| | |
|---|---|
| Private Institutions | 12. Research Institutions |
| | 13. Zambia National Farmers' Union (ZNFU) |
| | 14. Grain Traders Association of Zambia (GTAZ) |
| | 15. Millers |
| | 16. Zambia Agricultural Commodities Exchange (ZAMACE) |
| | 17. World Food Programme (WFP) |
| Regional Bodies | 18. Common Market for Eastern and Southern Africa (COMESA) |
| | 19. Southern African Development Community (SADC) |
| Others | 20. Consumers |
| | 21. Retailers |
| | 22. Small-scale farmers |
| | 23. Commercial farmers |
| | 24. Commercial banks |
| | 25. Civil societies |

Source: Authors' compilation

*Table A2. Summary of Key Agriculture Sector Policies, 1964 to 2015*

| **Time line** | **Policy** |
|---|---|
| First Republic (1964-1972) | • Introduction of fertiliser and consumer maize meal subsidies in 1971<br>• Pan-territorial pricing policy implemented.<br>• Expansion of State crop buying stations first through National Agricultural Marketing Board in 1969 and later through the Zambia Cooperative Federation (ZCF).<br>• Trade restrictions in terms of exchange controls, quantitative controls, and import and export restrictions imposed as a way of protecting the industry. |
| Second Republic 1972-1991) | • Implementation of its first Structural Adjustment Programme (SAP) in 1978 and producer/consumer subsidies reduced as part of the SAPs.<br>• Following urban riots, the government reverted to price controls and subsidy provision in 1987.<br>• Abolitiont of NAMBOARD in 1989 and partial liberalisation of the grain markets. |

| | |
|---|---|
| Third Republic (1991-2001) | • Accelerated and expanded the reform process by removing input and price subsidies.<br>• Exchange controls, quantitative controls, and import and export restrictions removed.<br>• Government's direct involvement in maize marketing minimised.<br>• Establishment of the Food Reserve Agency in 1996 through the Food Reserve Agency Act of 1995, to hold strategic reserves. |
| Fourth Republic (2001-2011) | • Introduced the Food Security Pack programme in 2001 to help the most vulnerable households.<br>• Resumed large-scale distribution of subsidised fertiliser to registered farmer cooperatives through the newly introduced Fertiliser Support Programme (FSP) in 2002/2003.<br>• Amendment of the Food Reserve Act (No. 20 of 2005), giving FRA the authority to participate and engage directly in maize marketing. |
| Fifth Republic (2011- to date) | • Recapitalisation of NCZ<br>• Increased FRA buying activities<br>• Increased spending on FISP<br>• *Ad hoc* maize export policies.<br>• Signing of the Agricultural Credits Act authorising the use of warehouse receipt system.<br>• Promise to reform FISP and implement it through the e-voucher. |

Source: Authors' illustrations.

# Achieving More with Less: Reform and Scaling Down of Food Reserve Agency and Farmer Input Support Programme and Boosting Social Protection

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*Zambia continues to suffer from a regime of ineffectual subsidies and insufficient social protection. Despite evidence showing how the country's signature farming input and output subsidy programmes, i.e. the Farmer Input Support Programme (FISP) and the Food Reserve Agency (FRA) respectively, have failed to spur agricultural diversification, address low agricultural productivity, food security, and stubbornly high rural poverty rates, the country has continued to allocate significant resources towards their implementation. Notably, Zambia is currently grappling with the need to make some tough choices as it seeks to deliver on the Zambia-Plus Recovery Plan proposed by the Minister of Finance. Among other options, the government should consider how to scale back on discretionary spending whilst supporting economic growth and social development. Politically, maintaining the status quo is likely to be very costly given that the country can no longer afford the continued financial haemorrhage from the current operations of FISP and FRA. This paper presents a case for reforming FISP and FRA by providing alternative approaches that will work better for both the individual Zambians who rely on the state for support, and the country as a whole.*

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**Key words:**
Farmer Input Support Programme, Food Reserve Agency, Policy Reform, Social Cash Transfer, Zambia

## Introduction

Zambia continues to suffer from a regime of ineffectual subsidies and insufficient social protection. Despite evidence showing how the country's signature farming input and output subsidy programmes i.e. the Farmer Input Support Programme (FISP) and the Food Reserve Agency (FRA), respectively, have failed to spur agricultural diversification and address low agricultural productivity, food security, and stubbornly high rural poverty rates, the country has continued to allocate significant resources to their implementation (see Box 1). Notably, Zambia is currently grappling with the need to make some tough choices as it seeks to deliver on the Zambia-Plus Recovery Plan proposed by the Minister of Finance. Among other options, the government should consider how to scale back on discretionary spending whilst supporting economic growth and social development. Currently FISP and FRA take up a large chunk of this discretionary spending (about 57% of the agricultural budget in 2016 and 2017 respectively.The government needs to carefully consider how these two programmes can be more effectively streamlined.

**Box 1: Reality Check**

- Rural poverty currently stands at 77% despite billions of Kwacha spent on FISP and FRA (LCMS, 2015)
- Maize production has increased since the implementation of FISP and FRA but mostly at the expense of agricultural diversification. Increases in maize production have mainly been due to area expansion. Maize yields have marginally increased and the level is very low and not commercially or sustainably viable.
- Using the national nutrition indicators (wasting, stunting, and underweight), the CSO's Demographic Health Survey of 2014 reported that 40% of children under 5 are stunted, with 17% being severely stunted. Additionally, children in rural areas are more likely to be stunted (42%) than children in urban areas (36%)
- The Global Hunger Index Report (2015) ranked Zambia among the three countries with the worst rates of hunger in the World (IFPRI, Welthungerhilfe & Concern Worldwide, 2015).

There are conflicting ideas regarding how best to resolve the seemingly wasteful spending on agricultural subsidies. One school of thought advocates for the status quo to be maintained, arguing that any responsible government has an obligation to support its farmers to ensure food security and poverty reduction. On the other hand, there are calls for the complete removal of the input and output subsidies arguing that the benefits of the billions of Kwacha spent do not match the sector's growth, poverty rates, or productivity growth. Notwithstanding the strong arguments to stop the subsidy programmes, the political economy of these subsidy programmes usually leads to the status quo being the most preferred despite the high cost to the nation.

Given the sensitivities around subsidies, Indaba Agricultural Policy Research Institute (IAPRI) has been advocating for cost effective alternatives that would not burden the treasury but help achieve sustainable agricultural growth and poverty reduction. In particular, the Institute has consistently recommended that the government move towards smart subsidy programmes led by the private sector such as: the use of the flexible e-voucher, supporting market-oriented solutions such as expanding social cash transfers (SCTs) to the poorest segments of the population in order to resolve the perceived problem of rising mealie meal prices, as well as managing the strategic reserves through the commodity exchange/warehouse receipts system.

Politically, maintaining the *status quo* is likely to be very costly given that the country can no longer afford the continued financial haemorrhage from the current operations of FISP and FRA. Government needs to make bold decisions and implement reforms that will have more far-reaching positive impacts in the agricultural sector. There is usually limited understanding of the opportunity cost of having massive programmes of this nature. At the same time, stakeholders do not understand when (for example) the government fails to pay farmers on time despite the fact that the FRA often purchases maize at above the budgeted target, or fails to fund the FISP e-voucher program.

Against this backdrop, this paper presents a case for reforming FISP and FRA by providing alternative approaches that will work better for individual Zambians who rely on the state for support, and the country as a whole. Throughout the paper, we argue that it is not prudent to maintain the *status quo* whilst simultaneously articulating alternatives that may enable the government to scale back the subsidy programme without huge political backlash.

## Can Zambia Afford to Continue on the Well-Trodden Path of Heavy Input and Output Subsidies?

Given that more than 65% of the Zambian population depends on agriculture, primarily through smallholder production, for their livelihoods and employment (CSO, 2013), growth in the agricultural sector is the clearest avenue through which poverty reduction can be achieved. Nevertheless, the current spending strategy—which consistently prioritises ineffective and costly subsidies—would not achieve this desired growth and poverty reduction. Notably, most of the funds allocated to the sector over the years have been spent on fertiliser subsidies through FISP, and maize price stabilisation through FRA. Together these two programmes have accounted for 30-60% of the total agriculture budget between 2003 and 2014 (Figure 1).

### *Farmer Input Support Programme*

Empirical evidence from IAPRI shows that in contrast to its major objectives (Box 2), FISP has not succeeded in reducing rural poverty as the upfront costs, explicit targeting, and land access requirements to be a FISP beneficiary tend to exclude poorer rural households (see Chisanga and Chapoto, 2015; Mason and Tembo, 2015; Mason *et al*., 2013). Evidence on the impact of FISP suggests that the programme has had minimal impact on poverty, food security, and

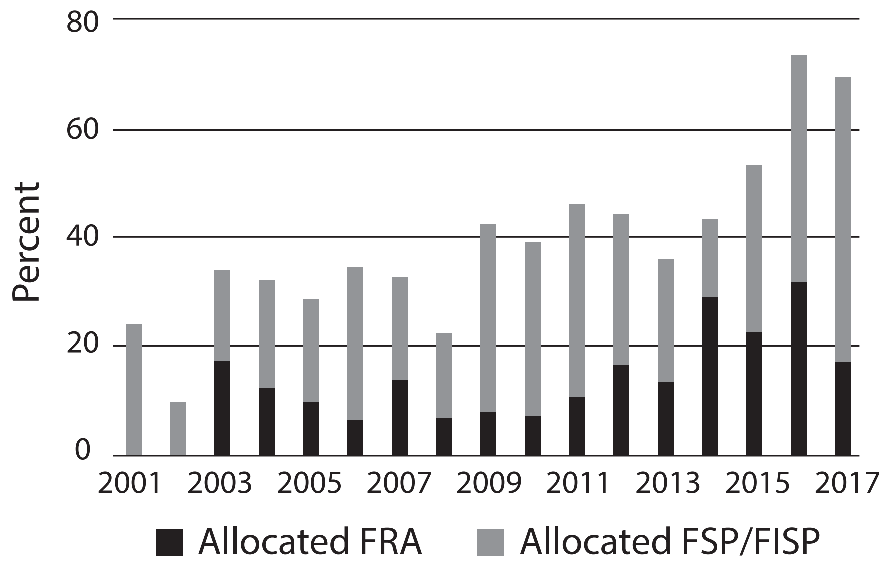


*Figure 1. Share of FRA and FISP to Total Agriculture Budget Allocations*
Source: MoFNP various years; MAL various years.

smallholder farmers' income due to implementation challenges. This includes late delivery of inputs, with 22% and 35% of farmers reporting late receipt of inputs in 2010 and 2014 respectively (Mason and Tembo, 2015; Mason *et al*., 2013). Nkonde (2016) reported that the late receipt of inputs has been associated with a 4.2% reduction in input use efficiency, and production losses of more than 85,000 metric tonnes. In addition, nationally representative farm survey data consistently show that FISP fertiliser and maize seed have been allocated disproportionately to households with relatively large farms and greater asset wealth (Chisanga and Chapoto, 2015).

Under the traditional FISP, the private sector plays a limited role in providing input and output marketing services. Provision of subsidies tends to sideline commercial fertiliser purchases and in turn affects investments from the private sector. Households accustomed to subsidies develop a dependency syndrome as there is little evidence that farmers are graduating after two years of being on the programme.

In terms of agricultural productivity, the traditional FISP fails to recognise the spatial variability of soil fertility, and climatic conditions in the country. As a result, the traditional FISP uses the blanket fertiliser recommendation of 'one-size fits all' as the basis for determining the package size, and in doing so disregards the comparative advantage of different agro-ecological areas. Consequently, we have seen the government continue investing heavily in D compound and urea fertiliser, which is not suitable in large parts of the country where soils are acidic. This has adverse implications on productivity and overall production.

**Box 2: Zambia's Farmer Input Support Program: Objectives and Reality:**

**Objectives**

- Introduced in 2002 in response to the severe droughts in the 2000/01 and 2001/02 agricultural years, as well as the low loan recovery rates under the (loan-based) Fertiliser Credit Programme.
- Improving household and national food security, incomes, accessibility to agricultural inputs by small-scale farmers through a subsidy and building the capacity of the private sector to participate in the supply of agricultural inputs thereby reducing direct role of government.
- Implicit goal of poverty reduction given that the programme is classified as a "Poverty Reduction Programme –PRP" and consumes about 56.3% of PRPs budget or 30% of the agricultural budget.
- Intended beneficiaries targeting criteria:
    - Be a registered small-scale farmer and actively involved in farming within the camp coverage area;
    - Cultivate up to a maximum of 5 ha of land;
    - Have the capacity to pay the prescribed farmer contribution towards the total cost of an input pack.
    - Not concurrently benefitting from the Food Security Pack (FSP) Programme; and
    - Not be a defaulter from any agricultural credit programme.

**Reality:**

- No significant reduction in rural poverty – in fact rural poverty has marginally reduced from 78% to 76% since FISP was established in 2001.
- Despite reaching maize self-sufficiency, yields remain persistently low. Production growth is mainly through areas expansion rather than productivity increases. Maize yields currently, average 2.1MT/h, 138% below the 5MT/ha as per the Malabo Declaration.
- Limited evidence of farmer graduation.
- Poor targeting of support, the 'one size fits all' approach hasn't worked.
- Delays in input distribution regularly experienced by farmers.
- Limited agricultural diversification.
- FISP impact on private sector participation. Limited private sector participation under traditional FISP

* *E-voucher implementing manual of 2016/17 has somewhat different targeting criteria in terms of land cultivated*. The programme's target was up to a maximum of 2 ha. In addition, the target was extended to livestock farmers i.e. farmers raising 2 to 10 cattle, or 5 to 30 pigs, or 5 to 30 goats, or 20 to 100 chickens.

Zambia is now in the process of reforming FISP to implement the subsidy programme through a flexible e-voucher. After years of lobbying for FISP reforms by various stakeholders, the Ministry of Agriculture (MoA) launched the e-voucher program as a pilot in 13 selected districts[1] during the 2015/2016 agricultural season with an initial target of 241,000 smallholder farmers. The pilot was expanded to 39 districts during the 2016/17 farming season. In the 2017 budget speech, the Minister of Finance, Hon. Felix Mutati announced intentions by the government to roll out the e-voucher to the rest of the country in the 2017/18 season. Unfortunately, the 2017 budget to FISP increased by over 189% as the number of planned beneficiaries surpassed the one million mark. Additionally, in the quest to promote agricultural diversification, MoA budgeting was done by crop. For example, the target beneficiaries for maize alone were set at one million farmers.

Reforming FISP will require the government to cut expenditure on it, and redirect these funds to investments in other key drivers of agricultural growth, such as research and development, extension, feeder roads, and irrigation. The government needs to acknowledge that FISP alone will not sufficiently energise the agricultural sector, but instead reduces funding to other key high return investments. The implementation of the traditional FISP alongside E-FISP[2] has also resulted in people concluding that the flexible e-voucher has been a failure. This heightened doubts whether the e-voucherwould be successful when it was rolled out to the whole country in the 2017/18 agricultural season. IAPRI's E-FISP monitoring activities reveal that delayed funding due to the current tight fiscal space has led to delays in activating e-voucher cards. This is one of the factors that has led to the pilot programme being labelled 'a failure' by advocates of the traditional FISP. However, evidence from the e-voucher system in the first 13 pilot districts shows that delivering the subsidy through the e-voucher helped to involve more private sector participation in inputs distribution to rural farmers (see Kuteya et al., 2016). Participating agro-dealers stocked more diverse inputs in their shops giving farmers an opportunity to purchase inputs of their choice. Thus, a well-managed E-FISP is likely to unlock the potential for agricultural diversification in the country (Kuteya *et al*., 2016).

### *Output Subsidies through Food Reserve Agency*

The verdict on FRA is equally bleak. Decades of government subsidy policies have done little to address the high levels of poverty and inequality within the rural sector given that maize production and sales from smallholder farmers are highly concentrated. Depending on the year, the first 50% of sales from smallholder farmers to FRA are made by only 3-5% of farmers, and only around 30% of all smallholder farmers sell any maize to FRA at all (Chisanga and Chapoto, 2015). In the context of a highly concentrated smallholder maize market, government maize purchases at elevated prices serve to transfer significant treasury resources to a small minority of relatively elite smallholder farmers. Given that most farmers, particularly the poorest farmers, are net buyers of the maize, at the very least, the FRA does nothing to help the majority of the rural poor which is in stark contrast to its mission of "*taking wealth to rural Zambia*" (Box 3).

**Box 3: Zambia's Food Reserve Agency: Objectives and Reality**

**Objectives**:

- The Food Reserve Agency (FRA) was created through the Food Reserve Act, Cap 225 of the Laws of Zambia to administer the strategic food reserves, engage in market facilitation, development and management of the national storage facilities.
- FRA's mission is to ensure national food security and provide market access for rural-based smallholder farmers by maintaining a sustainable national strategic food reserve.
- According to FRA, its main objective is to secure national food reserves and take wealth to rural Zambia.

Source: http://fra.org.zm/about-us/

**Reality**:

- Limited market facilitation: FRA in most years has failed to adhere to the statutory strategic reserve often buying above the prescribed target, hence, failing to encourage private sector participation.
- Setting FRA prices above the prevailing market prices causes market distortions.
- Interventions aimed at ensuring national food security and taking wealth to rural Zambia have had very little impact on the incomes of the poorest households.
- Increase in the average price levels of maize does not benefit the majority of the rural poor who are not able to produce a surplus.
- FRA buys mostly from larger and relatively better-off farmers.
- High pan-territorial and pan-seasonal prices hurt about 30% of rural farmers who are net buyers.
- FRA subsidy to consumers mainly benefit millers who receive subsidised maize.
- Delayed payments to farmers.
- FRA buying activities curtail agricultural diversification as most farmers tend to follow the market offered by FRA.

Buying beyond the prescribed strategic grain reserves target (currently 500,000 metric tonnes) has resulted in farmers being paid late, and made it difficult for the private sector to plan and operate efficiently. Further, the offloading of maize by FRA on the market at a reduced or subsidised price continues to hurt farmers producing early maize; grain traders; and all millers who do not have access to the discounted FRA maize price. These interventions come at a huge expense to the treasury and make it difficult to manage the country's budget deficit. Additionally, the money used to buy grain comes from commercial banks thus imposing an opportunity cost to the growth of other sectors within and outside agriculture.

Government has an adverse impact on commercial financial markets when it borrows money to finance maize-related purchases under FRA and FISP which could be financed by the private sector. IAPRI estimated that the cost to the national treasury for holding 500,000 metric tonnes of maize is approximately US$26.7 million (excluding the procurement costs and FRA-related costs) using a conservative storage loss of 10% over a period of eight months (for details see Annex 1, Table A1). Scaling back the size of the strategic grain reserve and using a combination of physical and non-physical stocks could save the country considerable financial resources. Consequently, a portion of these resources could be channelled for use in other socially robust programmes as recommended in this paper.

Similarly, the strategy of selling maize to millers at subsidised prices with the expectation that consumers will buy mealie meal at lower prices is inaffective. It is more cost-effective to empower poor consumers through SCTs in order for them to be able to afford food in times of high prices. SCTs are less disruptive than targeting a selected group of well-connected millers or traders. Low income urban consumers do not possess enough money to afford formal sector retail prices for commercially packaged maize meal. Instead, they rely on daily purchases of very small, very expensive repackaged maize meal (known locally as "pamela") purchased from vendors in the market (Mwiinga *et al*., 2003; Mason et al., 2009). Chisanga (2016) shows that maize meal purchased in repacks costs 27% more than the full 25kg bag. Additionally, it was noted that those with little or no income resort to skipping meals or switching to less preferred diets.

**FISP and FRA Reforms and Investments into Alternative Effective Social Protection Policies**

There is irrefutable evidence that FISP and FRA have been costly and ineffective in reducing rural poverty, raising productivity, and encouraging agricultural diversification. It is therefore imperative that the government considers reforming the two programmes, and begins to invest in alternative strategies. Going forward, a smarter subsidy regime which entails scaling back FISP and FRA allows the release of limited treasury resources to alternative social protection policies. These alternatives are far more cost-effective and can deliver on the key objectives of FRA and FISP more efficiently. . The recommendations suggested herein consider the political economy of the current subsidy regime, as well as the government objectives for implementing FISP and FRA which include market development, increased agricultural productivity and poverty reduction. The recommendations are structured around two key areas, namely; a) the reform agenda of FISP and FRA, and b) investment in alternative cost effective social protection policies and programmes.

***Reforming the Food Reserve Agency***

Discretionary and unpredictable FRA intervention continues to be one of the greatest policy problems plaguing the maize marketing system and food security in Zambia. This is because actual and potential government interventions by FRA generate uncertainties for the private sector, leading to inaction and a perpetual cycle of recurrent need for government intervention. Government, therefore, needs to consider reforms to the Agency in order to achieve food security and poverty reduction at the least possible cost. We make specific recommendations below.

*Policy Options/Recommendations to Reform FRA*

A. In order to create space for other effective social protection programmes, the government needs to review the size of the country's strategic grain reserve. We propose that the government reduces the physical stock level of the strategic reserve, as well as its procurement and management. In particular, the physical reserve should be scaled back to 300,000 metric tonnes[3] (MT) from the current statutory 500,000MT and save the country approximately US$44.7 million through buying and storing the extra 200,000MT (see Table A1 for computation of the saving). In addition, the strategic reserve stock should be procured and stored on behalf of the government by the private sector through the commodity exchange and warehouse receipts system. FRA's role would therefore be to ensure compliance by all those involved in the procurement and storage of the grain. Zambia can draw lessons on how to engage the private sector in management of the strategic grain reserves from Ghana and Tanzania (see Mulungu and Chilundika, 2016).

B. Where a well-managed early warning system incorporating both private and public stakeholders exists, the current 500,000MT is considerably more than the country needs if there's an impending shock. The current

Stocks Monitoring Committee is too ad-hoc and poorly equipped to deal with a long-term food security strategy. It is important to note that, due to improved irrigation capacity in the country, Zambia is now better placed to deal with shocks without the need to hold such huge and expensive stock levels. Commercial farmers can be contracted at short notice to produce maize to fill any anticipated shortfall. Further, consumption patterns today are different from many years ago, with demand for non-maize food products increasing. Finally, improvements in infrastructure over the years imply that it may be cheaper to procure and import grain as compared to physically holding all strategic reserves for at least eight months.

C. A well-managed strategic grain reserve and price stabilisation policy allowing for clear triggers for maize purchases and releases by FRA needs to be formulated. This would allow for normal seasonal price fluctuations, which is a key ingredient for encouraging private sector investments in the agricultural sector. The failure to have a clearly established price stabilisation policy causes panic and knee-jerk policies with few winners and many losers.

***Reforming the Farmer Input Support Programme***

Government is commended for piloting the E-FISP and delivering input subsidies through a flexible e-voucher. Despite the teething problems facing the pilot programme, the upscaling of the E-FISP is most welcome given its potential to help kick-start sustainable agricultural diversification, and input market development led by the private sector. This would in the long run reduce the government's discretionary expenditure on agricultural inputs. Nevertheless, as indicated earlier the FISP programme (both the traditional FISP and E-FISP), have become too large, gobbling ZMW 2.58 billion or approximately US$258 million equivalent to 52.6% of the MoA Budget) and are crowding out other cost-effective public investments which have high potential to increase productivity and sustainably reduce rural poverty in Zambia.

*Policy Options/Recommendations to Reform FISP*

A. As a first step, the government needs to acknowledge that FISP has achieved sub-optimal impacts on raising agricultural productivity, agricultural diversification, and reduced rural poverty. This would then allow for the programme to be scaled back over time to prioritise the implementation of other cost-effective social protection alternatives. Therefore, going forward, there is need to cut the overall spending on FISP and cap it at no more than US$105 million or not more than 20% of the agriculture budget and reach 500,000 smallholder farmers. Based on the 2017 budget, this will save the country up to US$178 million. A scaled back FISP delivered via the e-voucher system will improve targeting, diversification, and encourage private sector participation.

B. The E-FISP should prioritise some investment in soil testing that allows for identifying appropriate fertilisers for each agro-ecological region, and ensure extension officers are adequately trained and provided with enough, and timely, resources to enable them to disseminate this information effectively.

C. The identified shortcomings of implementing the e-voucher during the pilot phase need to be addressed if the programme is to be successfully rolled out to the whole country (see Annex 2). Specifically, the government will need to:
   a. Commit to the e-voucher now, so all the actors in the system, from banks to local agriculture dealers have time to prepare properly;
   b. Begin re-educating farmers now to ensure they understand the voucher and to limit abuse of the system; and,
   c. Ensure the activation process works effectively and that funds are in place to enable farmers to use the cards in time for the planting season. In particular, there is need to eliminate all human elements from all processes that can be automated.

D. We can see from examples of where the implementation has worked well, for example in Southern Province that the e-voucher is beginning to change behaviour and has been well received by farmers. Specifically, where the conditions above have been met, the e-voucher has:
   a. Brought in more private sector participation in agro-input distribution, thereby reducing public expenditure on the delivery of private goods such as fertiliser and seed;
   b. Ensured timely delivery and access to inputs by smallholder farmers;
   c. Allowed farmers to buy inputs of their choice and started to develop agricultural diversification; and,
   d. Reduced leakages through better targeting.

***Alternative Cost-Effective Social Protection Policies***

Scaling-back FISP and FRA is the right thing to do, but in isolation reducing expenditure on ineffective agriculture subsidies will not deliver the objectives stated in Boxes 2 and 3. Fiscal space created by reductions in expenditure on these programmes should be used to invest in higher return social protection alternatives that can deliver many of the objectives that FISP and FRA were purported to be delivering.

IAPRI proposes three alternative programmes that the government could invest in to deliver on the key objectives of reducing rural poverty, supporting farmers, and creating a sustainable and diverse market for farmers' agricultural products. So, in contrasting the government's current approach, there is a case to reinvest the saved resources. To alleviate poverty the government could spend more on Social Cash Transfers (SCT), to reduce malnourishment and promote child development the government could pursue an expanded Home-Grown School Feeding Programme (HGSF) as well as provide nutrition support via a Women, Infants and Children Programme (WIC). In the latter two examples, direct support in the form of food would be provided to the households needing it most, whilst indirectly supporting farmers by providing a reliable local market for a diverse range of agricultural products including grains and livestock products.

When delivered alongside reforms of the FISP and FRA this dual support approach will mean continued, better targeted support for farmers alongside improved support for the poorest households in Zambia. So, what should these new programmes look like, and why do we think they will be a success?

*Robust Social Cash Transfers Programme*

The SCT received a huge boost in the 2017 budget, increasing by 82.8% from ZMW302 million to ZMW552 million (US$30.2 million to US$55.2 million). However, even at this level, SCT is still a very small fraction of what is allocated to FISP, about 19.3% in the 2017 budget. Further scaling-up SCT is desirable given that an additional US$43.5 million for example, would mean that an extra 500,000 beneficiaries would be reached at the current levels of the monthly grant .[4]

Unlike FISP which targets food production among farmers, SCT tackles food-entitlement failures indirectly, by providing cash to both farmers and non-farmers. Hence, unconditional SCT can be used as an effective alternative to FISP because the programme stimulates demand for local goods and services, as most of the cash is spent on locally purchased goods. Further, SCT stimulates enterprises in rural areas enabling the poor to protect themselves and their assets against shocks, act as a support for development of human capital, in addition to enabling them to defend their long-term income-generating potential (Samson 2009). In so doing SCT improves agricultural productivity – due to increased spending on agricultural inputs – in contexts where the primary constraint was working capital rather than land.

Furthermore, the unconditional SCT has been found to have a positive effect on improving consumption and reducing poverty among participating households (Van Ufford et al., 2016). In addition, SCT has been shown to improve the nutritional status, health, and number of school-going children. Another recent evaluation of the Child Grant Programme (CGP) by Handa *et al*., (2016) showed that the increase in consumption observed among households receiving the SCT was close to the per capita value of the transfer, as is the expectation among very poor households. Consumption patterns among recipients also showed increased dietary diversity from starchy foods to protein containing foods (Chisanga and Zulu-Mbata, 2016). Additionally, due to SCT funds being spent locally within the communities where they were disbursed, economic activities in the local area were strengthened. SCTs are also linked to improved climate resilience among beneficiaries (Asfaw *et al*. 2016).

*Universal Home Grown School Feeding Programme*

The school feeding programme implemented by the Government of Zambia in collaboration with the World Food Programme (WFP) is acknowledged as an effective initiative that can simultaneously address the marketing challenge that farmers face, address the high malnutrition rate in school-age going children, and encourage school enrolment and attendance. Therefore, if the FRA is scaled down, funds saved could be channelled into a universal HGSF.[5] The programme is multi-sectoral incorporating agriculture, education, health and nutrition, local government and finance. Notably, the African Union (AU) has recommended the HGSF as a tool for food security and poverty reduction (Kalaluka, 2016).

Currently, the HGSF Programme covers 38 Districts in nine provinces of Zambia. A total of 1,052,759 beneficiaries are targeted with grains (maize), pulses (beans and cowpeas), and cooking oils for a total of 182 days/. The total cost of procuring the commodities in 2017 is estimated at K87.2 million (US$8.72 million), translating into about ZMW95 (US$9.5) per child per year (WFP, 2015; ILO, 2016). There is a total of 3.4 million school-going children in rural areas in Zambia, so doubling the number of children supported by the programme would mean that 61% of the rural schoolgoing children would benefit, which would cost an additional US$8.72 million each year excluding management costs. The bulk of this money would go directly to the farmers who were providing the food to the schools, thereby promoting local markets and diversification at local level.

The benefits of the current HGSF include the enhancement of smallholder farmers' productive capacity by linking them to a predictable market – in this case the school. By purchasing food requirements locally, the programme promotes participation of local smallholder farmers in value chains through market mechanisms. Farmers are reached through cooperatives, and capacitated with skills in crop aggregation to guarantee quality assurance. Through this approach, schools provide local farmers with a predictable outlet for their products, leading to a stable income, more investments and higher productivity. Due to the diversity of food requirements, the school feeding programme encourages food diversification as markets are provided for diverse foods other than maize alone.

Zambia can learn from one of the most celebrated school feeding programme in Brazil.[6] School feeding in Brazil is a duty of the State, and a universal right of students enrolled in public basic education, granted by the Constitution (Sidaner *et al*., 2013). The Brazilian programme is exemplary in its scope, reaching more than 45 million students, with an allocated budget of some US$1.9 billion for 2012, which is equivalent to US$44 per student per annum.

*Women, Infants and Children Programme*

Savings from FISP and FRA could also be spent on a social protection programme that deals with health, malnutrition, and agricultural marketing problems. Despite increased interventions on nutrition, undernutrition still remains a widespread problem. Zambia suffers from some of the highest levels of undernutrition in the world. The most affected are women in the reproductive age group, and children below the age of five years. Hundreds of thousands of children and women suffer from one or more forms of malnutrition, including low birth weight, wasting, stunting, underweight, and multiple micronutrient deficiencies such as vitamin A, iron, zinc, and iodine. Undernutrition is responsible for 52% of all deaths occurring in children below the age of five in Zambia (UNICEF, 2009; DFID, 2011).

Introducing a programme that deals with malnutrition among pregnant women, and a programme for infants and children would create a market for a variety of agricultural commodities and products, as well as provide nutrition education and supplemental nutritious foods to help keep underprivileged pregnant women, new mothers, infants, and children under 5 healthy and strong. Target families could receive a variety of healthier choices in their food items, including; fresh milk, eggs, fruits and vegetables, whole grains, and infant foods. All these products can be supplied by local farmers.

The WIC programme has been implemented in the United States of America since 1972 and over the years the programme has greatly expanded. The existing body of research shows various impacts of the programme on child health and household food security. For example, studies have shown that the programme improves birth weights andimproves women's prenatal care (Bitler and Currie 2004; Hoynes, Page, and Stevens 2011; Kreider, Pepper, and Roy 2014). Hanson and Oliveria (2009), estimated that the farm sector received almost US$1.3 billion from the sale of commodities that are used in producing the US$4.6 billion in WIC retail food sales.

Notably, introducing this programme in Zambia would not be to the scale of that in the USA, but would offer significantly cheaper support than current agriculture subsidies. Providing this programme to an estimated 250,000 women and 300,000 children would cost US$46.2 million if support is at the same level as the current SCT, ZMW70 (or US$7) per recipient per month. The bulk of this money would flow directly to farmers producing food for the programme, providing more indirect support to the industry whilst delivering improved nutrition outcomes for Zambian women, infants and for malnourished, impoverished Zambian children.

***Opportunities and costs of these proposals***

There is clearly a strong economic and social case for reform that is set out in the previous sections. Re-focussing support away from ineffective agricultural subsidies towards cost-effective social protection polices will deliver better social outcomes in Zambia. However, in proposing these alternatives, we must also determine if these proposals are affordable. With the government committed to economic recovery through the Zambia Plus plan, and a potential support package from the IMF, Zambia is likely to face a period of fiscal constraint. Proposals for reforms need to be affordable in addition to delivering improved outcomes for Zambian citizens.

Table 1 sets out the financial opportunities created by reforming the agricultural subsidies and provides some indicative costs for new social protection programmes. This clearly shows that the approach advocated for in this paper is affordable and will help constrain spending, in addition to delivering improved support to those Zambians who need it most.

| S/N | Proposal | Saving/ (Cost) (US$) | Objectives of Programme |
|---|---|---|---|
| 1 | FRA reform: Scale back strategic reserve stock level to 300,000MT from the current 500,000MT | 44.7 million | • Reformed FRA to focus on food security, ensuring less market distortion.<br>• Further savings can be made if government procures the reserves via the commodity exchange with maize stored in certified warehouses. |
| 2 | Cap total FISP expenditure at no more than US$100 million and target at least 500,000 smallholder farmers through a flexible e-voucher. | 178 million | • Reformed E-FISP provides more cost-effective and efficient support to farmers, taking account of local conditions and enabling choice and diversification.<br>• Promotes competitive private sector input provision. |

| | | | |
|---|---|---|---|
| 3 | Scale-up SCT beneficiaries by an additional 500,000 beneficiaries | (43.5 million) | • SCTs focused on poorest and most vulnerable households and target poverty reduction.<br>• SCTs have a positive multiplier effect on the economy as cash creates an effective demand for food and non-food products helping local economies to grow. |
| 4 | Support one million more children via the Home Grown School Feeding (HGSF) programme. | (8.7 million) | • HGSF will not only ensure that children have access to regular meals, but also create local markets for a diverse range of farming products. |
| 5 | Provide nutritious food vouchers to 500,000 women and children | (46.2 million) | • WIC provides nutritional support to mothers and infants, reducing malnutrition, and supporting child development. At the same time the programme provides a market for local farmers. |
| 6 | Net saving/(Cost) | 124.3.8 million+ | • Savings be invested into key drivers of agricultural growth and other high return programmes |

*Table 1. Summary of opportunities and costs of proposals*
Source: Authors' recommendations and calculations from 2017 Budget

**Conclusion**

In a liberalised market economy, the private sector is expected to effectively serve the needs of the millions of rural farmers and urban consumers, whilst the government is expected to provide a conducive environment and regulatory framework to benefit all stakeholders. Unfortunately, with a history of government intervention, the private sector in Zambia has often been blamed for failing to be responsive to the smallholder farmers' needs. The perceived failure of the market has led the Government of Zambia into spending colossal amounts of money on FISP and FRA. However, this paper has presented a case for reforms and consideration of reinvestment of public resources into more cost-effective, and multifaceted social protection programmes which involve the private sector.

Another recommendation of this article is that the government should redirect government funding to key drivers of agricultural growth. This reorientation of spending, away from FRA and FISP should go towards increased investment in public goods including: irrigation development as a means to mitigate drought and improve productivity; crop, soil, and livestock science research and development - to enhance genetic advances and refinements in the adaptation of improved practices and technologies; extension programmes, particularly focusing on effective and appropriate input use, and integrated soil fertility management practices to improve soils and raise crop response to inorganic fertiliser; and rural physical infrastructure development especially feeder roads. In addition, the government needs to improve the timing of budget releases. Effective monitoring systems need to be designed to increase budgeting transparency and accountability aimed at reducing or eliminating delayed budget releases.

Last but not least, the country needs to enact an Agricultural Marketing Act to guide all private and public agricultural marketing activities in Zambia. In the mixed policy environment, the government coexists with the private sector as an unfairly large competitor, and this hinders the development of the agricultural sector. Complete government withdrawal from the market is neither realistic nor desirable. However, the government must avoid policies that crowd out private sector participation, and should instead seek to facilitate market growth, as well as make every effort to leverage private sector investments. Therefore, an Agricultural Marketing Act will provide guidance on the involvement of the government in the maize market, fertiliser, seed, crops, and livestock markets bringing the most needed policy transparency and predictability that will enhance the market for smallholder farmers.

## Endnotes

1 Chibombo, Kabwe, Kapiri Mposhi, Mumbwa and Chisamba in Central Province; Ndola District in Copperbelt Province; Chongwe district in Lusaka Province; and Chikankata, Choma, Kalomo, Mazabuka, Monze and Pemba districts in Southern Province

2 The difference between the traditional FISP and E-FISP is the delivery mechanism. The traditional FISP involves the government physically delivering the inputs (currently limited to fertiliser and seed) sourced from few suppliers through a tender process. Whilst, the E-FISP involves giving targeted farmers an input voucher that can be redeemed electronically through licensed agro-dealers. Delivery of inputs is the responsibility of private sector dealers.

3 Before 2013, the statutory maize strategic reserve was 300,000 MT based on monthly human and industrial demand of 100,000 MT per month for at least three months before imports could arrive in the country. The irrigation capacity of the country then was limited.

4 Beneficiary households are entitled to ZMW70 per month which they receive on a bi-monthly basis as a sum of ZMW140. Beneficiary households with persons living with disabilities receive double the amount i.e. ZMW280.

5 The Home Grown School Feeding Programme, is a social safety net which uses food as a value transfer to schoolchildren recognizing that school health and nutrition are fundamentals for child development and a significant input into a child's learning

6 Established in the 1950s, the PNAE is one of the most important strategies of Brazil's food and nutrition security policy. Its large coverage and innovative design act to strengthen family farming, while promoting access to adequate and healthy diets in all public schools. For more details on the evolution of the PNAE in Brazil, see Otsuki and Arce (2007).

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## Appendix

*Table A1: Cost to the National Treasury for Holding 500,000 Metric Tonnes by FRA*

| **Description** | **Unit** | **Quantity** | **Price/ Cost per unit ZMW** | **Total ZMW** | **Total US$** |
|---|---|---|---|---|---|
| **1. Cost of new crop purchased July - October 2016** | | | | | |
| Value based on purchase price | MT | 500,000 | 1,700 | 850,000,000 | 85,000,000 |
| Logistics costs | MT | 500,000 | 200 | 100,000,000 | 10,000,000 |
| Estimated 8 months carry costs (Oct '16 to May '17) * | MT | 500,000 | 90 | 45,000,000 | 4,500,000 |
| Rebagging costs | MT | 500,000 | 100 | 37,500,000 | 3,750,000 |
| Estimated total costs of new crop purchased July-October 2016 | | | | 1,032,500,000 | 103,250,000 |
| Translated Cost/MT as at end May 2017 | | | | 2,065 | 207 |
| **2. Value of 2016 Crop at May 2017 Export Parity Prices*** | | | | | |
| Export Value by May 2017 based on Export Parity Price to Harare | MT | 0 | 2,600 | 0 | 0 |
| FRA maize sold at cost local market price | | 500,000 | 1,700 | 850,000,000 | 85,000,000 |
| Less 10% storage losses | | | | 85,000,000 | 8,500,000 |
| Net value of 2016 crop | | | | 765,000,000 | 76,500,000 |
| **3. Summary of Costs to Treasury** | | | | | |
| Estimated total costs of new crop purchased July-October 2016 | | | | 1,032,500,000 | 103,250,000 |
| Gross Cost | | | | 1,032,500,000 | 103,250,000 |
| Net value of 2016 crop | | | | 765,000,000 | 76,500,000 |
| Gross Export Revenue | | | | 765,000,000 | 76,500,000 |
| LOSS | | | | 267,500,000 | 26,750,000 |

Note: The following assumptions are used in computing the above costs to the Treasury: (a) Exchange rate 1US$/10ZMW; (b) 2016 FRA Purchasing Price/50kg bag at 85 ZMW; (c) Logistics cost/50kg bag (transportation, loading and offloading) at 10 ZMW; (d) finance cost per month at 40 ZMW/metric tonne; (e) storage losses estimated at 10 percent.

*Table A2*

| **2015/16 E-Voucher Pilot Implementation Challenges** |
|---|
| • Delayed submission of beneficiaries lists to the MoA Programme Coordinating Office resulting in delayed delivery and activation of e-cards;<br>• Rising fertiliser prices due to the depreciation of the Kwacha that nearly made the e-voucher less attractive to the traditional FISP. Government had to top-up the value of the voucher from 1,400 to 2,100 Kwacha, inclusive of farmer contribution of 400 Kwacha;<br>• There were cases in Central province of deliberate effort by some MoA staff to derail the implementation of e-voucher pilot in support of the traditional FISP. MoA's quick action to discipline renegade staff solved the problem;<br>• Reported selective activation of e-cards, a problem that led to delayed access of inputs by some farmers;<br>• Reported incidences of farmers surrendering their non-activated cards to agro-dealers to access inputs in advance. This could have led to some farmers being disadvantaged as some agro-dealers might have redeemed the cards in the absence of the farmers;<br>• The charging of a redemption fee of 7 Kwacha affected some farmers as they could not use the full value of the e-card; and<br>• E-voucher redemption system did not have the capability to identify the type of inputs redeemed by farmers limiting the usefulness of data captured. The inability to identify the inputs redeemed makes it impossible to map the demand for various inputs, information that will be useful for input suppliers and monitoring the extent to which the programme is helping unlock agriculture diversification. |

# A Long History of Low Productivity in Zambia: Is it Time to Do Away with Blanket Recommendations?

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*Although there have been calls to ramp up efforts to design and implement a fertiliser programme that recognises the spatial variability of soil fertility and climatic conditions in the country, Zambia like most countries in Africa, continues to rely heavily on outdated general fertiliser recommendations, which are uniform across geographic locations and crops. This could be one of the main reasons why Zambia continues to record low crop productivity despite government fertiliser subsidy programmes. Using soil analysis and household data collected in rural Zambia, this study presents a comparative analysis of location-specific fertiliser application versus blanket recommendation to demonstrate why it is important for the Zambian government to invest in area-specific fertiliser recommendations in order to raise crop productivity. As expected, the results show that soil fertility varies across the country. This was observed in all the mapped soil properties with ranges of 2.7 to 7.8 for soil pH, 0.08% to 10.1% for soil organic carbon and 1.0 ppm to 333.6ppm for soil Phosphorus. These values belong to different classes in terms of aciditys and levels of adequacy and deficiency. These results indicate that blanket fertiliser recommendations, or even liming, may not be well suited across the entire country. Instead, they support the need for Zambia to promote area-specific fertiliser recommendations. It is recommended that soil testing be promoted as part of extension messages, and that the government's Farmer Input Support Programme (FISP) should consider including soil testing as a requirement for the subsidy.*

**Key words:**
Blanket recommendation, fertiliser, productivity, soil fertility, Zambia

## Introduction

Africa continues to lag behind the rest of the world in food crop productivity. Low fertiliser use and low intensity of use are cited as two of the main factors hindering growth in agricultural productivity (FAO, 2005; Kelly et al., 2007; Guo, Koo and Wood, 2009). In response, some African countries, including Zambia, have been implementing fertiliser subsidy programmes in order to lower the cost of fertiliser and address supply issues. The main goal of such efforts has been to bolster fertiliser use and demand among many smallholder farmers who occupy a central position in agricultural production in most Sub Saharan African (SSA) countries. For example, Zambia's 2016 budget had fertiliser subsidies taking up approximately 58% of the budget for the Ministry of Agriculture (MoA) in Zambia. Despite this effort, crop productivity has risen only marginally, suggesting that there are other constraints limiting optimal fertiliser response (Chapoto and Ragasa, 2013).

Notably, there have been calls to bolster efforts to design and implement fertiliser programmes that recognise the spatial variability of soil fertility and climatic conditions in the country. Despite this observation, in the design and implementation of its fertiliser programme Zambia continues to rely heavily on the general fertiliser recommendation which is uniform across geographic locations and crops. This could be one of the main reasons why Zambia continues to record low growth in crop productivity . It stands to reason that, if farmers are applying the wrong type and amount of fertiliser on their fields, Zambia will continue to reap low yields. There have been advances in information and related technologies such as Geographical Information Systems (GIS), Global Positioning System (GPS), and data sources from remote sensing (e.g. satellite imagery and digital elevation models) but Zambia has been slow to embrace them. These advanced information and related technologies would provide almost limitless opportunities for data collection, manipulation and analysis, and would enable the country to devise policies which reflect the spatial variability of soil in an area. Embracing these approaches could be complimented by crop model simulations to determine the appropriate fertiliser rates and corresponding yield levels.

Generally, fertiliser recommendations in Zambia are based on yield response of various crop varieties in a particular location (Mwale, 1988). In this regard, seed companies base their fertiliser recommendation on the relative soil fertility status in a given locality (Zamseed, 1993) albeit in a general way with fertility status broadly classified as low, medium, or high. In many instances however, fertiliser recommendations are given as one blanket recommendation across the whole country. Fertiliser companies have also followed this general approach. For instance, Omnia Fertilizers (2013) recommended the application of the major nutrients, urea (N), P and K in the ratios 10:20:10 for maize (D compound), and in the ratios 10:12:27 for soya beans (HIPOT). The application of urea is recommended at 46%. Similarly, Zambian Fertilisers (2013) recommended the same application rates of D compound and urea in maize, and the ratios 5:20:20 for soya beans.

The foregoing examples indicate that fertiliser recommendations are mainly given as broad recommendations. With the intensification of smallholder agriculture, principally driven by government policies such as the Farmer Input Support Programme (FISP), the prescriptive fertiliser recommendations per hectare of 200kg of both D compound and urea in maize production are followed regardless of locality. While blanket recommendations may be useful, they tend to be problematic in that they do not consider factors that influence yield response of fertiliser such as climate and soil type. In a case where the soil has high levels of nutrients, blanket recommendations may lead to fertiliser wastage and economic loss to the farmer or even be an environmental hazard due to nitrate leaching (Ndlanga Mandla, 1998). On the other hand, inefficiencies in crop production resulting in low yields happen when the applied fertiliser does not meet soil nutrient status and crop requirements. The challenge therefore, is to address two key problems in the management of soil fertility, namely, soil depletion, and low yield due to inadequate levels of fertiliser use.

It is clear that several benefits accrue in agricultural production from fertiliser use. ( Russell et al., 2009; Tilman et al.,(2002; Rosenstock et al.,(2013). However, many researchers have questioned the logic and sustainability of blanket fertiliser recommendations due to soil variability across the landscape (Ezui et al., 2010; Snapp et al., 2003). The many questions and misgivings regarding blanket fertiliser recommendations call for the generation of country specific empirical data on the feasibility of location specific fertiliser recommendations which consider the spatial variability of soil across the country. In addition, evidence of the economic implications of such an approach is vital in gauging the suitability of location-specific fertiliser recommendation for adoption and/or up-scaling across the country. It is against this background that this study was initiated to assess the performance and utility of location-specific fertiliser recommendations in Zambia. The general objective of the research is to pilot location-specific fertiliser recommendations in Zambia. In particular, the study had three specific objectives as follows:

i. To map the spatial variability of soil phosphorus (P), soil pH, and soil organic carbon (SOC) in Zambia.
ii. To estimate location-specific fertiliser application rates
iii. To assess maize yield response to location specific application fertiliser rates.

The remainder of the paper is organised as follows. The soil fertility status in Zambia is presented in Section 2, followed by a discussion of data and methods in Section 3. Section 4 presents the results and discussion. Finally, Section 5 discusses our conclusions and policy recommendations on moving towards location-specific fertiliser recommendations.

**Soil Fertility status in Zambia**

***Soil fertility issues in Zambia***

Declining soil fertility in SSA has continued to reduce soil productivity and poses a major challenge in addressing problems of food security (Umar et al., 2012). This has been exacerbated by prevailing extreme climate events to which Zambia is no exception. Zambia is divided into three Agro-Ecological zones (AEZs) based mainly on precipitation regimes (Figure 1).[1]

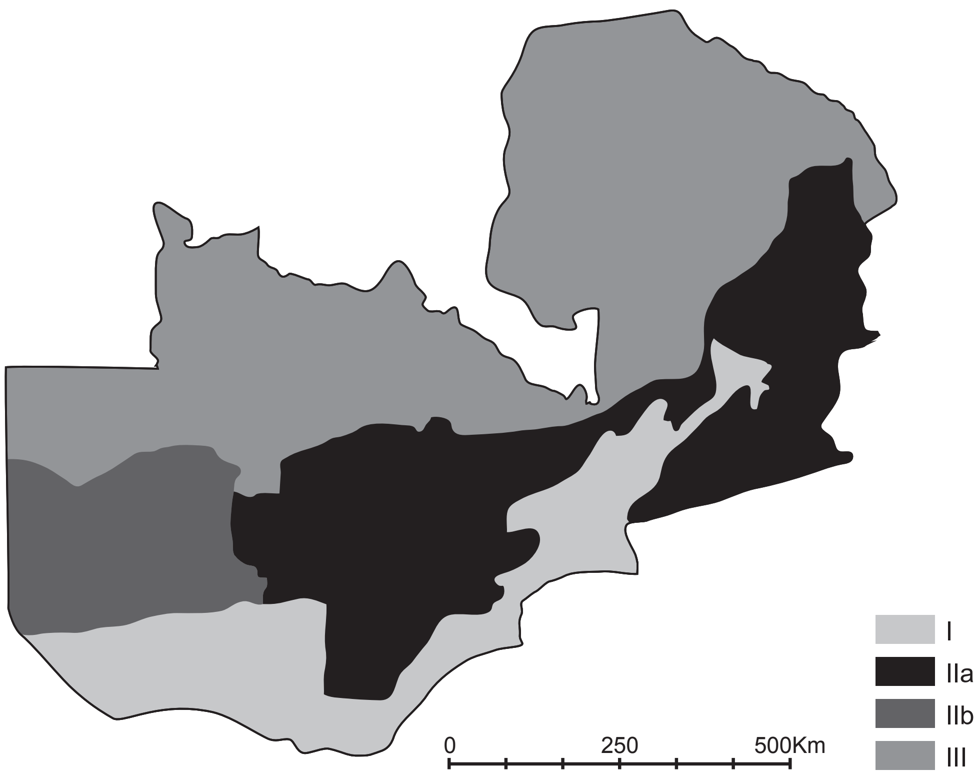



*Figure 1: Zambia Agro-ecological Zone Map*
Source: IAPRI, 2015

In AEZ III, for instance, there are generally highly leached and acidic soils, yet the recommendations do not take that into account (Figure 2). A study by Lungu and Dynoodt (2008) revealed that long-term annual application of urea resulted in soil acidification and decreases in exchangeable calcium (Ca) and magnesium (Mg), especially if these were already low in the soil. And yet other research has shown that crop yields on acidic and unlimed soils have declined even with the application of adequate amounts of inorganic fertilisers (Lungu and Chinene, 1993) because of its susceptibility to nutrient lock up. This was documented by Mambo and Phiri (2004), when they produced the national soil acidity map of Zambia (Figure 2).

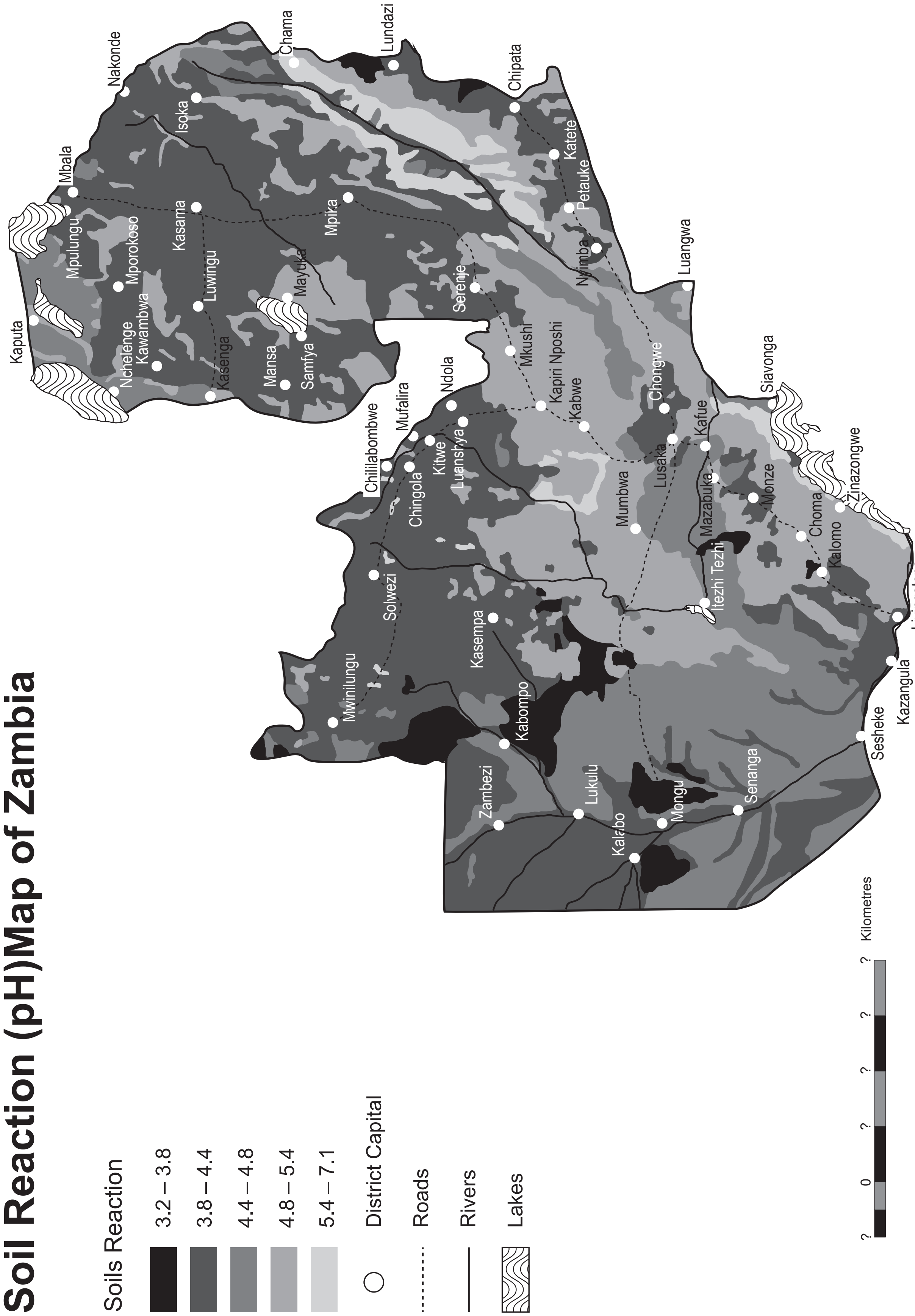



*Figure 2: Soil Acidity Map of Zambia* Source: Mambo and Phiri (2004)

Although, this map is more than ten years old, it illustrates that the soil in the northern region and some parts of the western region of the country were extremely acidic with pH values less than 4.5. This means that areas in this locality require lime, an approach that has been promoted by various stakeholders. However, it should be noted that other than acidity, soil type is an important aspect of optimal crop production and fertiliser utilisation.

Generally, soils in the high rainfall region III are heavily leached and acidic, while those of region II are believed to be fairly fertile and those of region I are mostly sandy and less fertile (JAICAF, 2008). Further, most of the agricultural land across the country lacks the much required organic matter, which is crucially important for the fertility of any given soil. The lack of this organic matter affects the physical, chemical, and microbial health of the soil.

### *History of Blanket Fertiliser Recommendation in Zambia*

Commercial agricultural production in Zambia was mainly done along the line of rail in the early 1980s. Soil samples were taken from these production sites and fertiliser recommendations were made based on the preliminary results (McPhillips, 1983, Lungu, 1987). This led to increased yields in most areas. The small-scale farmers also greatly contributed to crop production and recommendations such as lime application were made to help enhance their productivity (McPhillips and Prior, 1979 in Lungu, 1987).

In order to encourage massive production in all parts of the country, generalised or blanket recommendation were employed. It was assumed that nutrient requirements of the different soil types would fall within these recommendations. To date, there has not been enough effort to revisit this and update the recommendations based on updated soil and plant requirements findings. Some fertiliser companies in the country do, however, carry out soil tests in places where they put up their demonstration sites. With the long-term use of the soils, there have been tremendous changes in their status and one of the well known changes is the inherent fertility decline. Yields have stagnated and declined in some parts of the country and when blanket recommendations are made, they do not consider the soil's nutritional status and the plant requirements as a whole. This continues to increase fertiliser use inefficiencies in terms of costs and nutrient management.

### *Soils of Zambia*

*Soil Type*

According to Eswaran et al., (1997), most of the agricultural soils in Zambia are of the orders Alfisols, Ultisols and Oxisols. The national soil map of Zambia shows that Acrisols are the dominant soil grouping in AEZ III with mainly Gleysols occurring in very slight combination with Histosols in the swampy areas (Figure 3). The World Reference Base for Soil Resources (WRB) in 2006 states that Acrisols are strongly-weathered acid soils with low base saturation at some depth, and that they have higher clay content in the subsoil than in the topsoil. Adapted cropping systems with complete fertilisation and careful management are required for farming on such soils. On the other hand, Gleysols are wetland soils that, unless drained, are saturated with groundwater for long periods as is the case in the swampy areas of AEZ III. The main limitation to the use of Gleysols is the necessity to install a drainage system to lower the groundwater table. Adequately drained Gleysols can be used for arable cropping, dairy farming, and horticulture.

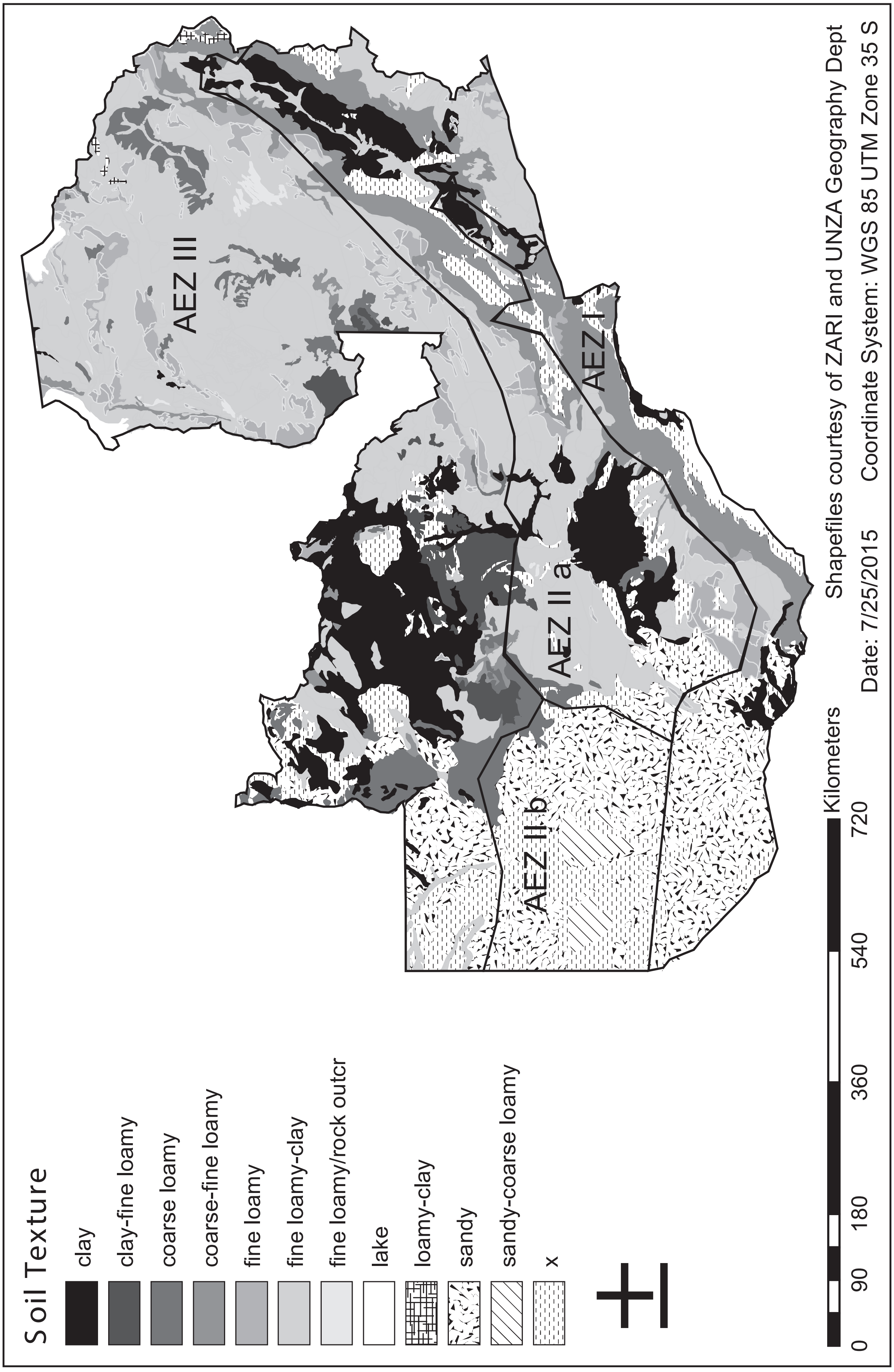
In AEZ IIa, Lixisols are dominant in the areas around Kapiri Mposhi, whilst Regosols and Leptsols are dominant around Mumbwa, and Vertisols characterise most of Southern Province (Figure 3). Generally, Lixisols have a higher clay content in the subsoil than in the topsoil although a high base saturation and low-activity clays occur at certain depths. Degraded surface soils have low aggregate stability and are prone to slaking and/or erosion when exposed to the direct impact of raindrops. The low absolute level of plant nutrients and the low cation retention by Lixisols means that recurrent use of fertilisers and/or lime is a precondition for their continuous cultivation (WRB, 2006). Vertisols on the other hand are churning, heavy clay soils with a high proportion of swelling clays. These soils form deep wide cracks from the surface downward when they dry out. The physical properties and the soil moisture regime of Vertisols represent serious management constraints. The heavy soil texture and domination of expanding clay minerals result in a narrow soil moisture range between moisture stress and water excess.

In AEZ IIb the dominant soils are the Arenosols whose main characteristic is the coarse texture, which accounts for the high permeability and low water and nutrient storage capacity. Arenosols offer ease of cultivation, rooting and harvesting of root and tuber crops. AEZ I is dominated by Arenosols on the western part while Leptosols dominate most of the land in the valley areas (Figure 3). Leptosols are very shallow coarse soils often occurring in stony areas. Leptosols on hill slopes are generally more fertile than their counterparts on more level land (WRB, 2006). One, or a few, good crops could perhaps be grown on such slopes but at the price of severe erosion.

*Soil texture*

In the case of soil texture, the soils in the northern section of AEZ III are dominated by fine loamy clays, whereas much of the western part is dominated by clay soils with some patches of sandy and loamy soils. Most of the soils in AEZ IIa are of sandy texture although a section of it has sandy soils (Figure 4).

*Figure 3: Soils of Zambia* Source: Ministry of Agriculture Soil Survey Section (1991)



Further, the AEZ I is dominated by coarse fine loamy soil textures with the areas around the lake having mainly soils of a fine loamy to loamy textures.

The variation in the soil texture and general soil grouping shows that there exists a wide variety in soil occurrence across the country. This means that specific nutrient requirements and fertiliser application are necessary for efficient crop production, rather than blanket recommendations. Among the nutrients required for plant growth, most of the major nutrients are found in scanty amounts in the soil. For instance, a study by Yerokun (2008) reported that most Zambian agricultural soils had small amounts of phosphorus (P) in them. In the same study, soils of different origins showed similar trends in their amount of available phosphorous. The low levels of phosphorus availability was attributed to the low organic matter content, nature of the soil, as well as the microclimates under which they existed.

The findings by the aforementioned study were consistent with those of Malama (2001) who found that most soils in the high rainfall regions of the country had low amounts of nutrients due to high levels of leaching. Additionally, the soils in AEZ III which receives rainfall above 1200mm per annum are usually acidic and have a high amount of exchangeable Aluminium (Al) and Hydrogen (H). Despite the existence of a number of studies showing the major soil fertility problems in the study areas, fertiliser recommendations have not been revised in accordance with the evidence provided by these studies. In optimal cases, the application rates are based on the yield targets, where one must apply more to realise high yields. However, Xu et al. (2009a; 2009b) reported that the maize yields were not economically reliable under the small-scale farmers who received the subsidised inputs, suggesting that something was wrong with blanket recommendations. Generally, the blanket recommendation of urea and D compound - which maize growers generally use - has not resulted in an increased production rate. This in turn means that the country is not getting an optimal return from its fertiliser subsidy investments.

***Some technologies addressing challenges in soil fertility***

A number of technologies and innovations have been suggested to address the issue of nutrient imbalance and general soil fertility in soils. Erestein (2003) proposed that crop cover mulching would ameliorate the soil fertility status of soils. The mulch if incorporated well in soils, can contribute to the soil organic carbon content. This would in turn improve the fertility of the soil. In a similar study on Zambian acidic soils, Malama, (2001) found that most soils in the high rainfall area had high exchangeable acidity, aluminium, and low phosphorous. Other efforts include conservation agriculture (CA), which still has a low adoption levels among the smallholder famers in Zambia. Under CA, a number of practices have been suggested such as the use of cover crop mulches and

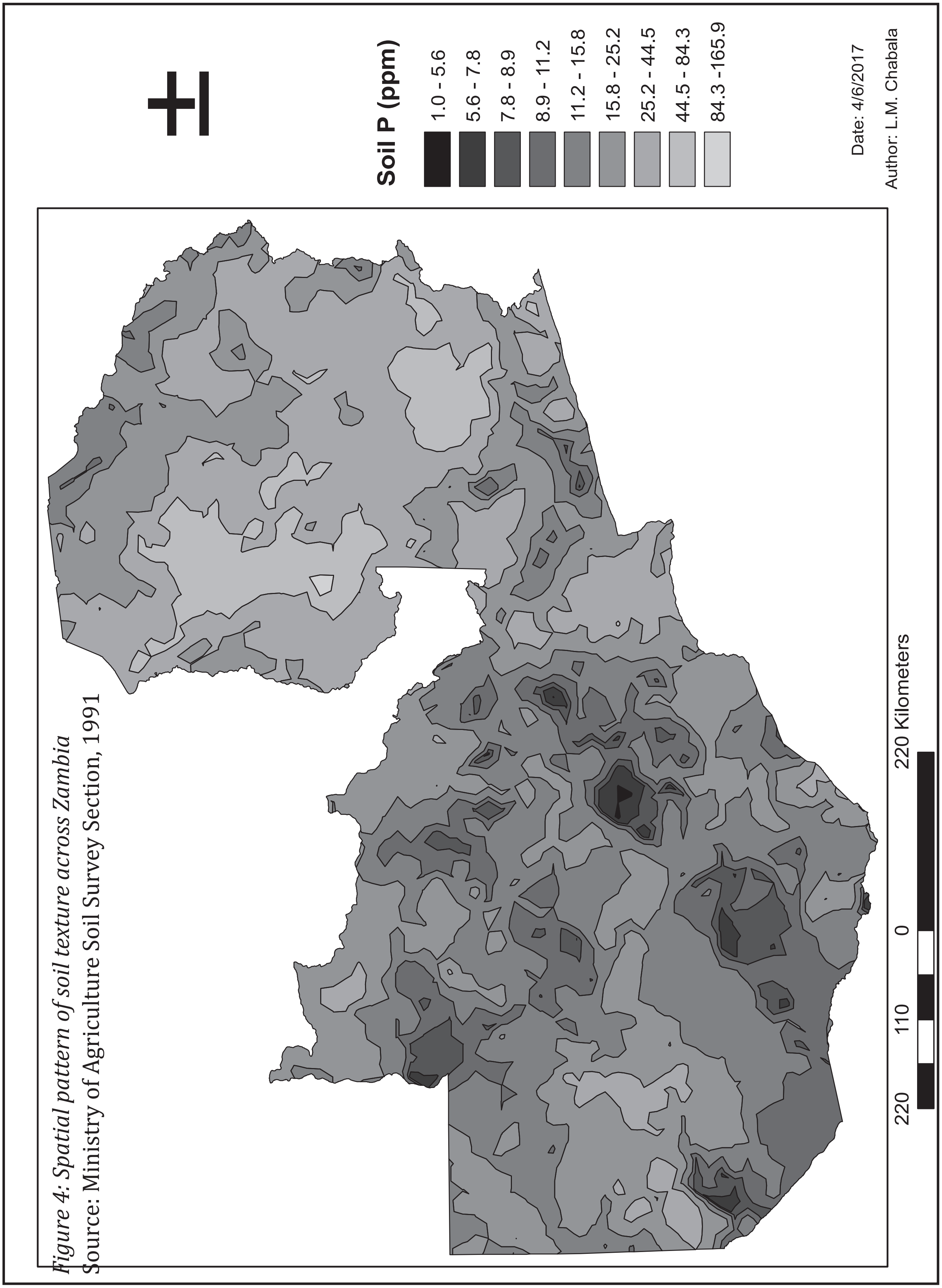



*Figure 4: Spatial pattern of soil texture across Zambia*
Source: Ministry of Agriculture Soil Survey Section, 1991

incorporation of Faderbia albida trees into the farming systems. According to Umar et al., (2013), and Shitumbanuma, (2012), the incorporation of Faderbia albida trees in the CA systems had a positive effect on the nutrient levels of the soils and subsequently on crop yield. Similarly, a study by Siame et al., (1998), on the highly acidic Oxisols of northern Zambia showed that the incremental addition of nitrogen through intercropping maize with beans increased the maize yield.

Despite these innovations showing positive productivity results, they have not been used on a sustainable basis by smallholder farmers in the country. This may largely be due to resource constraints inhibiting smallholder farmers from investing in simple technologies that can help improve fertiliser response rates. The government's subsidy programme has helped improve this situation but with limited success, as the packages given to farmers disregard spatial soil variations in the country. Inorganic fertilisers which are in the form of urea and D compound are mostly used across the country, and are applied at a general rate of 200kilograms (kg)/ha in maize production. This application rate is recommended regardless of the soil types and needs.

## Data and Methods

### *Data*

This study uses data from a random sample of households interviewed during the Rural Agricultural Livelihoods Survey (RALS), implemented in May/June 2012 by the Indaba Agricultural Policy Research Institute (IAPRI) in collaboration with Central Statistical Office (CSO), and MoA.

The sampling frame for the RALS 2012 survey was based on the 2010 Census of Housing and Population. A stratified two-stage sample design was used for the RALS 2012 sampling. The first stage involved identifying the Primary Sampling Unit (PSU), Standard Enumeration Areas (SEAs) with a minimum of 30 agricultural households. At the second stage, all households in selected SEAs were listed and agricultural households identified. Listed agricultural households were then stratified into three categories; A, B, and C, on the basis of total area under crops; presence of some specified special crops; numbers of cattle, goats and chickens raised; and sources of income. Systematic sampling was then used to select 20 households distributed across the three strata in each SEA. Within the selected 20 households, four households were randomly selected for soil sample collection from the largest maize field. For the sub-sample, an additional module was added to obtain information about the particular plot and other household economic data for the 2011/12 agricultural season. In particular, the module collected additional specific information about production and farm management practices, including fertiliser use for that particular plot. In addition, the plot size was physically measured with the aid of a GPS device.

*Sample size*

A total of 1,714 soil samples and plot surveys were completed from 1680 households. The intention was to collect one sample per household, but more than one sample was collected from some fields that had noticeable differences in terms of slope or soil colour, and texture. Twenty-six households provided two samples each and four households provided three samples, making the total of soil samples collected greater than the number of households. However, we were unable to determine the proportion the plots covered by these multiple sample households. Hence, they calculated a simple average across samples instead of a weighted average.

*Soil collection and analysis*

Soil samples were collected by enumerators and their supervisor, all of whom were trained by the Zambia Agricultural Research Institute (ZARI) (CSO/MAL/IAPRI, 2012 for details). Essentially, each sample was made out of a composite mixture of 10-20 sub-samples collected within the boundaries of the plot, following the prescribed collection depth, pattern, and size of the plot. Each sub-sample was in itself a composite of equal parts soil in the 0-10 cm and 10-20 cm depth (i.e., the depth of maize roots), and for fields planted using ridge tillage, samples were taken directly from the ridges (Burke et al., 2015). The location of soil sampling points across the country is shown in Figure 5.

The soil samples were analysed at ZARI for texture, soil organic carbon, phosphorus, pH and other soil attributes using standard laboratory procedures. Soil pH was determined using a standard pH meter in CaCl2 according to the method described by McNeal (1982). Soil organic carbon (SOC) was determined by the Walkley and Black procedure, and reported as soil organic matter (SOM) by multiplying the SOC by a constant conversion rate of 1.714. The available phosphorus was determined by the Bray and Kurtz 1 method (Bray and Kurtz, 1945). Cation exchange capacity (CEC) was analysed using the ammonium acetate method at pH 7.0, and measurement of the sorbed ammonium (NH) by titration following the exchange of sorbed NH with excess sodium chloride (NaCl). To evaluate the precision of the soil analysis results, 2% of the observations were randomly selected for a second round of testing and comparison to initial measurements. Burke et al., (2015), presents the detailed results of the comparison of the second round testing and the first testing. They concluded that the test results had acceptable levels of precision but could not attest to the accuracy of the laboratory's results because resources did not allow for blind testing of a random sample by another

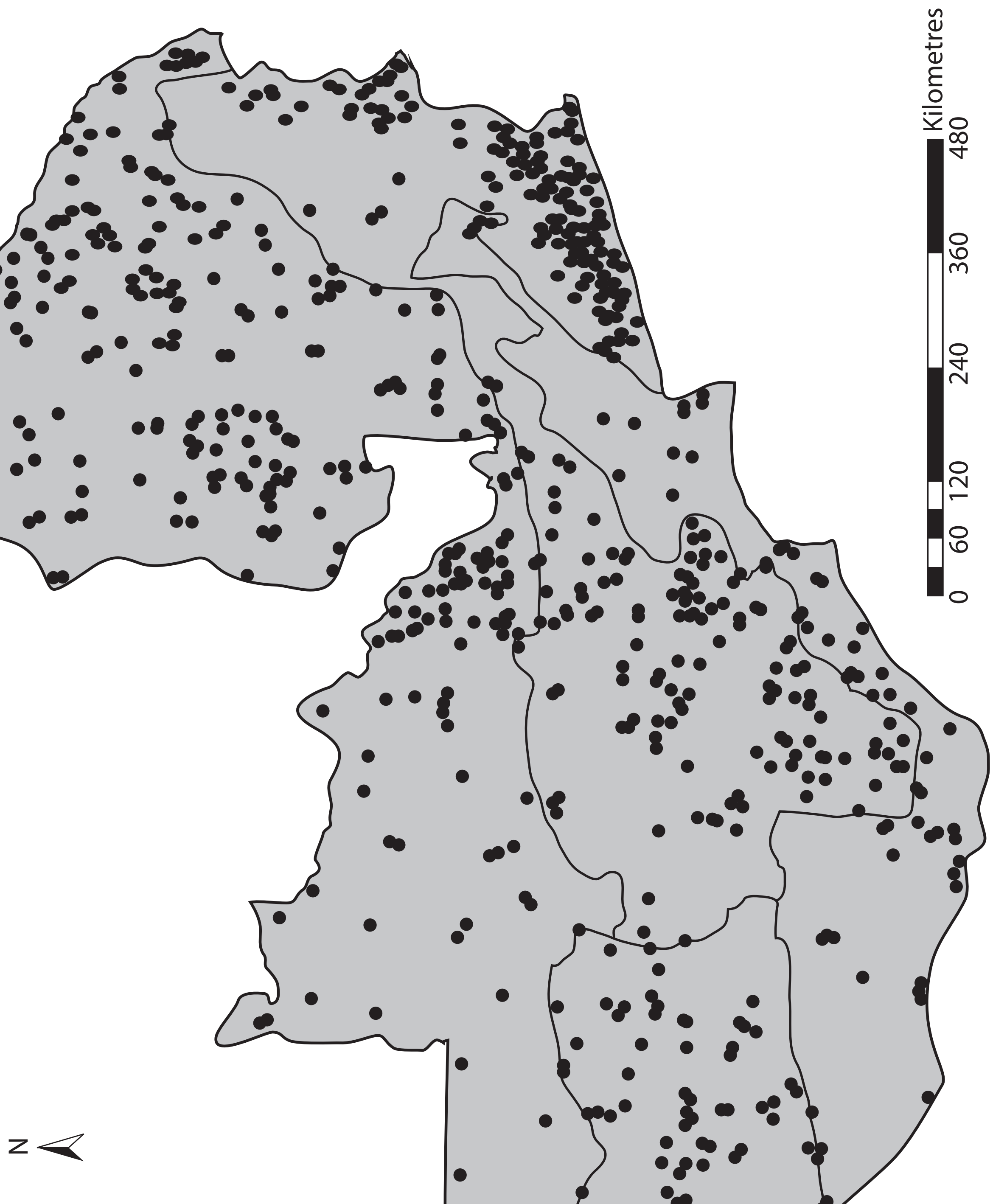



*Figure 5: Location of soil sampling points*
Source: Authors' calculations from CSO/MAL/IAPRI (RALS) 2012

independent laboratory. This study uses the results with this small caveat in mind, and recommends that future studies strive to verify the accuracy of the laboratory test in addition to the second round of testing.

***Mapping spatial variability of soil phosphorus, pH and soil organic carbon***

An initial 1,715 geo-coded soil samples were examined for use in this analysis. As a first step to mapping spatial variability of phosphorous, pH, and SOC, preliminary data cleaning was done. During the screening, all the data points that were falling outside Zambia were removed - this was attributed to errors in entering GPS coordinates during data entry. Further screening was done by drawing box plots of data. Outliers were identified visually as individually plotted rather than part of the whiskers in the box plots. Where such outliers were found, all suspect values were removed. Thus, after screening, a total of 1,593 data points were used to map the spatial variability of soil acidity (pH) and phosphorus, and 1,588 for SOC. With the screening completed, summary statistics were then generated to provide a basic understanding of the characteristics of soil phosphorus, SOC, and pH across the country.

Further data exploration was done using the histograms to analyse the distribution of the data for phosphorous, pH, and SOC. This exploration was relevant so as to select an appropriate modelling approach in the mapping of the soil properties. Where the data was not normally distributed, it was log transformed as was the case for soil phosphorous. This transformation of data to normal distribution was required because the method used in this study as discussed below relies on the assumption of stationarity which requires in part that all data values come from distributions that have the same variability (ESRI, 2013). In the final model output, the predicted soil properties were transformed back to the original scale in the interpolated surface.

The map of soil phosphorous and soil acidity was generated using Ordinary Kriging (OK). OK is one of the geostatistical models that use a set of statistical tools to predict the value of a given soil property at a location that was not sampled (Johnston et al., 2001). OK is said to be an exact interpolator in the sense that interpolated values, or their local average, coincide with values at the sampled locations (Burrough and McDonnell, 2004). The predicted property (x0), at an unsampled location s0 using observations Z(xi), i = 1,..., n was given by equation 1:

$$\hat{Z}x_0 = \sum_{i=1}^{n} \lambda i . Zx_i \qquad (1)$$

Where $\lambda_i$ is the kriging weight.

The map of SOC was generated using inverse distance weighting (IDW). The IDW was selected as the appropriate method for generating a map of SOC because the data did not fulfill all the basic assumptions of kriging. The assumption in IDW is that the value of a soil property in this case SOC, at the location that was not sampled is a distance - weighted average of data points occurring within a neighbourhood (Bolstad, 2009). Therefore, points that are further away from the location being estimated are given less weight compared to those points that are nearer. The values at unsampled locations are estimated by equation 2 below:

$$Zj = \frac{\sum_i \frac{Z_i}{\mathrm{d}^{\mathrm{n}}{}_{ij}}}{\sum_i \frac{1}{\mathrm{d}^{\mathrm{n}}{}_{ij}}} \qquad (2)$$

Where $Z_j$ is the estimated value for the unknown point at location j, $d_{ij}$ is the distance from a known point i and n is a user defined exponent. The number of points used in the interpolation were 10 as the minimum with a maximum of 15 points. It should be noted that the farther away the point (larger $d_{ij}$), the smaller the weight ($1/d_{ij}$), thus the less the influence that point had on the estimated value at the unknown point.

***Assessment of model performance used in map production***

The assessment of the Kriging models for soil pH and phosphorous is based on the Leave Out One Cross Validation (LOCV). The indices used in the LOCV were the average standard error (ASE), the root mean square error (RMSE), and the RMSE standardised. The goal is that an acceptable model for mapping should have the average standard error close to the RMSE, and the RMSE standardised should be close to one (1) if the model is correctly assessing the variability in the predictions. The statistical significance of IDW used to map SOC was evaluated based on the mean error and the RMSE. The goal in IDW is to have a mean prediction error close to zero (0) which would indicate that the predictions were not biased. The detailed geostatistical modelling procedures applied to map the spatial variability of soil phosphorous, pH, SOC, OK and inverse distance weighting will be addressed in a separate paper.

***Generation of location specific fertiliser recommendation***

Once the soil maps were produced, location-specific fertiliser recommendations were done. This was achieved by considering the soil phosphorus values in the soil map. Potassium was kept constant because it was assumed that it is not limiting in most Zambian soils. Further, since no soil test data was available for nitrogen, this nutrient was varied on 50% incremental basis from the actual household fertiliser application rate. Thus, with information on soil phosphorous and the varied rates of N, location-specific fertiliser recommendations were generated based on the nutrient levels of each of the soil units represented in the map.

## Results and Discussion

### *Spatial variability of soil phosphorus*

Table 1 presents the summary statistics for soil phosphorous, pH, and SOC, whilst Table 2 shows the prediction errors associated with the models used to generate the soil maps. The results in Table 1, column A show that the mean soil phosphorus was 23.73 ppm while the standard deviation was 29.15 ppm indicating a high variation around the mean. The minimum soil phosphorous value was 1.06 ppm while the maximum value was 333.63 ppm. The soil phosphorous levels were skewed to the left as indicated by the coefficient of skewness of 4.50 and coefficient of kurtosis of 34.3.

The spatial variation of soil phosphorous is shown in Figure 4. The map shows big spatial variation of soil phosphorus across the country. Soils in the Northern and Eastern parts of the country have P values concentrated around the range of 15.8 – 84.3 ppm. The levels of phosphorous were lower in Central Province and surrounding districts particularly in Mumbwa, Kabwe, Kasempa, and Itezhi-tezhi districts, where values ranged from 1.1 to 7.8 ppm. It was further observed that intermediate values of soil phosphorous predominate in most of Southern Province particularly in Mazabuka, Choma, and Kalomo where soil phosphorous ranged from 11.2 to 25.2 ppm. However, it should be noted that the prediction errors were very large. For instance, the RMSE standardized was 0.7 indicating that the Kriging model was underestimating the variability of phosphorous at locations that were not sampled (Table 2). Despite this shortcoming, the results show that there is high variability in soil phosphorus in the country, highlighting that blanket fertiliser recommendations are too generalised to lead to improved crop productivity.

It should be noted that soil P is one of least available plant nutrients in Zambian soils. This is particularly so in soils of AEZ III where pH values of less than 5.5 are common. Under such conditions, P availability is limited by aluminium and iron fixation usually associated with soil parent material. The generated soil P map (Figure 6) however shows that P levels were higher in the northern part of Zambia which is generally associated with high acidity levels as demonstrated in the soil pH map (Figure 7) produced in this study.

This is a rather conflicting result considering that soils in northern Zambia are considered limited in terms of available P. This is noteworthy as P ions can increase to considerable concentrations in highly fertilized soils (Hinsinger, 2001). Further, it has been shown that while both parent material and land use are responsible for soil P content, only the effect of parent material permeates the entire soil profile while land use only affects the surface horizon (Dufey et al., 2010). The effect of land use also may have contributed to the observed P levels in northern Zambia since most of the soil samples were collected from the 0 – 20cm soil layer which is most influenced by land use.

| | **Phosphorus (ppm)** | **Soil pH** | **SOC (%)** |
|---|---|---|---|
| | **(A)** | **(B)** | **(C)** |
| Mean | 23.73 | 5.4 | 1.09 |
| Minimum | 1.06 | 2.7 | 0.08 |
| Maximum | 333.63 | 7.8 | 10.1 |
| Median | 15.0 | 5.4 | 1.04 |
| Standard deviation | 29.15 | 0.68 | 0.46 |
| 1st Quartile | 8 | 5 | 0.81 |
| 3rd Quartile | 28.06 | 5.8 | 1.33 |
| Skewness | 4.52 | 0.31 | 5.19 |
| Kurtosis | 34.37 | 3.72 | 95.7 |

*Table 1: Summary statistics for soil Phosphorous, pH, and SOC*
Source: Authors' computation

| | **Phosphorus (ppm)** | **Soil pH** | **SOC (%)** |
|---|---|---|---|
| Mean | 0.0011 | 2.639 | -0.0035 |
| Mean standardised | 0.002 | 0.038 | - |
| RMSE | 0.5644 | 27.54 | 0.43 |
| Average standard error | 0.566 | 44.99 | - |
| RMSE standardised | 0.994 | 0.7 | - |
| Method | Kriging | Kriging | Inverse Distance Weighting |

*Table 2: Prediction errors for the mapped soil properties*
Source: Authors' computation

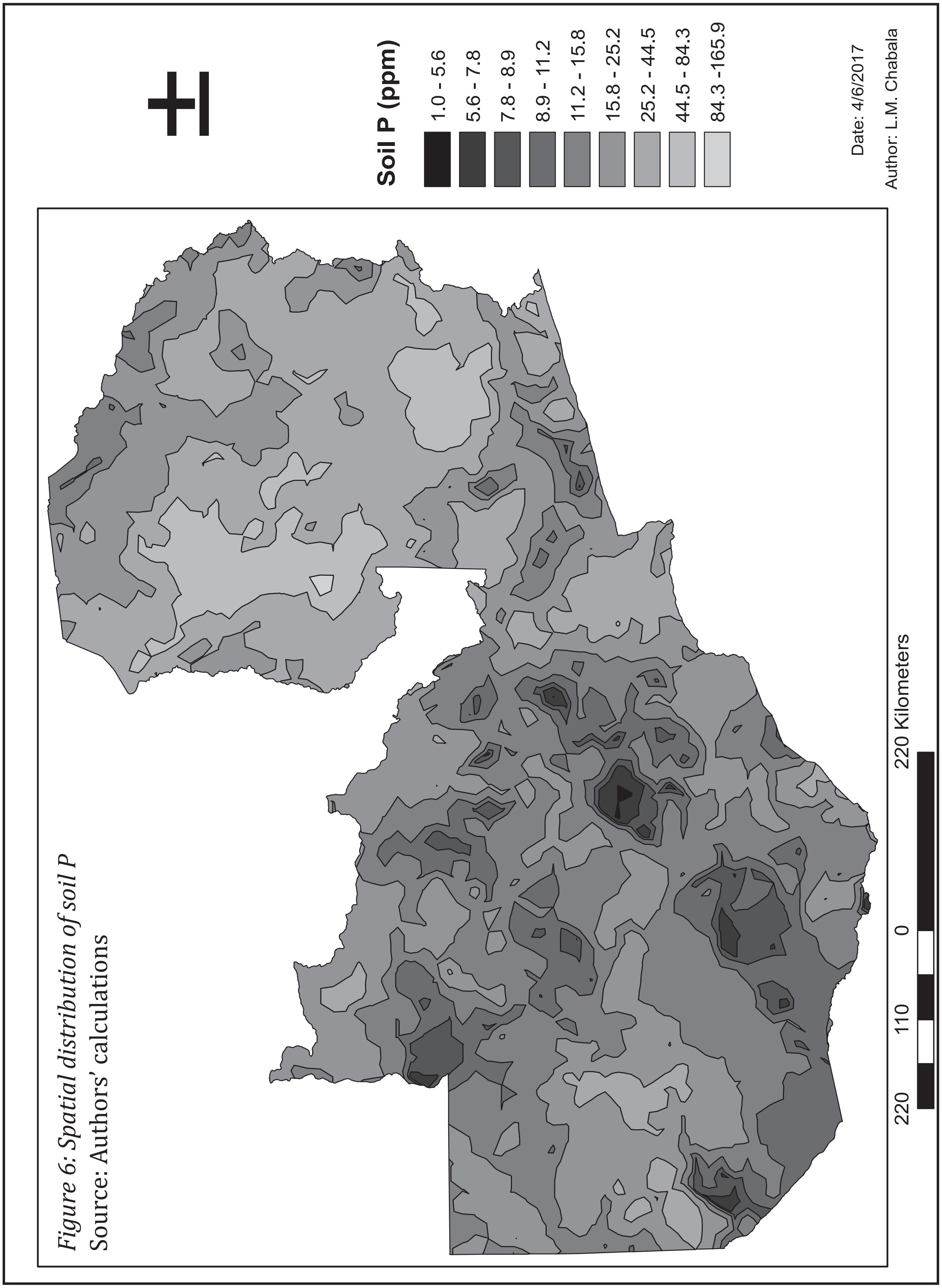



*Figure 6: Spatial distribution of soil P*
Source: Authors' calculations

***Soil pH***

The spatial variability of soil pH across the country is shown in Figure 7. The results show that ASE was 0.5660, which was approximately equal to the RMSE of 0.5644 (Table 3). Further the RMSE standardised was close to one (1). This means that the predicted soil acidity map was correctly assessing the variability of soil pH. The soil pH in most parts of Luapula and Northern provinces was generally in the range of 4.7 – 5, while a small part of the northern region, and the westernmost parts of the country recorded the lowest pH between 2.7 – 5.2. In contrast, most of the Eastern Province and parts of southern Zambia had pH values in the range of 5.5 – 5.8. These ranges represent the optimal levels for crop production, and suggest that in these areas liming cannot be generalised, but should be site-specific. Intermediate values were observed in the rest of the country which points to the need to avoid generalisation in terms of lime application. Additionally, the generated soil pH map reflects the acidic nature of the soils in AEZ III. This means that lime application is imperative in this region to ensure that crop yields do not decline due to nutrient lockup in un-limed soils

***Soil organic content***

In the case of SOC, it was observed that most of the western parts of the country were deficient in SOC. The values mainly ranged from 0.08% to 0.9% (Figure 8) which levels reflect the sandy nature of soils in this region. The rest of the country generally had marginal values of SOC, with values ranging from 1.03% to 1.85%. Only a small section of the country had adequate values of SOC with values above 2.7%. Normally the threshold for SOC in agricultural production is 2.5%, hence most of the soils in Zambia, like most tropical soils had very little SOC.

These results suggest that conservation measures that require preservation of organic materials (e.g. crop residues) should be promoted as a means of maintaining the carbon pool in the soil. The implication of these results is that certain practices that lead to depletion of SOC (such as burning), should be discouraged.

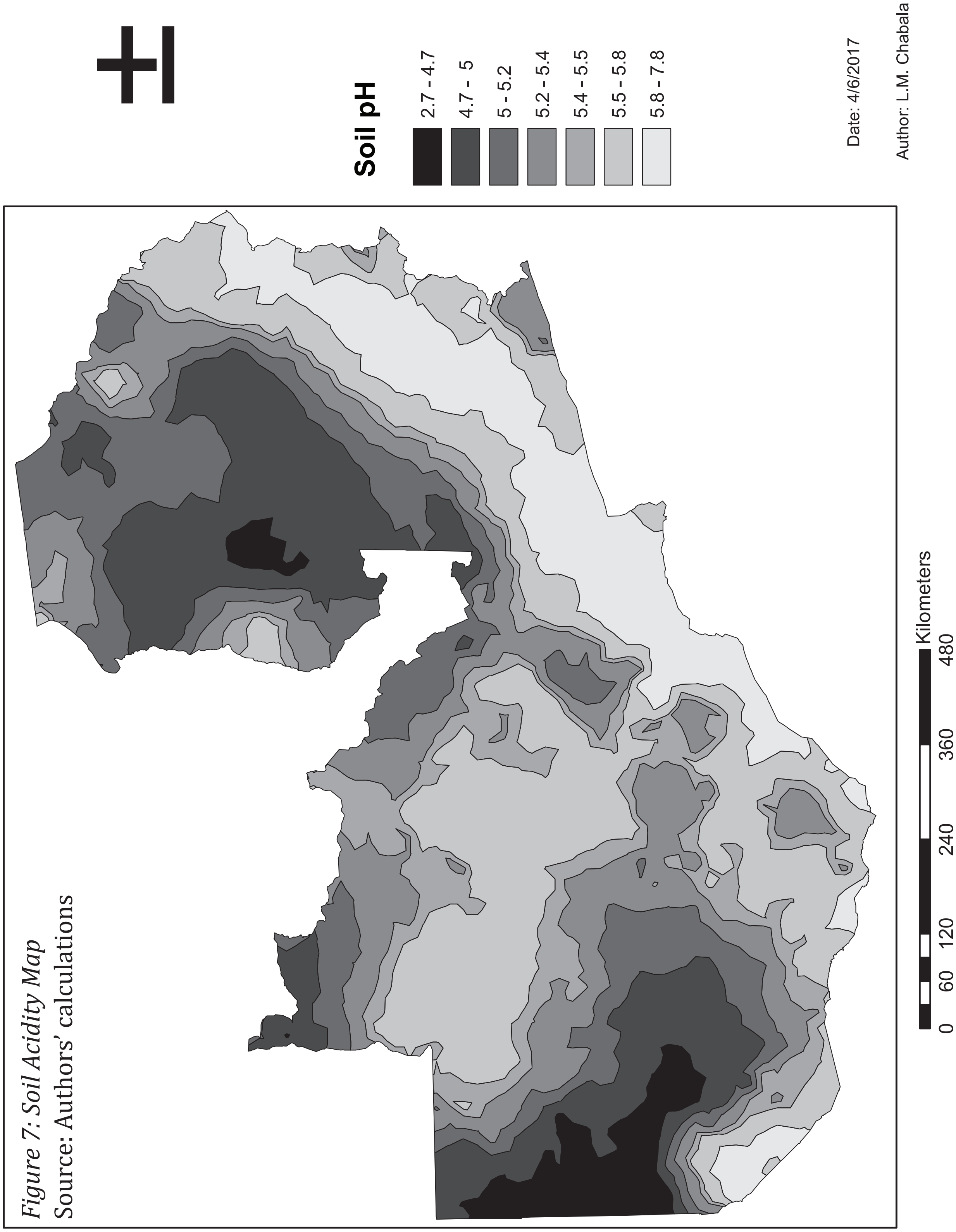



*Figure 7: Soil Acidity Map*
Source: Authors' calculations

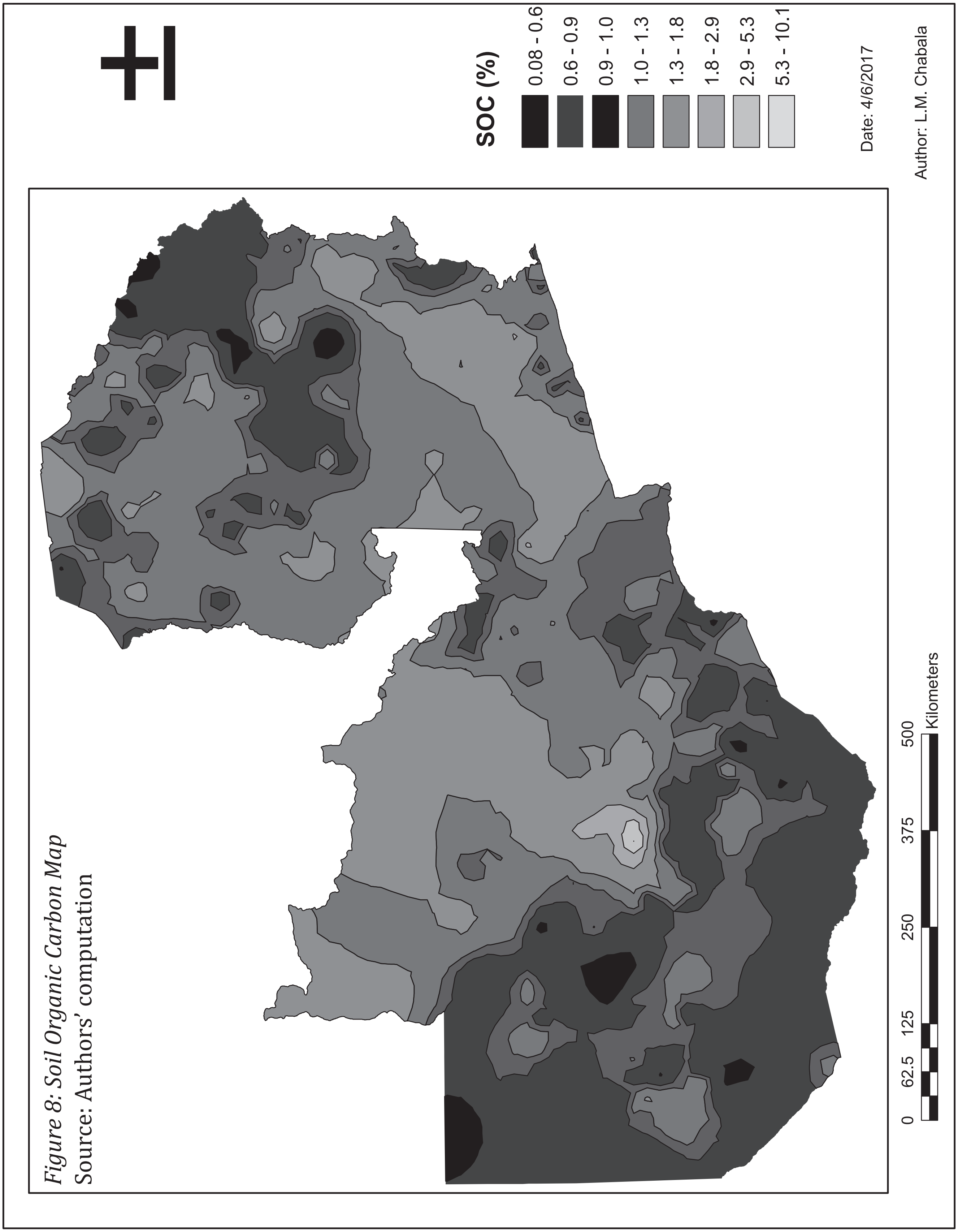



*Figure 8: Soil Organic Carbon Map*
Source: Authors' computation

***Location specific fertiliser recommendation***

Table 3 shows the categorisation of soil phosphorous at national level. Generally, Central, Western and Southern provinces were severely deficient to moderately deficient in soil phosphorous. The rest of the country particularly the northern section had adequate levels of phosphorous, meaning fertiliser application rates need to be varied across the country to suit the phosphorous levels.

Using the soil phosphorous classes generated from the soil analysis results, it was recommended to apply 300kg/ha of D compound fertiliser in the severely deficient soils and 200kg/ha in soils that have moderate and adequate phosphorous, whilst the current recommendation countrywide is 200kg for D compound. From this simple aggregated analysis, the results suggest that in severely deficient soils, farmers should have applied more fertiliser, whilst the blanket rate was adequate in the moderate and adequate soil phosphorous soils. The available soil analysis results showed that plant available phosphorous was low, and therefore classified according to the classes given in Table 3.

| P (mg/kg) | Average P (mg/kg) | kg P/ha | Category | Field Interpretation |
|---|---|---|---|---|
| 1-5.6 | 3.3 | 8.58 | Low | Severe Deficiency |
| 5.6-7.8 | 6.7 | 17.42 | Low | Severe Deficiency |
| 7.8-8.9 | 8.35 | 21.71 | Low | Severe Deficiency |
| 8.9-11.2 | 10.05 | 26.13 | Low | Severe Deficiency |
| 11.2-15.8 | 13.5 | 35.1 | Medium | Moderate Deficiency |
| 15.8-25.2 | 20.5 | 53.3 | Medium | Moderate Deficiency |
| 25.2-44.5 | 34.85 | 90.61 | High | Adequate |
| 44.5-84.3 | 64.4 | 167.44 | High | Adequate |
| 84.3-165.9 | 125.1 | 325.26 | High | Adequate |

*Table 3: Analysed Soil Phosphorous and Interpretation of Results*

Source: Authors' calculations

Fertilisation with phosphorous would be required at a level to restore the soil fertility to adequate status, and also to meet the crop requirement for target yields on lands represented by soils in the moderate soils category. Generally, 60 kg/ha Phosphorous pentoxide (P2O5) would be required to correct the deficiency on severe deficiency soils for maize production (Havlin et al., 2004). In order to maximise the yield potentials for maize, this can be achieved by applying D compound fertiliser at the rate of 300 kg/ha to avoid nutrient mining. In soils with adequate P, fertilisation should be maintained to achieve target yields, and avoid a decline in soil fertility (Wasonga et al., 2008). Both fertilisers should be banded or applied to the planting furrow or basin. In addition, about 100 kg/ha N as ammonium nitrate applied as top dressing should be adequate. General fertiliser recommendations such as 200 kg/ha of mixed fertiliser such as D compound followed by 200 kg/ha of urea or ammonium nitrate should suffice for maize on these soils to achieve yields above 4 tons/ha. However, this recommendation would be best based on the actual nitrogen requirements of the soil. Furthermore, land husbandry practices that increase soil organic matter content such as retention of crop residues on land, manuring and crop rotation, especially with legumes, and use of lime to raise the soil pH, should be encouraged in acidic soils to allow crops to thrive better in these soils.

Table 4 shows the distribution of farmers based on D compound fertiliser application rates by soil phosphorous status, compared to the area-specific fertiliser recommendation by soil phosphorous status. In general, the results show that more than 40.8% of the households did not use any fertiliser, whilst more than 90% in severe deficiency phosphorous soils used less than the recommended amount. Furthermore, about 25% of households in areas with moderate to adequate phosphorous used more than the 200kg/ha of D compound fertiliser.

| **Soil P Status** | **Number** | **Did not use fertiliser** | **Percentile of Compound D fertiliser per Hectare (kg/ha)** | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Mean** | **25th** | **50th** | **75th** | **90th** |
| Severe | 631 | 40.8% | 141.00 | 80.00 | 123.46 | 200.00 | 246.91 |
| Moderate | 494 | 30.2% | 162.71 | 100.00 | 150.00 | 200.00 | 266.67 |
| Adequate | 459 | 36.3% | 168.56 | 100.00 | 164.61 | 200.00 | 300.00 |
| Full sample | 1584 | 34.5% | 156.29 | 90.00 | 133.33 | 200.00 | 246.91 |

*Table 4: Compound D Fertiliser use by Soil Phosphorous Status*
Source: Authors' calculations

Figure 9 shows the average yield differences by soil P status. In general, the results show that irrespective of soil P status the average maize yields with fertiliser application are more than 1000kg/ha higher than the yields obtained with no fertiliser application. With fertiliser, soils with adequate P had slightly higher yields compared to medium and severe deficiency P soils.

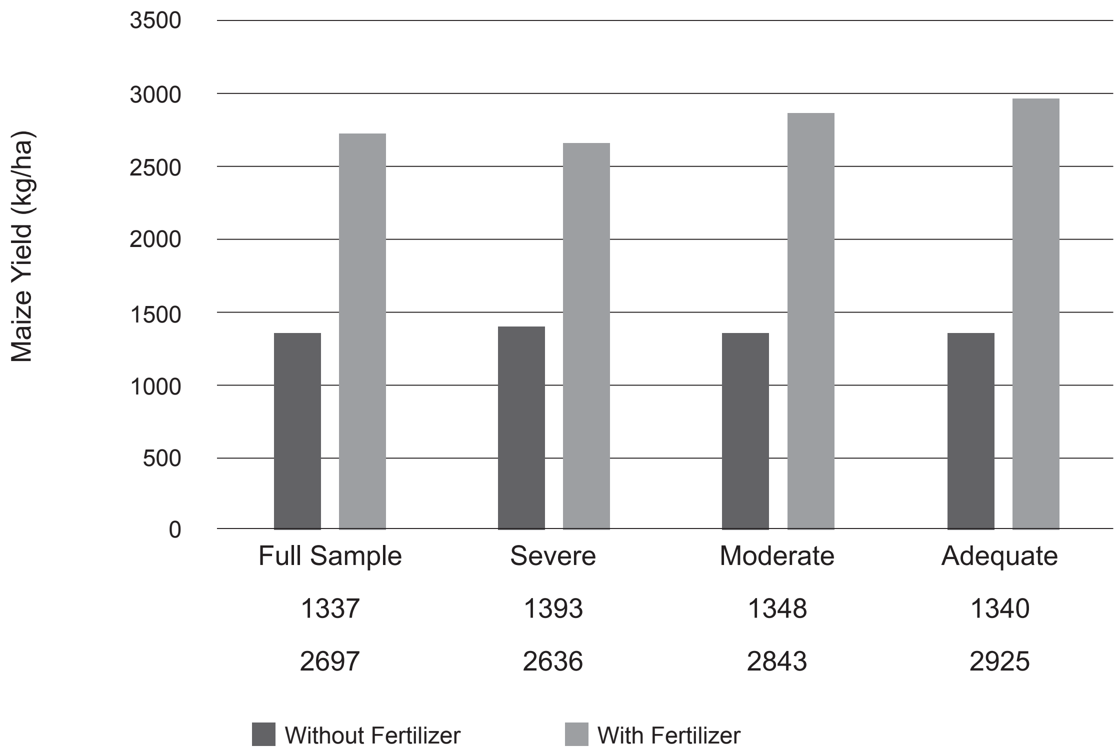



*Figure 9: Maize yield with and without fertiliser*
Source: Authors' computation

***Economics of fertiliser use***

From an agronomic perspective, one would expect to see a declining trend in maize yield with higher level of fertiliser application (diminishing returns). However, it was not possible to clearly show this trend for all the soil types as our data was not based on field fertiliser trials, but rather on self-reported yields and applications rates by the farm households. Figure 10 shows that there are diminishing returns of fertiliser use. However, apart from the severe deficiency phosphorous status fields, we were not able to see the inflexion maize yield points for medium and adequate phosphorous soils. The researchers further note that the adequate and moderate phosphorous soils have plant-available phosphorous in the soil solution, which the plants readily use during the critical growth stages.

The incremental maize yield resulting from additional application of fertiliser shown in Figure 11 is calculated by taking the maize yield for a particular fertiliser application level, and subtracting the maize yield when no fertiliser is applied, and dividing the result by the rate of fertiliser applied. For example, if the average yield in fields with no fertiliser is 1366 kg/ha, and in a field where the farmer applied 200kg/ha is 2031 kg/ha, then the kg increase in maize yield per kg of fertiliser applied is given by (2031- 1366) ÷ 200 = 4.1.

Thus, at 200kg/ha, the additional increase in maize yield for every kilogram of fertiliser is 4.1kg. If the law of diminishing returns did not apply, then the increase in yield for different rates would be the same. In this regard, Figure 12 shows diminishing returns with increased use of fertiliser for all types of soils. However, the incremental yield benefit is more limited in severe deficiency phosphorous soils compared to the medium and adequate phosphorous soils. The problem of high phosphorous fixation is generally experienced in acidic soils with sesquioxides and rarely in calcareous. (Sanchez, 1980).

Generally, if a phosphorous-deficient soil can be managed by 20-50kg/ha, then it is not problematic, more than 300kg/ha, however, poses an economic threat. Phosphorous deficiencies affect plant growth and can be very detrimental to the plants in that sometimes they may not recover (Grant et al., 2001). This leads to reduced yields as the phosphorous is present in inaccessible forms in the soil due to formation of insoluble compounds with aluminium (Cakmak, 2002). This may explain why the yield response in severe deficiency phosphorous soils was lower than in moderate and adequate soils as shown in Figure 11.

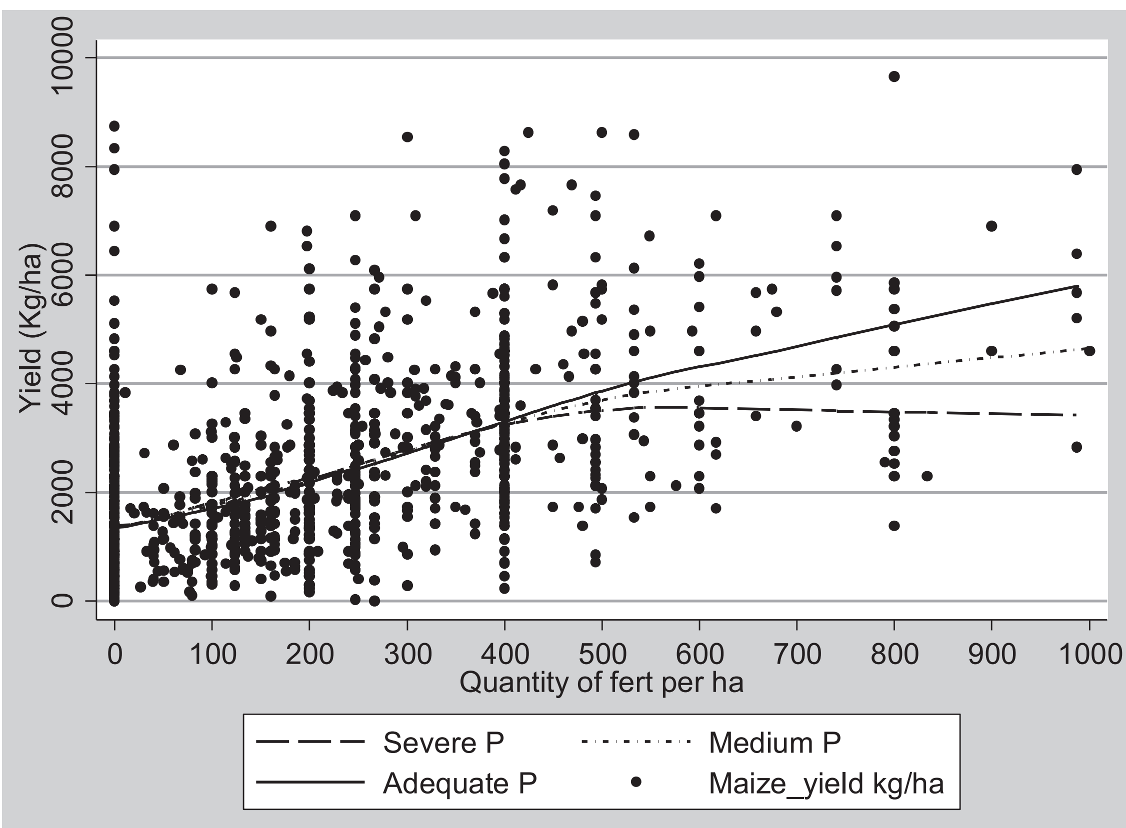



*Figure 10: Maize yield by fertiliser application rate and soils P status*
Source: Authors' computation

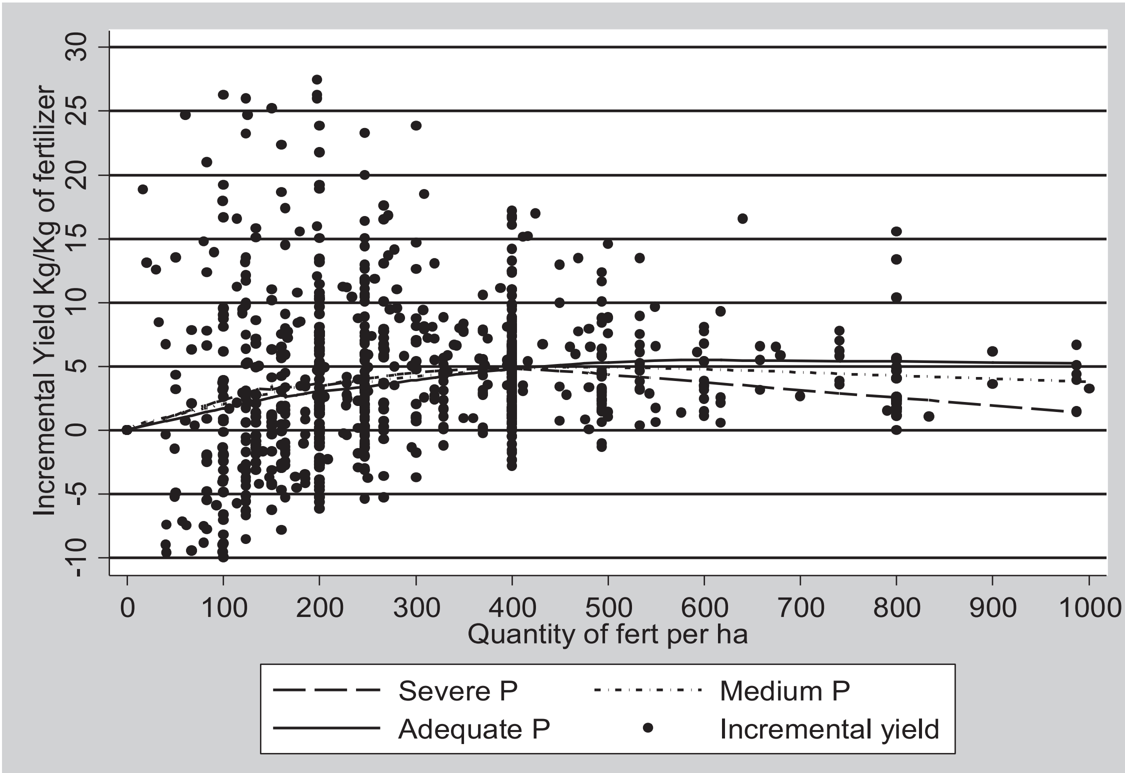



*Figure 11: Incremental maize yield by fertiliser application rates*
Source: Authors' computation

The trend is similar for maize net returns per hectare (computed as gross value of maize production less fertiliser costs per ha). In general, with additional application of fertiliser, the net returns decline a bit faster in severe deficiency phosphorous soils than in medium and adequate phosphorous soils. For example, in severe deficiency phosphorous soils, fertiliser application rates beyond 350kg result in a decline in net revenue as compared to about 500kg/ha in medium phosphorous soils, and more than 600kg/ha in adequate phosphorous soils. This is mainly due to the yield response to additional fertiliser which is greater in adequate phosphorous soils, followed by medium phosphorous soils, and lastly severe deficiency phosphorous soils (Figure12).

Economically there is a rate of fertiliser application, much lower than the agronomic maximum level, where no additional net benefit will result from applying more fertiliser. This rate is where the value to the farmer of any additional maize produced will be less than the cost of any additional fertiliser applied to the maize. This would be the level of fertiliser application which should be the maximum rate recommended for farmers. The amount of fertiliser actually applied is dependent to a large degree on the cost of the fertiliser and the value of the maize for the farmer. This amount may vary with

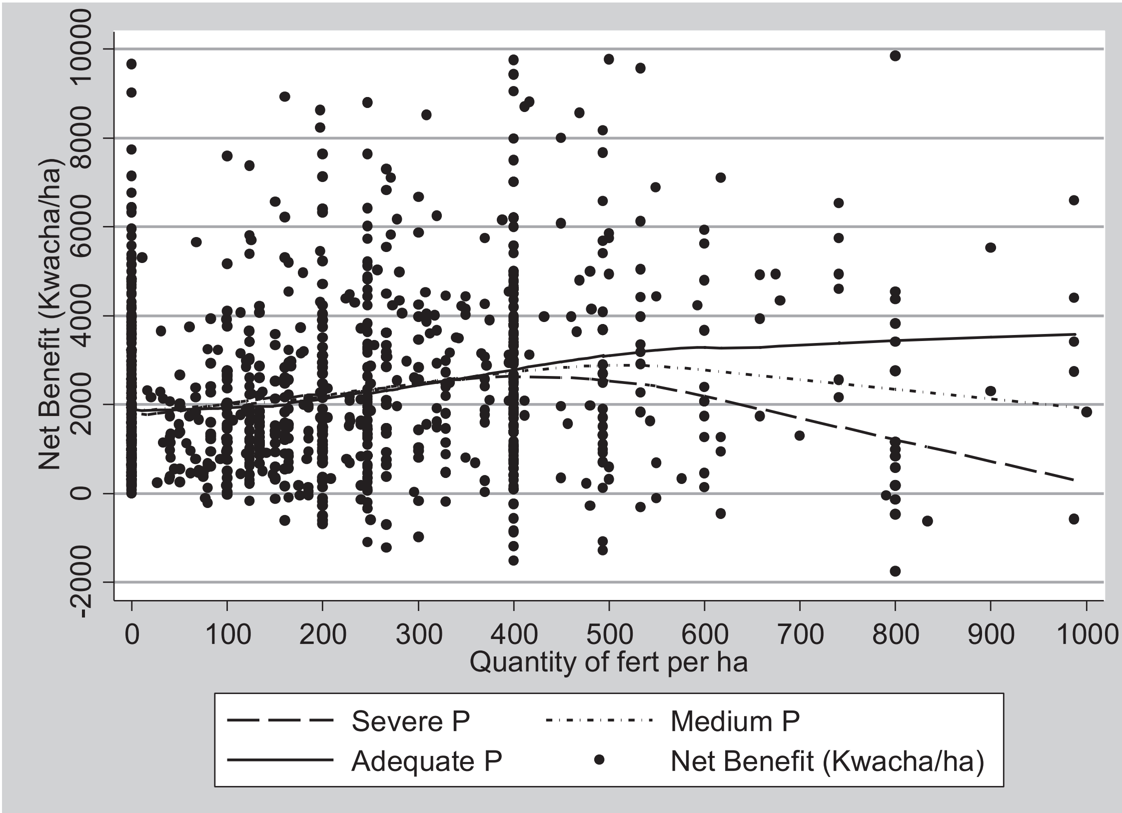



*Figure 12: Net revenue per hectare by fertiliser application rate and soil P status*
Source: Authors' computation

the recommended rate across the country. In Zambia, this has been a challenge because high fertiliser costs result in unprofitable use of fertiliser given the current low productivity. The Government of Zambia has responded to this by offering farmers prices above the market rate. Unfortunately this intervention is not optimal as the solution lies in addressing productivity issues through area-specific fertiliser recommendations. There is no doubt that high fertiliser prices, lower maize prices, and lower maize productivity, will result in lower levels of fertiliser use. There is an inverse relationship between the ratio of fertiliser to the price of maize, and the level of fertiliser use. Thus, if the fertiliser to maize price-ratio is increasing, the recommendation should be for farmers to use lower levels of fertiliser, and vice versa. This suggests that the blanket fertiliser application rate does not take into account the relative price ratio. This could be one of the reasons why fertiliser use levels are low in the country.

***Moving towards area-specific fertiliser recommendations***

It has been shown thus far that soil variability in terms of SOC, pH, and phosphorous is evident across the country. This variability, though not completely comprehensive for all soil nutrients, indicates that area-specific fertiliser recommendations are important for successful crop production. More importantly, they provide evidence that without soil analysis it is impossible to determine what the soil needs to be productive (Fery and Murphy, 2013). Farmers should use soil testing as a management practice for identifying nutrient variability across farm fields. This practice will ultimately guide decisions about soil fertility programmes that are responsive to crop needs, and will ensure that crops grow uniformly, whilst simultaneously assuring that all monies channelled towards fertiliser support are utilised in an efficient manner. We argue that soil testing may be the missing link in Zambian agriculture, particularly for smallholder farmers.

The challenge in soil testing for smallholder farmers is to guarantee that the process is agronomically sound. It should be noted that soil testing comprises various sampling procedures including: packaging and labelling, soil analysis, interpretation, and management recommendations. To be effective, extension officers and, ultimately, farmers will require training in the testing aspects to warrant scientific soundness of the soil test results and recommendations arising therefrom. Another challenge to area-specific recommendation is the prohibitive costs that may be associated with soil testing. Generally, farmers, whether large or small, need cheaper, reliable soil testing facilities that can give them results in a quick and efficient manner. They should not have to use distant central laboratories (e.g. Lusaka), which have a long waiting time before test results and recommendations are recieved.

The hindrances outlined above can be overcome by applying current on-site soil testing technologies such as: infra-red spectroscopy, and mobile soil analyser. These technologies and associated soil testing kits can be located at district level where logistics for travel are simpler. Extension workers can be trained to instruct farmers on how to take a soil sample that conforms to the science of soil sampling and testing. These samples can then be brought to the district office where farmers can wait for them to be analysed, and receive the recommendations upon completion of the analysis. Some of the analysis in these newer technologies can take 2 to 24 hours, this represents a realistic time frame for farmers to wait. Notably, this approach is already being piloted in certain developing countries such as Kenya and Rwanda (Agriculture for impact: Growing opportunities for Africa's development, 2015). Therefore, apart from central laboratory facilities, mobile testing kits and facilities can be used to make testing facilities more accessible across the country. This approach is being piloted by a project in Zambia, at ZARI and UNZA, sponsored by the Japanese International Cooperation Agency (JICA). Under this project, mobile soil testing kits are being stationed in various provinces and districts to make them easily accessible to farmers, thus eliminating long travel distances to testing facilities.

Mobile soil testing enhances the feasibility of area-specific fertiliser blending and production based on the general soil nutrient status of a given area. Soil testing may be tied to the government supported fertiliser support programmes by making soil testing a precondition to accessing the fertiliser as farmer input support. This may guarantee that fertilisers accessed and applied by farmers are area specific. This approach may also be supported by other projects that support conservation farming where farmers accessing support for CA practices can test their soils. This soil testing may in the long run allow for monitoring how the soil status is changing with use of inputs and other practices such as CA.

**Conclusion and Recommendations**

This study has demonstrated that soil variation exists across the country. We observed this in all the mapped soil properties with ranges of 2.7 to 7.8 for soil pH, 0.08% to 10.1% for SOC and 1.0 ppm to 333.6 ppm for soil phosphorous. These values belong to different classes in terms of acidity, levels of adequacy, and deficiency. This indicates that blanket fertiliser recommendations or even liming may not be well suited across the entire country.

In view of the findings of this study, we make the following recommendations;

1. The promotion of soil testing by farmers: It should be noted that yield and ultimately economic return are optimised when fertiliser is applied according to soil conditions. Therefore, soil testing by farmers should be recommended. This can be done either by setting up soil testing centres or using mobile soil testing kits. Central to the success of this programme is proper soil sampling. This entails that the soil testing facilities should also provide training to farmers and extension staff on the correct procedures and/or methods of soil sampling. The current cost of mobile testing kits ranges from US$20 to around US$50 for pH, N, P, and K besides reagents needed for their routine operation and maintenance. It should be noted that average cost of laboratory soil testing in Zambia is K255 (US$26) per sample. This may be too expensive for most smallholder farmers who have been relying mainly on government-subsidised fertiliser support.
2. Given the extent of financial allocation to FISP, the effectiveness of the programme can be enhanced if some of the resources can be channelled to soil testing and map production. The soil testing can be done using mobile kits by extension staff with a few samples taken for confirmatory tests in the laboratory. Some of the resources can also be channelled to research centres such as ZARI, and universities such as UNZA, to enable them to provide affordable soil testing services to farmers within their locality. It would be important that the soil testing information and results are geocoded and collated for use in updating and generating soil maps at various levels.

3. The establishment of farmer demonstration plots: In order for farmers to understand the need for soil testing and the results of location-specific fertiliser recommendation, there is need to set up demonstration plots in various locations. To ensure effective learning, the demonstration plots can be set up as farmer field schools.
4. Regular generation and updating of soil maps: Since soil properties change with time, there is need for regular updating of existing maps as well as generation of new maps. TGeostatistical approaches as demonstrated in this paper and soil legacy data coupled with appropriate remote sensing toosl can be used to generate new maps. These maps should be produced at national as well as district level to ensure that even soil variation at this larger scale is addressed.

## Endnotes

1 AEZ I covers the country's major valleys: Gwembe, Lunsemfwa, and Luangwa, and the southern parts of Western and Southern provinces that are drought-prone. It is characterised by low rainfall (< 800 mm/year) and a short, hot growing season. AEZ II is the medium rainfall area (800-1,000 mm/year) and is divided into AEZ IIa and IIb. AEZ IIa has higher rainfall with a longer crop growing period. The highest maize producing areas in Zambia are found in this region. AEZ IIb mainly has coarse sandy soils and is able to support some agriculture production. AEZ III, with rainfall of 1,000-1,500 mm/year occupies 41% of the country covering Northern, Luapula, Copperbelt and, North-western provinces, and parts of Central Province.

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# Conservation Agriculture; Gendered Impacts on Households Livelihoods

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*In response to climate change, new technologies resilient to climatic variability have been promoted among smallholder farmers. Conservation Agriculture (CA) has been promoted since the 1990s in sub-Saharan Africa. However, as with any new technology, various factors affect adoption and ultimately the impact of the technology.Gender is one such factor. Both female and male smallholder farmers are faced with numerous constraints to accessing productive resources Female farmers face more problems in adopting new technology than do male farmers, resulting in few of them adoptining them. This in turn reduces the impact that these technologies have on their livelihood. Using Zambian nationally representative data, the study examines the gendered impacts of CA on smallholder households' livelihood outcomes - household income, crop income, crop diversification, and dietary diversity score. Results show that CA adoption improves a household's level of dietary diversity and crop diversification. However, the impact of CA on these livelihood outcomes reduces if the household is femaleheaded or the farmer (male or female) is in a female headed household. Therefore, promotion of CA should take into account the gender differences at household level and within the household, as well as female farmers' access to productive resources.*

**Key words:**
Conservation agriculture, Gender, Impact, Livelihood outcomes, Zambia

## Introduction

Sub-Saharan Africa's (SSA) agricultural production is threatened by climate variability and change which is evident in the increase in variable temperatures, changes in precipitation patterns and increased occurrences of extreme events such as droughts and floods (IPCC, 2014; Nelson, 2009). In order to sustain food production and productivity in light of these challenges, new innovative technologies which are resilient to climatic variability have been promoted over the years, especially among smallholder farmers who form the bulk of farmers and are the most vulnerable. One such technology is Conservation Agriculture (CA). CA consists of a package of farming practices based on three main principles, namely: minimum mechanical soil disturbance; permanent organic soil cover; and crop rotation (FAO, 2001; Haggblade and Tembo, 2003). It isintended to reduce the negative impacts of climate variability and change by optimizing crop yields and profits while maintaining a balance between agricultural, economic and environmental benefits (FAO, 2011). It has been promoted in SSA since the 1990s (FAO, 2001; Haggblade and Tembo, 2003). However, as a practice that has been promoted for over a decade, and despite the benefits, adoption rates remain relatively low.

Among smallholder farmers, female farmers play a significant role in agricultural production, with more female farmers engaging in agriculture (78%) compared to male farmers at 69% (Sitko et al. 2011). However, even though female farmers engage in agriculture production more than male farmers, the rates of technology adoption are lower among female farmers than male farmers (Quisumbing 1996; Ragasa et al. 2013). Both female and male smallholder farmers are faced with numerous constraints when it comes to having access to productive resources. However, female farmers find it even more challenging to access these resources due to traditional and cultural barriers (Doss, 2001). In particular female farmers have limited access/ownership to land, credit, and other productive assets such as livestock. This hinders adoption of new technologies by female farmers, as their limited resource endowments have an impact on their adoption capability which in turn reduces the impact that these technologies have on their livelihood.

The adoption of CA as an improved technology has remained relatively low due to a number of issues. Studies have been carried out in Zambia to try and establish the factors that might contribute to the adoption of the various CA practices. These studies examine a number of factors affecting CA adoption, for instance resource availability, e.g. land, labour, income, access to machinery, credit, as well as household/farmer characteristics such as education level and gender of the household head/farmer (Arslan et al., 2013; Chomba, 2004; Grabowski et al., 2016; Haggblade and Tembo, 2003; Kabwe, Donovan and Samazaka, 2005; Ngoma, Mulenga and Jayne, 2014; Ngombe et al., 2014; Nyanga, Johnsen and Kalinda, 2012). Other studies have also looked at the impacts of CA on yield and household income (Abdulai, 2016; Manda et al., 2016; Goeb, 2013; Ngoma, 2016;Haggblade and Tembo, 2003; Kabamba and Muimba-Kankolongo, 2009). However, little attention has been paid towards understanding the gender dynamics in CA uptake, for instance how CA adoption among female farmers within male-headed households, and as household heads themselves, impacts on their livelihoods. These dynamics are important as CA interventions are not gender-neutral and as such have different impacts on the adopter based on the gender and the household dynamics (Farnworth et al, 2016). This study will examine the impact of CA and gender on different livelihood outcomes considering the different gender types within the household. In particular the study will examine the gendered CA impacts on total household income and gross value of crop production. The study goes further to look at the gendered impact of CA on household crop diversification, and dietary diversity which most existing studies have not explored. The findings from this study will help to have more gender sensitive programming and promotion of CA.

The rest of the study is organised as follows: the data and methods used in the study are described in Section 2, and the results of the study are presented in Section 3. Section 4 presents the conclusion and recommendations.

## Data and Methods

### *Data*

The study uses nationally representative data drawn from two waves of the Rural Agricultural Livelihoods Surveys (RALS). These surveys were conducted by IAPRI in collaboration with the Zambia Central Statistical Office (CSO) and the Ministry of Agriculture and Livestock (now Ministry of Agriculture) and cover the 2010/11 (RALS 2012) and 2013/14 (RALS 2015) agricultural season. The RALS data sets provide comprehensive information on smallholder farm households cultivating less than 20 hectares of land for farming and /or livestock production purposes. The first survey wave (RALS 2012) was administered to 8,840 agricultural households in 442 SEAs. A follow-up survey of the same households was conducted in May/June 2015, and a total of 7,254 were re-interviewed. The RALS 2012 sampling frame was based on information and cartographic data from the 2010 Zambia Census of Population and Households.

The RALS data provide reliable estimates at both provincial and national levels. We use a balanced panel of 6,989 crop-producing households in both 2010/11 and 2013/14 farming seasons from the 7,254 balanced panel households, excluding 265 livestock-only raising households. Furthermore, CA is most suited for areas that are prone to drought and erratic rainfall. These are Agro-Ecological Zone (AEZ) I, IIA and IIB, excluding AEZ III. Therefore, our analysis is based on these three zones, excluding AEZ III. In terms of CA adoption, we used household data from the 2013/14 agricultural season with some lagged household factors (initial household conditions) from RALS 2012 used as explanatory variables. Hence, we assume that all the lagged household level variables used in our models are at least weakly exogenous.[1]

In addition, we also used other data sets to include variables that were not collected in the RALS data. In particular qualitative data from Focus Group Discussions (FGDs) to get more insight about CA adoption. The FDGs were held in selected districts in AEZ I, IIA and IIB in which CA has primarily been promoted though recent promotional activities which also covered AEZ III (the high rainfall zone in the northern parts of the country). The districts that were covered during the period February/March 2016 were Sesheke, Sinazongwe, Choma, Monze, Kaoma, Mumbwa, Nyimba, Petauke, and Katete.

***Conceptual Framework***

CA is intended to improve farm soil fertility, improve water retention to mitigate against low and/or variable rainfall, reduce soil erosion and in turn increase yields and incomes, as well as improve household food and nutrition levels (Mayer, 2015; FAO, 2001). This has been the basis under which it has been promoted for the past two decades among smallholder farmers in Zambia. However, to achieve these outcomes, several factors are at play, for instance the farmers choose the best collection of commodities (practices) based on the limited resources available to them and the environment they operate in. To gain a better understanding of the factors at play to achieve these outcomes we turn to the Sustainable Livelihoods Framework (SLF) (Figure 1). The SLF is centred on the multiple livelihood options and strategies that household have to make to attain different livelihood outcomes. The outcomes are dependent on the households' resource base which might be tangible or intangible (livelihood assets), the context in which the household operates (vulnerability context), the policy and institutional environment, and the technologies available (Ashley and Carney, 1999 and DFID, 1999). The household's ability to access resources is one of the most important aspects to attaining improved livelihood outcomes. This access is, however, dependent on the vulnerability context of the household. Among the main issues influencing a household's vulnerability is gender of the household head and/or the household's decision marker. Female household heads and/or decision makers tend to have limited access to resources such as land, credit and information and technology, compared to their male counterparts (Quisumbing et al., 2014; Farnworth et al., 2016). This difference in resources based on the gender of the household head and/or decision makers influences the household's livelihood outcomes.

Drawing from this framework, this study examines the gendered impacts of CA on selected livelihood outcomes. In particular we look at the gendered impact of CA on total household income and gross value of crop production. In addition, the study looks at the gendered impact of CA on crop diversification. Crop diversification is expected to increase a household's resilience to shocks and maintain or increase its food security. Crop diversification is measured through the computation of the Simpson Index for Diversification (SID). SID is a widely used measure of the level of diversification in the context of crop production and is calculated as follows:

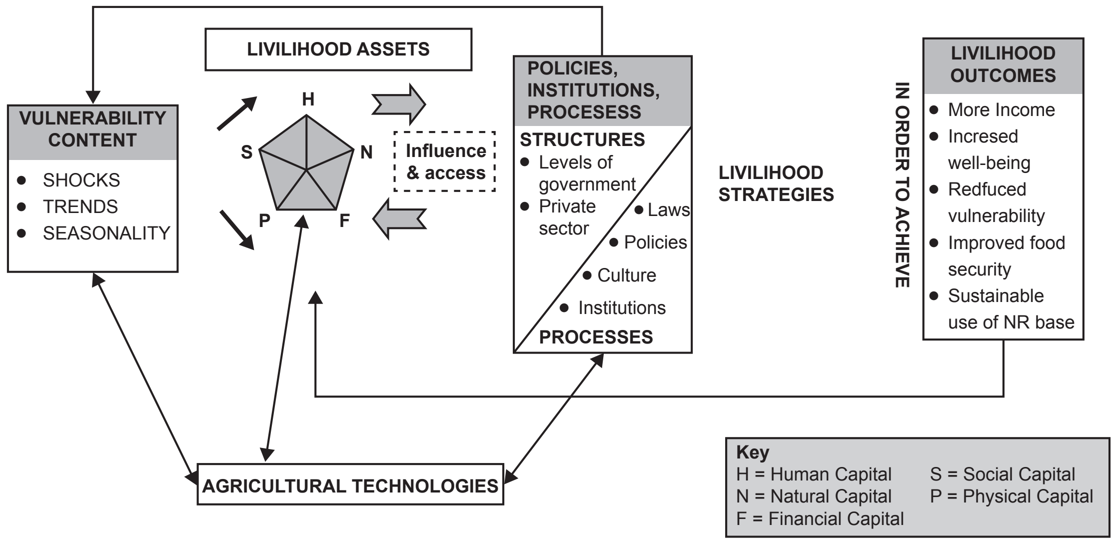


*Figure 1: Sustainable Livelihoods Framework*
Source: Adapted from DFID, 1999

$$SID = \sum_{i=1}^{n} P_i^2 \qquad (1)$$

Where Pi is the proportionate area of the ith crop in the total cropped area. The SID ranges from 0 to 1 such that 0 is a complete lack of diversification and 1 indicates complete diversification.

Finally, we analyse the gendered impact of CA on the household's dietary diversity (HDDS), which we use to proxy for the household's nutrition status. The HDDS relates to nutrient adequacy (coverage of basic needs regarding macro and micro nutrients) and to diet variety/balance, which are two of the main components of diet quality. In general, the HDDS reflects a snapshot of the economic ability of a household to access a variety of foods. The score is calculated by summing the number of food groups consumed in the household or by the individual respondent over the 24-hour recall period. Table A1 shows the twelve food groups that are used to compute the score.[2] Based on this set of food groups, the HDDS ranges from 0 to 12—with the level of diversity increasing with the HDDS.

A priori, we expect CA to have a positive effect on total household income, gross value of crop, crop diversification and HDDS, more so for male farmers, compared to their female counterparts, due to better resource endowments.

***Econometric Model***

A common measure of impact is given by the mean difference in the outcome variable between the participants after receiving the treatment and what their outcome variable would have been had they not received the treatment, also referred to as the average treatment effect on the treated or ATT (Wooldridge, 2001; Smith and Sweetman, 2001). That is,

$$ATT = E(Y_i^1 - Y_i^0 \mid w_i = 1 \qquad (2)$$

where $Y_i^1$ is the outcome variable if household i participates in the programme/ treatment $Y_i^0$ is the outcome variable if household $i$ did not participate in the treatment, $x$ is a vector of household characteristics, and $w_i \in \{0,1\}$ is an indicator variable equal to 1 (one) if the household is in the treatment group and 0 (zero) otherwise.

One of the biggest challenges in impact evaluation is that only $Y_i^1$ or $Y_i^0$, and not both, is observed for any given household, as the case may be. This is so because it is not possible for the same unit of study to be both a participant and a non-participant. Thus, with $w=1$only $Y_i^1$ is observed and $Y_i^0$ is missing data. In randomised experiments, $Y_i^0$ can be estimated from control households[2]. This makes it possible to attribute any systematic differences in the outcome variable between treated and control units to the programme in question. In a non-randomised study like ours, the counterfactual has to be estimated from the controls through carefully chosen statistical tools. This is necessary because the systematic differences common between participants and non-participants in the absence of the intervention are likely to lead to selection bias, given by

$$b = E(Y_i^0 \mid w_i = 1) - E(Y_i^0 \mid w_i = 0) \qquad (3)$$

This bias could be corrected if $E(Y_i^0 \mid w_i = 1)$ were known. We then estimate the conditional average treatment effect on the treated as follows

$$ATT = E(Y_{1i} - Y_{0i} \mid x, w_i = 1) \qquad (4)$$

where $x$ is a vector of covariates.

***Empirical Model and Estimation Strategy***

Following from equation 4, we measure the gendered impact of CA on outcome $Y_i$, by estimating a model that contains binary variables for CA, and gender as explanatory variables. The following base model is formulated:

$$Y_i = y_i + CA_i + gender_i + x_i + e_i \quad i=1,\ldots,N \qquad (5)$$

where $Y_i$ denotes an outcome, such as household income, gross value of crop production, or dietary diversity score for household $i$ ; $CA_i$ = 1 if a household used CA and 0 otherwise; $gender_i$= 1 if female and 0 if male; $x_i$ captures the household-level fixed effects (assumed constant over time); and $e_i$ is an error term.

To get the differential impact of gender and adoption of CA on crop and household income, we interacted CA adoption and gender of either the household head or the decision maker, yielding equation 6:

$$Y_i=y_i + CA_i + gender_i + CA_i * gender_i + x_i+ e_i \quad i=1,....,N \qquad (6)$$

We estimate equations 5 and 6 using a conditional treatment effect as it is more realistic because there are other factors affecting the outcome variables apart from CA and gender and we need to control for them by including a vector of other explanatory variables. The estimated treatment effect is interpretable as a *ceteris paribus* effect.

***Variables Used in the Models***

The livelihood outcome variables examined in this study include the following: (a) household income; (b) gross value of crop production; (c) level of crop diversification (SID); and (d) household dietary diversity score (HDDS). With CA adoption as the treatment variable of interest. CA, as defined earlier consists of a package of farming practices based on three main principles namely: 1) minimum mechanical soil disturbance (minimum tillage); 2) permanent organic soil cover, and 3) crop rotation. CA adoption can be disaggregated into *full* CA (i.e. practising minimum tillage, maize-legume rotation and residue retention); *partial* CA (minimum tillage with either maize-legume rotation or residue retention and *general* CA (minimum tillage with either crop rotation and/or residue retention). For our analysis we use the definition of general CA. For the gender explanatory variables of interest, we examine the effect of the household head's gender on the livelihood outcome variables, as well as the gender of the decision maker's field.

Other explanatory variables were included based on literature and these were disaggregated into six categories as follows: human capital assets, household/farm assets, institutional factors, social factors, market access, and climatic factors. Although the treatment effects estimator used in this study controls for unobserved time-invariant characteristics, there may be area-specific time-variant effects that might be corrected with both CA and the outcome. To control for such area-specific time-variant effects, agro-ecological/ were added to the estimation models. We measure the impact of CA on the outcome variables in zones AEZ I, IIa and IIb excluding AEZ III. This is because CA is suitable in these zones and most of the promotional activities are also centred in these zones compared to AEZ III. Table 1 presents the descriptive statistics for all the variables used in this study.

*Table 1: Variable Description*

| Variables | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| CA Adoption | 0.06 | 0.228 | 0 | 1 |
| **Human capital assets** | | | | |
| Gender of the HH head (1=female) | 0.19 | 0.40 | 0 | 1 |
| Female Decision Marker (=1) | 0.28 | 0.451 | 0 | 1 |
| Age of the HH head | 47.65 | 14.71 | 18 | 105 |
| Education level of the HH head in years | 5.99 | 3.63 | 0 | 19.00 |
| Adult equivalents | 4.57 | 2.19 | 1 | 23.42 |
| HH with chronically ill adults | 0.05 | 0.21 | 0 | 1 |
| Household head/spouse has kinship ties (=1) | 0.61 | 0.488 | 0 | 1 |
| Hired Labour (=1) | 0.41 | 0.492 | 0 | 1 |
| **Household/Farm assets** | | | | |
| Landholding Size (Ha) | 2.49 | 2.47 | 0.01 | 45.2 |
| Log of Productive assets (ZMW)* | 11.69 | 3.77 | 0 | 23.30 |
| Ownership of cell phone (=1) | 0.56 | 0.49 | 0 | 1 |
| Ownership of Radio/TV (=1)* | 0.64 | 0.48 | 0 | 1 |
| **Institutional factors** | | | | |
| Access to credit (=1) | 0.17 | 0.37 | 0 | 1 |
| Membership in a farmer organisation (=1) | 0.55 | 0.50 | 0 | 1 |
| Off-farm participation (=1)* | 0.75 | 0.434 | 0 | 1 |
| **Social factors** | | | | |
| Witchcraft, not hard work can make you successful | 2.86 | 1.35 | 1 | 5 |
| Prayer, not hard work can make you successful | 3.30 | 1.40 | 1 | 5 |
| **Market access** | | | | |
| Distance to the nearest Boma (Km) | 39.11 | 32.76 | 0.00 | 250 |
| **Climatic Factors** | | | | |
| AEZ I (=1) | 0.08 | 0.28 | 0 | 1 |
| AEZ IIb (=1) | 0.06 | 0.25 | 0 | 1 |
| AEZ IIa (=1) | 0.43 | 0.49 | 0 | 1 |

Source: Authors' computations   *Lagged Variables

## Results

We begin this section by presenting some descriptive statistics regarding gender differences in CA adoption and livelihood outcomes. We then econometrically examine whether there are differences in gendered impacts of CA on household's livelihood outcomes by gender of the household head and gender of the decision maker.

### *Descriptive Statistics*

*Gender Differences in CA Adoption*

Table 2 below shows the differences in CA practices, CA adoption in general, and CA disaggregated into full CA and partial CA by the gender of the household head and the decision maker. The results show that statistically, male headed households tend to practice ripping (5.6%) more compared to female headed households (2.7%), showing that male heads have more access to mechanisation compared to the female headed households. While there are no statistical differences among male and female headed households in terms of adoption of the other practices. However, we look at whether this still remains the same when the gender dynamics within the households are examined, i.e. by the gender of the decision maker in a female headed household. In particular, female farmers in female headed household (FFHH), female farmers in male headed household (FMHH), male farmers in female headed households (MFHH) and male farmers in male headed households (MMHH). We find that MMHH households have higher minimum tillage adoption rates compared to the other farmer household dynamics, followed by FFHH. On the other hand, FFHH tend to practice crop rotation more than the other farmers in different household dynamics, while male farmers tend to adopt partial CA more than FFHH. This shows that the gender dynamics within the household and not just the gender of the household head tend to matter for adoption of certain practices.

*Table 2: Percent of Households Using CA Practices by Gender of the Household Head and Decision Maker*

| | | | | **Female farmers in** | | **Male farmers in** | |
|---|---|---|---|---|---|---|---|
| | **All Households** | **Male Headed Household** | **Female Headed Household** | **Female Headed Household** | **Male Headed Household** | **Female Headed Household** | **Male Headed Household** |
| Number of Households | 838,472 | 576,700 | 204,341 | 460,987 | 162,088 | 19,476 | 1,330,176 |
| Minimum Tillage (%) | 14.3 | 14.5a | 13.7a | 6.7a | 4.5b | 3.0b | 8.2c |
| Planting Basins/ Potholes (%) | 5.3 | 4.7a | 6.3a | 3.3a | 2.2a | 0.7c | 2.1ac |
| Zero Tillage (%) | 4.9 | 4.6a | 5.6a | 1.5a | 1.2a | 0.6a | 4.2b |
| Ripping (%) | 4.8 | 5.6a | 2.7b | 2.0a | 1.2a | 1.6a | 1.9a |
| Crop Rotation (%) | 49.6 | 48.7a | 44.8a | 29.0a | 45.6b | 28.0a | 26.1a |
| Crop Residue Retention (%) | 58.5 | 58.4a | 58.7a | 46.5a | 40.2b | 36.3ab | 42.3cb |
| CA general | 11.7 | 12a | 11.1a | 5.5ab | 6.6a | 7.9a | 6.8ac |
| Full CA adopters | 4.8 | 5.0a | 4.3a | 1.7a | 1.4a | 4.7a | 1.4a |
| Partial CA adopters | 6.9 | 7.0a | 6.8a | 3.8ac | 5.1a | 3.2a | 5.4ab |

Source: CSO/MAL/IAPRI 2015. Note: Values with the same superscript are not significantly different at 5%.

*Gender Differences in Livelihood Outcomes*

Table 3 shows the gender differences in the livelihood outcomes of interest by household head, as well as by the gender of the decision maker in a female headed household. As outlined before, differences in access to resources vary based not just on gender of the household head level, but also on the dynamics within the household. We find that female headed households have significantly lower livelihoods outcomes across all the outcomes of interest except for crop diversification compared to the male headed household. These results are consistent with evidence showing that women/female headed households across sub-Saharan Africa tend to have limited access to productive agricultural resources compared to their male counterparts (Farnworth et al., 2016; Doss and Morris 2000; Koru and Holden 2008), which translates to lower productivity and reduced livelihood outcomes.

*Table 3: Gender Differences in Livelihood Outcomes*

| | Household Income (ZMW) | Gross value of crops harvested (ZMW) | Simpson Index of Crop Diversification | Household Dietary Diversity Score (1-12) |
|---|---|---|---|---|
| **All Households** | 16865.15 | 5621.27 | 0.38 | 5.73 |
| **Male Headed Household** | 19420.14a | 6429.23a | 0.38a | 5.86a |
| **Female Headed Household** | 9687.93b | 3351.63a | 0.37a | 5.34b |
| **Female farmers in Female Headed Household** | 10518.34a | 4066.97a | 0.44a | 5.45a |
| **Female farmers in Male Headed Household** | 21570.72b | 7700.83b | 0.45a | 6.12c |
| **Male farmers in Female Headed Household** | 10744.66a | 4933.68a | 0.46a | 5.65ac |
| **Male farmers in Male Headed Household** | 20280.32c | 7578.28b | 0.45a | 5.96c |

Source: CSO/MAL/IAPRI 2015. Note: Values with the same superscript are not significantly different at 5%.

On the other hand, farmers in male headed households generally have better household and crop income, than farmers in female headed household's, implying that the presence of a male head in the household tends to increase the farmers' livelihood outcomes. In particular, compared to the other groups, FMHH had statistically significant higher household and crop income, followed by MMHH.

*Gender Differences in Conservation Agriculture and Livelihood Outcomes*

CA adoption is said to have numerous benefits, one of which is that it encourages production of various crops, through crop rotation. This is said to increase a household's crop production and productivity which in turn leads to improved gross value of crop production and ultimately total household income. The cereal-legume rotation also increases crop diversification and diversity in a household's food groups. Based on these benefits, we examine the four livelihood outcomes of interest by gender of the household head among CA and non-CA users (Table 4). The bivariate results show that CA users generally have higher livelihood outcomes than non-CA users.

*Table 4: Gender Differences in Conservation Agriculture and Livelihood Outcomes*

| | **---Non-CA users---** | | **---CA users---** | |
|---|---|---|---|---|
| | **Male Household Head** | **Female Household Head** | **Male household Head** | **Female Household Head** |
| Household Income (ZMW) | 19288.37$^{a}$ | 9857.66$^{b}$ | 21656.62$^{a}$ | 6720.51$^{bc}$ |
| Gross value of crops harvested (ZMW) | 6312.43$^{a}$ | 3346.5$^{bd}$ | 8374.2$^{c}$ | 3483.29$^{d}$ |
| | **---Non-CA users---** | | **---CA users---** | |
| | **Male Household Head** | **Female Household Head** | **Male Household Head** | **Female Household Head** |
| Household Dietary Diversity Score (1-12) | 5.82$^{a}$ | 5.37$^{b}$ | 6.68$^{c}$ | 4.78$^{db}$ |
| Simpson Index of Crop Diversification | 0.38$^{a}$ | 0.37$^{a}$ | 0.46$^{b}$ | 0.47$^{bc}$ |

Source: CSO/MAL/IAPRI 2015. Note: Values with the same superscript are not significantly different at 5%.

In particular, both male and female headed households adopting CA have significantly higher household and crop income and are more diversified in term crop than non-CA users. Male headed households in both CA and non-CA users obtain higher crop and household income, than their female counterparts, the same applies for HDDS. This as mentioned before might be because male headed households are said to be more resource endowed.

***Econometric Results***

The bivariate results in the above section indicate that there might be differences in the livelihood outcomes based on the gender of the household head and more so on the inter-household gender dynamics. Therefore, in this section, controlling for all other variables, we examine whether there are any gendered impacts of CA on the selected livelihood outcomes.

*Are there gender differences in CA's impact on households' livelihood outcomes?*

Table 5 shows the results for the impact of CA and the gender of the household head on household income, crop income, crop diversification, and HDDS. The results show that CA adoption has impact on household income but increases crop income. This might indicate that the gains from CA under current conditions are not large enough, thus income at crop production level does not differ between CA and non-CA households. We also find that gender alone has an impact on both household and crop income. In both outcomes, female headed households tend to obtain lower levels of household and crop income - affirming findings by other studies (Doss and Morris 2000; Koru and Holden 2008). However, when we consider the gendered impact of CA, we find that there are no differences between male and female household heads and CA and non-CA adopters. For crop diversification and HDDS, we find that CA adoption has a positive impact on both. However, this impact is reduced if a household is headed by a female. Table 6 shows the differential impact of CA on crop diversification and HDDS, and it can be seen that households with male heads who adopt CA have higher crop diversification levels and HDDS compared to female headed household.

However, as alluded to earlier, the household gender dynamics might affect the livelihood outcomes, and the descriptive results indicate that it could be the case. Therefore, we examine the effect of the gender of the decision maker and the gender dynamics at field level.

*Does the CA impact differ by intra-household gender dynamics?*

Table 7 shows the gendered impact of CA on the livelihood outcome by gender of the decision maker on a particular field as well as the gender of the decision maker in different household dynamics. Similar to the results that we obtained when we looked at the gender of the household head, we find that there is no statistical difference between gendered impact of CA adopter and non-CA adopter when it comes to household income and crop income, even when disaggregated by the gender of the decision maker and the household dynamics that the decision makers finds themselves in.

The impact of CA on crop diversification and HDDS tends to matter by gender of the decision maker as well as the household dynamics that the decision makers find themselves in. We find that the impact of CA on both crop diversification and HDDS is reduced if the field decision makers are female compared to if they are male. When we took a closer look at the intra-household gender dynamics, for crop diversification we found that MMHH who adopted CA had the highest impact of 0.28, while MFHH had the lowest impact. FMHH on the other hand had a higher impact of 0.073 compared to FFHH (Table 8). Under HDDS, FMHH had the highest impact, while FFHH had the lowest. These findings imply that the presence of a male head boosts the female's livelihood outcome, which could be stemming from the fact that male farmers have better access to resources compared to female farmers. Therefore, going a step further, we examine the gendered impact of CA on the livelihood outcomes, with regard to the household's access to productive assets.

*Table 5: Impact of CA and Gender of Household head on Household Income, Crop income, Crop Diversification and HDDS*

| Variables | Household Income | Household Income | Crop Income | Crop Income | Crop Diversification | Crop Diversification | HDDS | HDDS |
|---|---|---|---|---|---|---|---|---|
| CA Adoption (=1) | -0.481 | -0.198 | 0.719* | 0.403 | 0.395*** | 0.256*** | 2.134*** | 1.632** |
| | (0.386) | (0.341) | (0.428) | (0.378) | (0.082) | (0.078) | (0.732) | (0.689) |
| Gender of the HH head (1= female) | -0.182*** | -0.193*** | -0.227*** | -0.201*** | -0.001 | 0.016 | 0.063 | 0.217** |
| | (0.040) | (0.047) | (0.044) | (0.052) | (0.010) | (0.011) | (0.082) | (0.097) |
| Gender of HH head*CA Adoption | | 0.122 | | -0.327 | | -0.223*** | | -1.969*** |
| | | (0.356) | | (0.394) | | (0.082) | | (0.720) |
| Constant | 5.364*** | 5.332*** | 5.362*** | 5.399*** | 0.468*** | 0.485*** | 1.741*** | 1.808*** |
| | (0.170) | (0.167) | (0.188) | (0.184) | (0.042) | (0.039) | (0.352) | (0.342) |
| Observations | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: See Appendix A2, for the full set of results

*Table 6: Calculated Impact of CA and Gender of Household head on Crop Diversification and HDDS*

| | Crop Diversification | HDDS |
|---|---|---|
| **CA** | 0.275 | 1.162 |
| **Gender** | 0.021 | 0.249 |
| **Gender CA** | -0.252 | -1.219 |
| **Female Headed Impact** | 0.044 | 0.192 |
| **Male Headed Impact** | 0.275 | 1.162 |

*Table 7: Impact of CA and Gender of Decision Marker on Household Income, Crop Income, Crop Diversification and HDDS*

| **Variables** | CA adoption (=1) | | Female Decision Marker (=1) | | Female Decision Maker* CA Adoption |
|---|---|---|---|---|---|
| **Household Income** | -0.281 | (0.172) | -0.091*** | (0.025) | 0.221 |
| **Household Income** | -0.270 | (0.172) | | | |
| **Crop Income** | 0.198 | (0.184) | -0.119*** | (0.026) | -0.200 |
| **Crop Income** | 0.204 | (0.183) | | | |
| **Crop Divers-ification** | 0.275*** | (0.038) | 0.021*** | (0.006) | -0.252*** |
| **Crop Divers-ification** | 0.284*** | (0.038) | | | |
| **HDDS** | 1.162*** | (0.369) | 0.249*** | (0.053) | -1.219*** |
| **HDDS** | 1.122*** | (0.368) | | | |

| | FMHH*CA Adoption | | FFHH* CA Adoption | | MFHH | | FMHH | | FFHH | | Variables |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | (0.178) | **Household Income** |
| (0.196) | 0.163 | (0.182) | 0.227 | (0.120) | 0.141 | (0.035) | 0.118*** | (0.028) | -0.195*** | | **Household Income** |
| | | | | | | | | | | (0.190) | **Crop Income** |
| (0.209) | -0.270 | (0.194) | -0.181 | (0.127) | 0.129 | (0.037) | 0.064* | (0.029) | -0.211*** | | **Crop Income** |
| | | | | | | | | | | (0.039) | **Crop Divers-ification** |
| (0.044) | -0.236*** | (0.040) | -0.272*** | (0.028) | 0.019 | (0.008) | 0.025*** | (0.006) | 0.020*** | | **Crop Divers-ification** |
| | | | | | | | | | | (0.381) | **HDDS** |
| (0.421) | -0.478 | (0.390) | -1.498*** | (0.257) | 0.014 | (0.076) | 0.346*** | (0.059) | 0.191*** | | **HDDS** |

| **Variables** | **Household Income** | **Household Income** | **Crop Income** | **Crop Income** | **Crop Divers-ification** | **Crop Divers-ification** | **HDDS** | **HDDS** |
|---|---|---|---|---|---|---|---|---|
| MFHH*CA Adoption | | -0.340 | | -0.530 | | -0.272*** | | -0.091 |
| | | (0.314) | | (0.335) | | (0.072) | | (0.676) |
| Constant | 5.401*** | 5.473*** | 5.580*** | 5.643*** | 0.605*** | 0.603*** | 1.624*** | 1.675*** |
| | (0.096) | (0.096) | (0.102) | (0.102) | (0.022) | (0.022) | (0.205) | (0.206) |

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: See Appendix A3, for the full set of results

*Table 8: Calculated Impact of CA and Gender of Decision Marker on Crop Diversification and HDDS*

| | CA | FFHH | FMHH | MFHH | FFHH | FMHH | MFHH | IMPACT | |
|---|---|---|---|---|---|---|---|---|---|
| Crop Divers-ification | 0.284 | 0.02 | | | -0.272 | | | 0.032 | FFHH |
| | 0.284 | | 0.025 | | | -0.236 | | 0.073 | FMHH |
| | 0.284 | | | | | | -0.272 | 0.012 | MFHH |
| | | | | | | | | 0.284 | MMHH |
| HDDS | 1.122 | 0.191 | | | -1.498 | | | -0.185 | FFHH |
| | 1.122 | | 0.346 | | | | | 1.468 | FMHH |
| | 1.122 | | | | | | | 1.122 | MFHH |
| | 1.122 | | | | | | | 1.122 | MMHH |

*Do resource endowments matter?*

Table 9 shows the impact of CA, productive assets, and gender of decision marker on the selected livelihood outcomes. The productive assets are examined based on terciles. The results show that for household income, crop diversification, and HDDs, the impact of Female decision makers adopting CA, in the higher assets group, the impact is higher compared to the lower productive assets group.

*Table 9: Impact of CA, Productive assets and Gender of Decision Marker on Household Income, Crop Income, Crop Diversification, and HDDS*

| Variables | Household Income | Crop Income | Crop Diversification | HDDS |
|---|---|---|---|---|
| CA Adoption | -0.396** | 0.124 | 0.270*** | 1.471*** |
| | (0.161) | (0.178) | (0.037) | (0.361) |
| Female Decision maker | -0.063*** | -0.107*** | 0.013*** | 0.262*** |
| | (0.021) | (0.023) | (0.005) | (0.048) |
| Productive assets (=1) | -0.437*** | -0.316*** | 0.009* | -0.453*** |
| | (0.021) | (0.023) | (0.005) | (0.047) |
| Productive assets (=3) | 0.498*** | 0.323*** | -0.045*** | 0.351*** |
| | (0.021) | (0.023) | (0.005) | (0.048) |
| FDM*CA*PA1 | 0.125 | -0.243 | -0.244*** | -1.917*** |
| | (0.178) | (0.197) | (0.041) | (0.400) |
| FDM*CA*PA3 | 0.437** | -0.080 | -0.224*** | -0.914** |
| | (0.177) | (0.195) | (0.041) | (0.398) |
| Constant | 7.102*** | 6.746*** | 0.517*** | 3.094*** |
| | (0.103) | (0.113) | (0.025) | (0.233) |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Note: See Appendix A4, for the full set of results

**Conclusion and Recommendations**

Sub-Saharan Africa's (SSA) agricultural production is threatened by climate variability and change as seen by the increase in variable temperatures, changes in precipitation patterns and increased occurrences of extreme events such as droughts and floods. Hence for sustained food production and productivity, new innovative technologies which are resilient to climatic variability have been promoted along the years, especially among smallholder farmers who form the bulk of farmers and are the most vulnerable. Conservation Agriculture (CA) which consists of a package of farming practices based on three main principles, namely: minimum mechanical soil disturbance; permanent organic soil cover; and crop rotation is one such technology. It has been promoted in SSA and Zambia in particular since the 1990s with relatively low adoption rates despite the benefits. This has been due mainly to a number of issues including the constraints to access to productive resources by farmers more so for female farmers than male farmers. In particular female farmers have limited access/ ownership to land, credit, and other reproductive assets such as implements.

This then hinders adoption of new technologies by female farmers, as their limited resource endowments have an impact on their adoption capability which in turn reduces the impact that these technologies have on their livelihood. Even with this being the case, little attention has been paid towards understanding the gender dynamics in CA uptake, for instance how CA adoption among female farmers, within male headed households and as household heads themselves impacts on their livelihoods. These dynamics are important as CA interventions are not gender-neutral and as such have different impacts on the adopter based on the gender and the household dynamics.

Using nationally-representative data and insights from FGDs, the study therefore examined the impact of CA and gender on different livelihood outcomes (crop income, household income, crop diversification, and household dietary diversity). The results showed that at household level there are no differences between male and female household heads in terms of the impact of CA on crop income and household income. This holds even when the CA impact is examined by the gender of the decision maker and the household dynamics. For crop diversification and household dietary diversity, the results showed that MMHH and FMHH adopting CA had the highest impact respectively. While farmers under female headed households tended to have lower CA impacts on both crop diversification and HDDS. We also found that female decision makers in households with more productive assets tended to have better CA impacts than females decision makers in households with less productive assets, implying the importance of resource endowments. Based on these results, we recommend that CA promotions and programming should take into account the gender of the farmers as well as the dynamics within different households. As the impact of CA on certain livelihood outcomes reduces among female farmers, stemming from the differences in resource accessibility among male and female farmers.

## Endnotes

1 The set of food groups is derived from the U.N. FAO (Food and Agricultural Organization). Food Composition Table for Africa. Rome, Italy, 1970. As viewed at www.fao.org/docrep/003/X6877E/X6877E00.htm.

2 Although randomisation does not necessarily get rid of selection bias, it balances the bias between the treatment and comparison groups (Barker 2000).

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## Appendix

*Table A1: Table of Food Groups Used to Compute the Household Dietary Diversity Score*

| | | |
|---|---|---|
| A. Cereals | E. Meat, poultry, offal | I. Milk and milk products |
| B. Root and tubers | F. Eggs | J. Oil/fats |
| C. Vegetables | G. Fish and seafood | K. Sugar/honey |
| D. Fruits | H. Pulses/legumes/nuts | L. Miscellaneous |
| **HDDS** = A+B+C+D+E+F+G+H+I+K+J+K+L (ranges between 0 and 12) | | |

*Table A2: Impact of CA and Gender of Household head on Household Income, Crop income, Crop Diversification, and HDDS*

| Variables | Household Income | Household Income | Crop Income | Crop Income | Crop Divers-ification | Crop Divers-ification | HDDS | HDDS |
|---|---|---|---|---|---|---|---|---|
| CA adoption (=1) | -0.481 | -0.198 | 0.719* | 0.403 | 0.395*** | 0.256*** | 2.134*** | 1.632** |
| | (0.386) | (0.341) | (0.428) | (0.378) | (0.082) | (0.078) | (0.732) | (0.689) |
| Gender of the HH head (1=female) | -0.182*** | -0.193*** | -0.227*** | -0.201*** | -0.001 | 0.016 | 0.063 | 0.217** |
| | (0.040) | (0.047) | (0.044) | (0.052) | (0.010) | (0.011) | (0.082) | (0.097) |
| CA adoption * Female HH head | | 0.122 | | -0.327 | | -0.223*** | | -1.969*** |
| | | (0.356) | | (0.394) | | (0.082) | | (0.720) |
| Age of HH head (years) | -0.004*** | -0.004*** | -0.003** | -0.002** | -0.000 | 0.000 | -0.006*** | -0.005** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.000) | (0.000) | (0.002) | (0.002) |
| Level of education HH head (years) | 0.063*** | 0.062*** | 0.010** | 0.011** | -0.005*** | -0.004*** | 0.089*** | 0.090*** |

| Land-holding Size (Ha) | | Hired Labour (=1) | | Household head/ spouse has kinship ties (=1) | | Adult equiva-lents | | HH with chronically ill adults (=1) | | **Variables** |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.053*** | (0.031) | 0.427*** | (0.032) | -0.120*** | (0.007) | 0.070*** | (0.065) | -0.123* | (0.005) | **Household Income** |
| 0.053*** | (0.031) | 0.423*** | (0.031) | -0.124*** | (0.007) | 0.070*** | (0.065) | -0.119* | (0.005) | **Household Income** |
| 0.121*** | (0.035) | 0.435*** | (0.035) | -0.006 | (0.008) | 0.054*** | (0.072) | -0.184** | (0.005) | **Crop Income** |
| 0.120*** | (0.034) | 0.439*** | (0.034) | 0.000 | (0.008) | 0.054*** | (0.072) | -0.189*** | (0.005) | **Crop Income** |
| 0.006*** | (0.008) | -0.001 | (0.008) | 0.038*** | (0.002) | 0.001 | (0.016) | -0.020 | (0.001) | **Crop Divers-ification** |
| 0.006*** | (0.007) | 0.001 | (0.007) | 0.041*** | (0.002) | 0.001 | (0.015) | -0.022 | (0.001) | **Crop Divers-ification** |
| 0.045*** | (0.065) | 0.415*** | (0.066) | -0.109* | (0.015) | 0.047*** | (0.136) | 0.148 | (0.010) | **HDDS** |
| 0.043*** | (0.064) | 0.419*** | (0.064) | -0.085 | (0.014) | 0.047*** | (0.133) | 0.133 | (0.009) | **HDDS** |

| Membership in a farmer organisation (=1) | | Access to credit (=1) | | Ownership of Radio/ TV (=1)* | | Ownership of cell phone (=1)* | | Log of Productive assets (ZMK)* | | **Variables** |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.102*** | (0.039) | 0.162*** | (0.036) | 0.151*** | (0.036) | 0.295*** | (0.011) | 0.141*** | (0.006) | **Household Income** |
| 0.093*** | (0.036) | 0.149*** | (0.036) | 0.147*** | (0.035) | 0.288*** | (0.010) | 0.144*** | (0.006) | **Household Income** |
| 0.258*** | (0.043) | 0.404*** | (0.040) | 0.115*** | (0.040) | 0.062 | (0.012) | 0.086*** | (0.007) | **Crop Income** |
| 0.270*** | (0.040) | 0.421*** | (0.039) | 0.120*** | (0.039) | 0.072* | (0.011) | 0.084*** | (0.007) | **Crop Income** |
| 0.012 | (0.009) | 0.150*** | (0.009) | 0.026*** | (0.009) | -0.025*** | (0.003) | -0.011*** | (0.002) | **Crop Divers-ification** |
| 0.018** | (0.009) | 0.158*** | (0.008) | 0.029*** | (0.008) | -0.020** | (0.002) | -0.012*** | (0.002) | **Crop Divers-ification** |
| 0.113 | (0.079) | 0.020 | (0.075) | 0.126* | (0.075) | 0.243*** | (0.022) | 0.154*** | (0.013) | **HDDS** |
| 0.144** | (0.074) | 0.065 | (0.073) | 0.140* | (0.072) | 0.271*** | (0.021) | 0.148*** | (0.013) | **HDDS** |

| **Variables** | **Household Income** | **Household Income** | **Crop Income** | **Crop Income** | **Crop Divers-ification** | **Crop Divers-ification** | **HDDS** | **HDDS** |
|---|---|---|---|---|---|---|---|---|
| | (0.035) | (0.033) | (0.039) | (0.037) | (0.009) | (0.008) | (0.072) | (0.069) |
| Off-farm participation (=1)* | 0.572*** | 0.572*** | -0.185*** | -0.186*** | -0.023*** | -0.024*** | 0.318*** | 0.306*** |
| | (0.034) | (0.034) | (0.038) | (0.038) | (0.009) | (0.008) | (0.072) | (0.070) |
| Witchcraft not hard work can make you successful | 0.008 | 0.009 | 0.008 | 0.006 | 0.002 | 0.001 | 0.034 | 0.030 |
| | (0.011) | (0.011) | (0.012) | (0.012) | (0.003) | (0.003) | (0.023) | (0.023) |
| Prayer not hard work can make you successful | -0.022** | -0.021** | -0.025** | -0.027** | -0.002 | -0.003 | -0.008 | -0.013 |
| | (0.011) | (0.010) | (0.012) | (0.012) | (0.003) | (0.002) | (0.022) | (0.021) |
| Distance to the nearest Boma (Km) | 0.002*** | 0.002*** | 0.005*** | 0.004*** | -0.000 | -0.000 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.000) | (0.000) | (0.001) | (0.001) |

| **Variables** | **Household Income** | **Household Income** | **Crop Income** | **Crop Income** | **Crop Divers-ification** | **Crop Divers-ification** | **HDDS** | **HDDS** |
|---|---|---|---|---|---|---|---|---|
| AEZ IIa (=1) | 0.092** | 0.087* | 0.534*** | 0.539*** | 0.016 | 0.018* | 0.695*** | 0.701*** |
| | (0.045) | (0.045) | (0.050) | (0.049) | (0.011) | (0.010) | (0.094) | (0.091) |
| AEZ IIb (=1) | 0.245*** | 0.249*** | 0.521*** | 0.515*** | 0.088*** | 0.085*** | -0.831*** | -0.846*** |
| | (0.064) | (0.063) | (0.070) | (0.069) | (0.016) | (0.015) | (0.132) | (0.129) |
| Constant | 5.364*** | 5.332*** | 5.362*** | 5.399*** | 0.468*** | 0.485*** | 1.741*** | 1.808*** |
| | (0.170) | (0.167) | (0.188) | (0.184) | (0.042) | (0.039) | (0.352) | (0.342) |
| Observations | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 | 3,872 |

*Table A3: Impact of CA and Gender of Decision Maker on Household Income, Crop Income, Crop Diversification, and HDDS*

| Variables | Household Income | Household Income | Crop Income | Crop Income | Crop Divers-ification | Crop Divers-ification | HDDS | HDDS |
|---|---|---|---|---|---|---|---|---|
| CA adoption (=1) | -0.281 | -0.270 | 0.198 | 0.204 | 0.275*** | 0.284*** | 1.162*** | 1.122*** |
| | (0.172) | (0.172) | (0.184) | (0.183) | (0.038) | (0.038) | (0.369) | (0.368) |
| Female Decision Maker (=1) | -0.091*** | | -0.119*** | | 0.021*** | | 0.249*** | |
| | (0.025) | | (0.026) | | (0.006) | | (0.053) | |
| Female Decision Maker* CA adoption | 0.221 | | -0.200 | | -0.252*** | | -1.219*** | |
| | (0.178) | | (0.190) | | (0.039) | | (0.381) | |
| FFHH | | -0.195*** | | -0.211*** | | 0.020*** | | 0.191*** |
| | | (0.028) | | (0.029) | | (0.006) | | (0.059) |
| FMHH | | 0.118*** | | 0.064* | | 0.025*** | | 0.346*** |

| | Age (years) | | MFHH* CA Adoption | | FMHH* CA Adoption | | FFHH* CA Adoption | | MFHH | | **Variables** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (0.001) | -0.005*** | | | | | | | | | | **Household Income** |
| (0.001) | -0.005*** | (0.314) | -0.340 | (0.196) | 0.163 | (0.182) | 0.227 | (0.120) | 0.141 | (0.035) | **Household Income** |
| (0.001) | -0.003*** | | | | | | | | | | **Crop Income** |
| (0.001) | -0.003*** | (0.335) | -0.530 | (0.209) | -0.270 | (0.194) | -0.181 | (0.127) | 0.129 | (0.037) | **Crop Income** |
| (0.000) | 0.000* | | | | | | | | | | **Crop Divers-ification** |
| (0.000) | 0.000** | (0.072) | -0.272*** | (0.044) | -0.236*** | (0.040) | -0.272*** | (0.028) | 0.019 | (0.008) | **Crop Divers-ification** |
| (0.001) | -0.003** | | | | | | | | | | **HDDS** |
| (0.001) | -0.003** | (0.676) | -0.091 | (0.421) | -0.478 | (0.390) | -1.498*** | (0.257) | 0.014 | (0.076) | **HDDS** |

| Hired Labour (=1) | | Household head/ spouse has kinship ties (=1) | | Adult equivalents | | HH with chronically ill adults | | Education level (years) | **Variables** |
|---|---|---|---|---|---|---|---|---|---|
| 0.408*** | (0.017) | -0.122*** | (0.004) | 0.069*** | (0.037) | -0.068* | (0.003) | 0.058*** | **Household Income** |
| 0.410*** | (0.017) | -0.126*** | (0.004) | 0.065*** | (0.037) | -0.089** | (0.003) | 0.056*** | **Household Income** |
| 0.404*** | (0.018) | -0.028 | (0.004) | 0.054*** | (0.039) | -0.092** | (0.003) | 0.016*** | **Crop Income** |
| 0.406*** | (0.018) | -0.031* | (0.004) | 0.050*** | (0.039) | -0.111*** | (0.003) | 0.015*** | **Crop Income** |
| 0.001 | (0.004) | 0.027*** | (0.001) | -0.000 | (0.008) | -0.004 | (0.001) | -0.003*** | **Crop Divers-ification** |
| 0.000 | (0.004) | 0.027*** | (0.001) | -0.001 | (0.008) | -0.005 | (0.001) | -0.003*** | **Crop Divers-ification** |
| 0.434*** | (0.037) | -0.114*** | (0.008) | 0.040*** | (0.079) | 0.056 | (0.006) | 0.091*** | **HDDS** |
| 0.434*** | (0.037) | -0.113*** | (0.008) | 0.037*** | (0.079) | 0.040 | (0.006) | 0.089*** | **HDDS** |

| | Ownership of Radio/ TV (=1)* | | Ownership of cell phone (=1)* | | Log of Productive assets (ZMK)* | | Landholding Size (Ha) | | **Variables** |
|---|---|---|---|---|---|---|---|---|---|
| (0.020) | 0.157*** | (0.019) | 0.267*** | (0.006) | 0.149*** | (0.003) | 0.055*** | (0.017) | **Household Income** |
| (0.020) | 0.143*** | (0.019) | 0.266*** | (0.006) | 0.146*** | (0.003) | 0.054*** | (0.017) | **Household Income** |
| (0.021) | 0.146*** | (0.021) | 0.086*** | (0.006) | 0.089*** | (0.004) | 0.107*** | (0.018) | **Crop Income** |
| (0.021) | 0.133*** | (0.021) | 0.086*** | (0.006) | 0.087*** | (0.004) | 0.107*** | (0.018) | **Crop Income** |
| (0.005) | 0.024*** | (0.004) | -0.025*** | (0.001) | -0.014*** | (0.001) | 0.003*** | (0.004) | **Crop Divers-ification** |
| (0.005) | 0.024*** | (0.004) | -0.025*** | (0.001) | -0.014*** | (0.001) | 0.003*** | (0.004) | **Crop Divers-ification** |
| (0.043) | 0.147*** | (0.042) | 0.243*** | (0.013) | 0.152*** | (0.007) | 0.050*** | (0.037) | **HDDS** |
| (0.043) | 0.135*** | (0.042) | 0.244*** | (0.013) | 0.150*** | (0.007) | 0.050*** | (0.037) | **HDDS** |

| **Variables** | **Household Income** | **Household Income** | **Crop Income** | **Crop Income** | **Crop Divers-ification** | **Crop Divers-ification** | **HDDS** | **HDDS** |
|---|---|---|---|---|---|---|---|---|
| Access to credit (=1) | 0.130*** | 0.129*** | 0.354*** | 0.353*** | 0.130*** | 0.130*** | 0.138*** | 0.139*** |
| | (0.019) | (0.019) | (0.020) | (0.020) | (0.004) | (0.004) | (0.041) | (0.041) |
| Membership in a farmer organisation (=1) | 0.090*** | 0.091*** | 0.233*** | 0.234*** | 0.004 | 0.004 | 0.148*** | 0.150*** |
| | (0.019) | (0.019) | (0.020) | (0.020) | (0.004) | (0.004) | (0.040) | (0.040) |
| Off-farm participation (=1)* | 0.520*** | 0.522*** | -0.139*** | -0.137*** | -0.013*** | -0.013*** | 0.275*** | 0.274*** |
| | (0.019) | (0.019) | (0.020) | (0.020) | (0.004) | (0.004) | (0.040) | (0.040) |
| Witchcraft not hard work can make you successful | 0.009 | 0.009 | 0.005 | 0.005 | 0.002 | 0.002* | 0.052*** | 0.052*** |
| | (0.006) | (0.006) | (0.007) | (0.007) | (0.001) | (0.001) | (0.013) | (0.013) |

| **Variables** | Prayer not hard work can make you successful | | Distance to the nearest Boma (Km) | | AEZ IIa (=1) | | AEZ IIb (=1) | | Constant |
|---|---|---|---|---|---|---|---|---|---|
| **Household Income** | -0.012** | (0.006) | 0.002*** | (0.000) | 0.065** | (0.025) | 0.326*** | (0.036) | 5.401*** |
| **Household Income** | -0.013** | (0.006) | 0.002*** | (0.000) | 0.073*** | (0.025) | 0.330*** | (0.036) | 5.473*** |
| **Crop Income** | -0.025*** | (0.006) | 0.004*** | (0.000) | 0.484*** | (0.027) | 0.589*** | (0.038) | 5.580*** |
| **Crop Income** | -0.026*** | (0.006) | 0.004*** | (0.000) | 0.491*** | (0.027) | 0.594*** | (0.038) | 5.643*** |
| **Crop Divers-ification** | -0.002* | (0.001) | -0.000*** | (0.000) | 0.004 | (0.006) | 0.075*** | (0.008) | 0.605*** |
| **Crop Divers-ification** | -0.002* | (0.001) | -0.000*** | (0.000) | 0.004 | (0.006) | 0.075*** | (0.008) | 0.603*** |
| **HDDS** | 0.005 | (0.012) | -0.002** | (0.001) | 0.719*** | (0.055) | -0.798*** | (0.077) | 1.624*** |
| **HDDS** | 0.003 | (0.012) | -0.002*** | (0.001) | 0.723*** | (0.054) | -0.803*** | (0.077) | 1.675*** |

| Variables | Household Income | Household Income | Crop Income | Crop Income | Crop Divers-ification | Crop Divers-ification | HDDS | HDDS |
|---|---|---|---|---|---|---|---|---|
| | (0.096) | (0.096) | (0.102) | (0.102) | (0.022) | (0.022) | (0.205) | (0.206) |
| Observations | 11,216 | 11,216 | 11,216 | 11,216 | 11,216 | 11,216 | 11,216 | 11,216 |

*Table A4: Impact of CA, Productive assets, and Gender of Decision Maker on Household Income, Crop Income, Crop Diversification, and HDDS*

| LABELS | Household Income | Crop Income | Crop Divers-ification | HDDS |
|---|---|---|---|---|
| CA Adoption | -0.406** | 0.145 | 0.277*** | 1.409*** |
| | (0.162) | (0.180) | (0.037) | (0.364) |
| Female Decision maker | -0.060*** | -0.111*** | 0.014*** | 0.281*** |
| | (0.021) | (0.023) | (0.005) | (0.047) |
| Productive assets (=1) | -0.440*** | -0.316*** | 0.009* | -0.458*** |
| | (0.021) | (0.023) | (0.005) | (0.047) |
| Productive assets (=3) | 0.498*** | 0.324*** | -0.045*** | 0.346*** |
| | (0.021) | (0.023) | (0.005) | (0.048) |
| FDM*CA*PA1 | 0.146 | -0.257 | -0.251*** | -1.842*** |
| | (0.179) | (0.198) | (0.042) | (0.403) |
| FDM*CA*PA3 | 0.426** | -0.104 | -0.229*** | -0.888** |
| | (0.178) | (0.196) | (0.041) | (0.400) |
| Age (years) | -0.007*** | -0.005*** | 0.000** | -0.005*** |
| | (0.001) | (0.001) | (0.000) | (0.001) |
| Education level (years) | 0.051*** | 0.012*** | -0.002*** | 0.085*** |
| | (0.002) | (0.003) | (0.001) | (0.005) |
| HH with chronically ill adults | -0.048 | -0.076** | -0.004 | 0.087 |
| | (0.035) | (0.038) | (0.008) | (0.078) |
| Adult equivalents | 0.053*** | 0.042*** | 0.000 | 0.027*** |
| | (0.004) | (0.004) | (0.001) | (0.008) |
| Household head/spouse has kinship ties (=1) | -0.088*** | -0.009 | 0.025*** | -0.082** |
| | (0.016) | (0.018) | (0.004) | (0.037) |
| Hired Labour (=1) | 0.344*** | 0.360*** | 0.004 | 0.363*** |
| | (0.017) | (0.018) | (0.004) | (0.037) |
| Landholding Size (Ha) | 0.041*** | 0.098*** | 0.004*** | 0.041*** |
| | (0.003) | (0.004) | (0.001) | (0.007) |
| Log of Productive assets (ZMK)* | 0.053*** | 0.026*** | -0.009*** | 0.069*** |
| | (0.006) | (0.007) | (0.002) | (0.014) |

| LABELS | Household Income | Crop Income | Crop Divers-ification | HDDS |
|---|---|---|---|---|
| Ownership of cell phone (=1)* | 0.198*** | 0.037* | -0.023*** | 0.166*** |
| | (0.019) | (0.020) | (0.004) | (0.042) |
| Ownership of Radio/TV (=1)* | 0.161*** | 0.144*** | 0.022*** | 0.137*** |
| | (0.019) | (0.021) | (0.005) | (0.043) |
| Access to credit (=1) | 0.148*** | 0.361*** | 0.127*** | 0.132*** |
| | (0.018) | (0.020) | (0.004) | (0.041) |
| Membership in a farmer organisation (=1) | 0.064*** | 0.211*** | 0.004 | 0.106*** |
| | (0.018) | (0.020) | (0.004) | (0.040) |
| Off-farm participation (=1)* | 0.531*** | -0.130*** | -0.013*** | 0.287*** |
| | (0.018) | (0.019) | (0.004) | (0.040) |
| Witchcraft not hard work can make you successful | 0.012** | 0.007 | 0.002 | 0.058*** |
| | (0.006) | (0.006) | (0.001) | (0.013) |
| Prayer not hard work can make you successful | -0.009 | -0.022*** | -0.002* | 0.008 |
| | (0.005) | (0.006) | (0.001) | (0.012) |
| Distance to the nearest Boma (Km) | 0.002*** | 0.004*** | -0.000*** | -0.002** |
| | (0.000) | (0.000) | (0.000) | (0.001) |
| AEZ IIa (=1) | 0.089*** | 0.506*** | 0.004 | 0.741*** |
| | (0.024) | (0.026) | (0.006) | (0.054) |
| AEZ IIb (=1) | 0.424*** | 0.664*** | 0.071*** | -0.702*** |
| | (0.034) | (0.037) | (0.008) | (0.077) |
| Constant | 7.159*** | 6.780*** | 0.515*** | 3.148*** |
| | (0.103) | (0.113) | (0.025) | (0.233) |
| Observations | 11,216 | 11,216 | 11,216 | 11,216 |

# Book Reviews

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*Agriculture in Zambia: Past, Present, and Future*
by Antony Chapoto and Nicholas J. Sitko eds, 2015, 165 pp.
ISBN 978-0-692-59279-3

Despite having over 750,000 km2 of land, massive endowments in surface and sub-surface water resources, including the largest reservoir by volume in the world, and a population density of less than 20 people per square kilometre, Zambia's agriculture sector has not yet reached its full potential. The book "Agriculture in Zambia: Past, Present, and Future" aims to inform policymakers and stakeholders about the effects of current agricultural policies and the alternatives available to them – a critical step towards transforming Zambia's agricultural potential into reality.

Chapter 1 clearly outlines the current performance of Zambia's Agricultural sector and how it has been affected by the different Zambian political regimes since the country gained independence in 1964 (the authors delineate these political regimes by classifying them into four "republics"). The writers conclude that political decisions from the "first republic" to the "fourth republic" have largely been biased towards supporting maize production. All successive republics have treated maize as a political crop which has continued to shape agricultural policy in Zambia.

Chapter 2 focuses on two issues; the land ownership patterns in rural Zambia and smallholder maize production and market participation. The authors surmise that most smallholder farmers tend to have insufficient access to land despite its availability and that improving such access for the most land-constrained smallholder households might be an effective way to reduce poverty. Furthermore, it is noted that the heterogeneity with respect to smallholders' position in maize markets is driven in part by inequitable land access, inadequate access to productive assets, and large variation in crop productivity across households and regions. As with Chapter 1, this Chapter also alludes to the concern of Zambia's agricultural growth heavily relying on subsidy programmes such as the Farmer Input Support Programme (FISP) and the output price support through the Food Reserve Agency (FRA). The writers conclude that these programmes have been a huge drain to the treasury and have not been effective at addressing high rural poverty rates and low crop productivity.

Chapter 3 discusses the performance of the Zambian agricultural sector in the past decade. The writers continue to demonstrate the perils of an agricultural development strategy that is myopically focused on maize production and marketing in the context of predominately rain-fed agriculture. With the FISP and FRA programmes accounting for 30-60% of the total budget between 2003 and 2014, the returns on these investments have been low and rural poverty levels remain high. The writers review the performance of other agricultural commodities such as wheat, soya beans, rice, mixed beans, groundnuts, cotton, livestock, and fisheries and how these sectors have been weakened by under-investments due to a policy focus on maize.

Chapter 4 looks at the political economy of the maize sector and the key policy levers and actors who have the potential to change the maize-centric policies. The writers indicate that apart from President Chiluba's government that tried to reform the maize sector, all other governments have followed in the footsteps of the colonial government which promoted the production of maize through heavy subsidies to the farmers (as of 2014/2015 farming season). However, it is noted that the Minister of Agriculture, Minister of Finance and the president hold the keys for change in the maize sector. This change can only be achieved if politically motivated policy pronouncements and large unbudgeted expenditures can be avoided.

Chapter 5 focuses on the maize yield gap in Zambia. Yield gap is defined as the difference between the average farmers' actual yields and the potential yield for a specific area per given time. The chapter addresses two questions. What explains the difference in yields within the Zambian smallholder sector? What can be done to raise yields broadly among smallholders? It is clear that to answer these questions, policymakers and other stakeholders have to address three major factors: closing the social-economic, technology, and institutional gaps, for instance by improving the targeting of FISP beneficiaries as well as having workable policies that support private-public partnership; develop technologies that are tailored to the needs of the smallholder farmers, such as use of location-specific seed varieties; and, enhance the rate of adoption of improved technologies such as use of hybrid seed and use of fertilisers among smallholder farmers.

Chapter 6 looks at agricultural diversification and what is really holding Zambia back with respect to agricultural development. The writers give reference to Chapter 4 and allude to the difficulty in promoting agricultural diversification due to the politics involved in the maize sector in Zambia. It is very helpful that alternative value chains to maize are analysed such as horticulture, soya beans, groundnuts, livestock, and fisheries. These value chains have a significant domestic market opportunity which is driven by urban income growth in Zambia.

Chapter 7 analyses the effects of climate change on agriculture in Zambia. The authors outline the potential adaptation options for smallholder farmers such as use of conservation farming technologies, planting heat-tolerant seed varieties, agricultural investments, and policies and strategies to reduce risk for these farmers. This chapter also shows the potential of the forestry sector to mitigate climate change through prudent management of Zambia's forest resources, given its vast forest cover.

In conclusion, the empirical approach used in the book is couched in a tone that speaks clearly to policymakers and stakeholders in the agricultural industry. With a chronological outline of where the current problems facing the Zambian agricultural sector started from, it proves to be a good base in understanding the dynamics of Agriculture in Zambia. I definitely agree that the expectation by policymakers that doing the same things repeatedly will lead to a different outcome is the main enemy for Zambia to achieve sustainable, broad-based, pro-poor agricultural growth. All in all, it is a well written book.

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*Forced to leave: Commercial farming and displacement in Zambia*.
By Human Rights Watch (Human Rights Watch, 2017) 100 pp. ISBN: 978-1-6231-35324

'Forced to leave' is a report based on a field study conducted by the Human Rights Watch (HRW) from 2016 to 2017 in Zambia. It outlines crucial and fundamental issues with regards to human rights in one of Zambia's agricultural districts, Serenje. The report begins with addressing the underlying factors that concern the protection of rights of vulnerable people and the perceived role that government has played in diminishing the said rights. The authors express concern with how commercial agriculture is being introduced and regulated in Serenje at the expense of rural households and how this new wave of large-scale land acquisitions is pushing these households further into the quicksand of poverty. Further, the report discusses the displacement of rural residents from their homes and farmland primarily because of commercial farming ventures being undertaken on the same land. This has been done with very little or no compensation to affected rural farmers.

The chapters of the book are presented in a sequential order, the first chapter giving a background of how agriculture remains the footstool of Zambia's economy. It gives insight into the importance of agriculture and by extension, commercial farming, and the positive impacts it would also have on the livelihoods of rural residents. This chapter nicely crafts the intentions and promises of government to develop basic infrastructure in rural areas and use agriculture as a means to reduce rural poverty, among other positive outcomes. The authors also zoom in on the high poverty rates in Zambia and argue that agriculture is meant to be a stepping stone, rather than cause a further injustice. Additionally, the authors describe the availability of rural land in Zambia, and how much of it is deemed vacant when in actual fact, some of this land is occupied by rural settlers.

Chapter Two gives a realistic picture of the commercial farming ventures in Serenje district by delving into six case studies of commercial farms. The authors are clearly impelled to link the Zambian government's initiative of developing farm blocks to the incorrect and poorly handled land conversion system in Serenje. While it appears to be clear that governing bodies and related agencies are to blame for the poorly handled situation and in some cases, misguidance of the commercial investors, the authors do not unequivocally lay blame on them. In the third chapter of the book, the authors engage in specific cases of evictions and resettlements and argue that despite the positive initiative of commercial farmers—mostly foreign farm owners—to bring about positive change or development, they are in fact bringing more physical and psychological harm to local residents. Unsurprisingly, in most cases these commercial farmers have legally exculpated themselves of such acts.

The authors then move on to depict the negative impacts and risks of displacement and resettlement of local residents. The importance of this is also assessed from a gender perspective and how this is expected to drive things on a trajectory of devastation. Aspects related to food, water, health, and education insecurity are tackled and the gravity of the effects is felt through the excerpts of interviews quoted in the chapter. The inability of residents to access remedies or redress is well captured in this fourth chapter.

In Chapters Five and Six, the authors continue to develop their argument on how the Zambian government and responsible agencies have failed to regulate land transfers, hold consultations with affected parties, and facilitate resettlement and compensation of affected parties. The authors' argument is anchored in the recognised international human rights provisions and is focused on how these rights are not being upheld. The link between how governing bodies are doing a disservice to the very people they should protect and how international standards for human rights have been set up for guidance to governing bodies is nicely depicted in these chapters. The authors are clear enough to make a case for the local residents not only against the governing bodies but against the commercial farmers, too, who also have a responsibility to uphold human rights.

In the last chapter, the authors outline a series of recommendations in formal language, to the parties assumed to be responsible for the injustices observed; the parties being the Zambian government, commercial farmers, the international and regional financial institutions, and bilateral and multilateral donors.

The recommendations are presented in a meticulous fashion outlining what the "experts" should be able to do to ameliorate the living standards of the local residents. They recommend that the National Resettlement Policy and Compensation guidelines should be implemented to ensure displaced people have access to basic necessities such as housing, food, water, education, health services, and legal services. Compensation remedies should account for assets, interests, and equal participation of women affected by forced evictions. Additionally, ongoing monitoring of commercial farms should be done with all information released to the public domain in accessible format and language. It is worth noting that none of the recommendations offered in the report have been made to local residents and their headmen.

In summary, the report's recommendations are the most important contribution because an escape plan lies within reachable distance to circumvent the injustices suffered by the target communities.