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Mofya-Mukuka and Jairos Sambo are Senior Research Fellow and Intern respectively at Indaba Agricultural Policy Research Institute, Lusaka, Zambia, and Kuhlgatz is Market Analyst, Federal Office for Agriculture, Bern, Switzerland.

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Comments and questions should be directed to:

The Executive Director
Indaba Agricultural Policy Research Institute
26A Middleway
Kabulonga
Lusaka
Telephone: +260 211 261194
Telefax: +260 211 261199
Email: info@iapri.org.zm

INDABA AGRICULTURAL POLICY RESEARCH INSTITUTE
TEAM MEMBERS

The Zambia-based IAPRI research team comprises of Antony Chapoto, Brian Chisanga, Munguzwe Hichaambwa, Chance Kabaghe, Mulako Kabisa, Stephen Kabwe, Auckland Kuteya, Henry Machina, Rhoda Mofya-Mukuka, Olipa Zulu-Mbata, Thelma Namonje-Kapembwa, Hambulo Ngoma, Paul Samboko, Mitelo Subakanya, and Ballard Zulu. Michigan State University-based researchers associated with IAPRI are Eric Crawford, Steven Haggblade, Thomas S. Jayne, Nicole Mason, Melinda Smale, and David Tschirley.

EXECUTIVE SUMMARY

Food insecurity and malnutrition in rural parts of Zambia have remained a big challenge despite the country achieving self-sufficiency in production of a wide variety of food. Micronutrient intake at household level is extremely low with diets mainly composed of carbohydrates and vegetables (NFNC 2006). A national picture further indicates that stunting rates among children under the age of five have remained strikingly high for several decades, at around 40% (45-50% in rural areas and 35-40% in urban areas) (CSO 2007, 2014). This problem has been exacerbated by government's maize centric agricultural policies of maize input subsidies through Farmer Input Support Program (FISP) and marketing support through the Food Reserve Agency operations. A consequence of this is low supply of diverse micronutrient at household level (Mofya-Mukuka and Kuhlgatz 2015). In an effort to address the low diversity in micronutrient intake at household level, the Government has designed several policy interventions aimed at increased farm productivity and productive diversification. However, food insecurity and undernourishment has remained widespread.

Accumulation of assets such as livestock, farm implements, and land play a major role in promoting sustained farm production and productive diversification, which are at the core of improved food security. Evidence elsewhere on the linkage between asset ownership, however, seems overwhelming and mixed, with the link still being unclear. Related studies have analyzed the multidimensional measurement of food security, gender roles, and culture and the relative importance of productive assets in promoting food security. To the best of our knowledge, no study has explicitly analyzed key drivers of asset accumulation and their relative importance in promoting household level dietary diversity in Zambia.

This paper seeks to bridge this knowledge gap in the understanding of the determinants of asset accumulation among rural households and the interplay between these assets and dietary diversity. Our hypothesis is that households that own more land, livestock, and implements are more likely to consume a diverse range of foods.

The study is guided by the following questions:

- Which factors determine ownership of farm productive assets among rural smallholder households in Zambia, and
- Which productive assets are closely associated with adequate diverse food supply to a rural household in Zambia?

The study applied the fractional response models with Mundlak (1978) correlated random effects using panel data from Zambia within the Sustainable Livelihood Approach to determine the major factors affecting asset ownership accumulation and its overall impact of food security outcomes, namely Household Dietary Diversity Score (HDDS) and Months of Adequate Household Food Provisions (MAHFP). The assets are anlaysed in two parts. First, we examine productive assets including land (farm implements at the 2015 value, value of livestock ownd by the household during the observed period and land owed by the household based on the 2015 value). The second analysis excluded land and focused on the 2015 value of farm implements and livestock owned only. The separate analysis with and without land value is done due to the fact that land is an asset with a more long-term investment perspective, which might have implications for its determinants as well as its effects on household food security .

Key Findings

Determinants of Productive Asset Ownership Are:

- *Age and adult household members:* with higher age of the household head and increasing number of adult household members, the asset value of the household is likely to be higher. This effect present with and without accounting for land value, and indicates life cycle effects and asset accumulation particularly in the productive age group.
- *Financial capital:* Financial indicators, such as having a bank account, obtaining a loan, or engaging in off-farm work, have significant effect on asset accumulation. Being below the poverty line however hampers accumulation of productive assets. The positive correlation between most financial variables is less prominent when land ownership is considered. Only loans are more strongly correlated, showing the backward linkage of land as a collateral.
- *Family ties to local authorities and participation in an economic group:* These social capital factors play an important and positive role in asset ownership. Participating in an economic group such as cooperatives or women clubs have a positive effect on implements and livestock, but none on land accumulation. On the other hand, households with family ties to the local traditional authority have high probability of accumulating land.
- *Market access:* Being nearer to big cities and along the line of rail has a positive impact on asset accumulation.
- *Technology adoption:* innovative farms, i.e., those practicing minimum tillage and having received extension on crop diversification, accumulate more assets.
- *Policy environment:* The provision of market access through state-owned FRA increases the asset value of farms. However, the effect of FRA on asset accumulation is negative when poverty status of the household is taken into account. This result is expected given that the majority of the household that sell to FRA are the relatively well off. Similarly, the quantity of fertilizer received by the household through the FISP program is not significant in asset accumulation, taking into account the poverty status of the household.

Impact of Asset Accumulation on HDDS and MAHFP

Livestock, farm implements, and land holding value in combination have a positive effect on both the HDDS and MAHFP. On the other hand, once land value is excluded from the productive assets, the effect on MAHFP is not significantly positive anymore. In contrast, productive assets without land have a more significant effect on HDDS than it is the case when land is included. We can argue that land is necessary for achieving adequate household food provisions.

Overall, the results show that accumulations of agricultural productive assets and land is driven by many factors. Government policy as well as other non-state interventions aimed at improving household food security need to take into account the key drivers and the challenges constraining asset accumulation especially among the female-headed households. Specifically, access to credit, markets, and extensions services are important for increasing the value of assets of the household, which is critical for household food security. Given the positive and significant impact of land on household adequate food provisions, policies should also focus on promoting access to land by the majority of the smallholder households.

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ACRONYMS

CRE	Correlated Random Effects
CSO	Central Statistical Office
DFID	Department for International Development
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FISP	Farmer Input Support Program
FRA	Food Reserve Agency
HDDS	Household Dietary Diversity
IAPRI	Indaba Agriculture Policy Research Institute
MAHFP	Months of Adequate Household Food Provisions
MAL	Ministry of Agriculture and Livestock
NFNC	National Food and Nutrition Commission
RALS	Rural Agricultural Livelihood Survey
SEA	Standard Enumeration Area
SLA	Sustainable Livelihood Approach
ZDHS	Zambia Demographic and Health Survey

1. INTRODUCTION

While Zambia has made steady progress in agricultural food production, reducing household food insecurity and malnutrition especially among agricultural smallholder households has remained a challenge. Diverse micronutrient intake at household level is extremely low with diets mainly composed of starchy foods and vegetable (NFNC 2009. The problem of inadequate micronutrient intake is reflected in widespread stunting rates among children under the age of five, which has remained strikingly high for several decades, at around 40% (45-50% in rural areas and 35-40% in urban areas) (CSO 2007 2014). Zambia experiences low agricultural productivity and poor markets, which present threats to a sustainable household food supply and dietary diversity for the rural agriculture households, the majority of whom rely entirely on rain-fed agriculture and forests for their food provisions (CSO 2015; CSO/MoA/IAPRI 2015). Further agricultural support policies have focused on providing maize input subsidies and market support resulting in maize dominating household food production. A consequence of this is low diverse micronutrient intake.

Empirical evidence on the role of productive assets on food security has increased in the last two decades with most studies finding a positive link between asset ownership and food security (See Winters, Davis, and Carletto 2009; Johnson et al. 2016; Fisseha 2014). According to Winters, Davis, and Carletto (2009), productive assets are key for producing food, generating income, accessing loans, and several other opportunities. Hence, they serve as buffer against shocks, such as adverse weather conditions that threaten food production and supply (Johnson et al. 2016). Winters, Davis, and Carletto (2009) argue that since assets support the economic activities of a household in a given context, interventions that improve a household's asset position result in increased household participation in income-generating activities. Further, evidence has shown that productive assets impact the general well-being of individuals and households, for example, by increasing status and empowerment (Johnson et al. 2016). A study conducted among farm households in southern Ethiopia found that productive assets—in particular land and livestock—were associated with improved food security (Fisseha 2014). The Fisseha (2014) study found that the food secure households had access to the largest size of farmland and the food insecure had access to a greater variety of livestock compared to food insecure.[1]

In Zambia however, studies that have analyzed the causal link between asset ownership and food security have found mixed results (e.g., Wineman 2014; Tembo et al. 2014a and b). As such, Wineman (2014) concludes that since food security status of a household encompasses the many dimensions of food security and reveals a household's latent food security status, a statistical analysis that links explanatory variables with a household's overall experience of food security would provide better results for policy recommendation.

Even though there is overwhelming evidence of the effect of asset ownership on food security elsewhere, evidence in Zambia is still mixed such that the link between asset ownership and food security is still unclear. Furthermore, very little has been done to consider factors that drive ownership of key productive assets in Zambia and elsewhere. Most studies in Zambia and elsewhere have concentrated on multidimensional measurements of food security (Webb et al. 2006; Coates et al. 2006; Wineman 2014), relationships between gender roles and culture (Coates et al. 2006; Mason et al. 2014; Johnson et al. 2016), and the relative importance of productive assets in promoting food security (Fisseha 2014; Tembo et al. 2014a and b). To the best of our knowledge, no study has explicitly analyzed key drivers of

[1] Ownership of cattle compared to small animals had a greater effect on food security (Fisseha 2014). Households invest in cattle because they get milk and milk products which are important for rural budgets and food security.

asset accumulation and their relative importance in promoting household level dietary diversity.

This paper seeks to bridge this knowledge gap in the understanding of the determinants of asset accumulation among rural households and the interplay between these assets on one side and dietary diversity and food provisions on the other side. Our hypothesis is that households that own more land, livestock, and implements are more likely to consume a diverse range of foods and have adequate food provisions for most parts of the year. To guide the analysis, the paper asks the following questions: a) Which factors determine accumulation of farm implements and livestock among rural households in Zambia? and b) How do agriculture productive assets impact an adequate diverse food supply to a rural household in Zambia?

The rest of the paper is organized as follows: Section Two gives a background on the status and development of dietary intake in Zambia. Given the previous finding that land assets correlate with dietary diversity, Section Three gives a literature review on the factors affecting ownership of assets that are relevant for food security. Section Four provides a conceptual framework and leads to the presentation of the estimation approach and data used in this investigation in Section Five. Section Six presents the results while the conclusion and recommendations are given in Section seven.

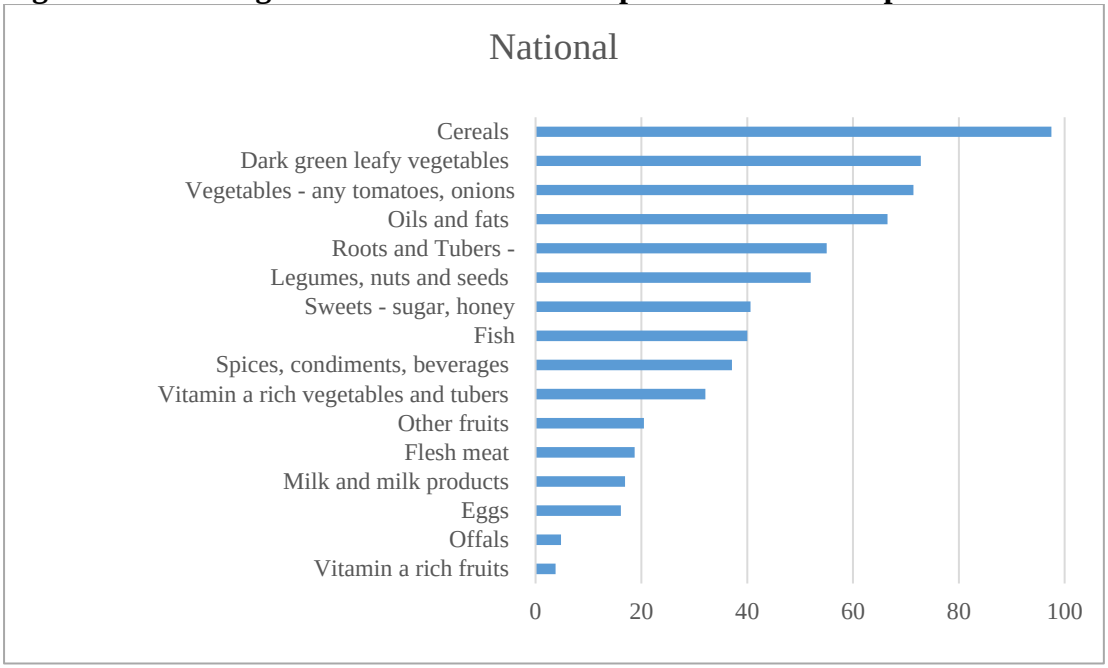
2. DIETARY DIVERSITY AND FOOD PROVISIONS IN ZAMBIA

The typical rural Zambia food diet is composed of maize products, some other starchy roots (e.g., cassava) and, to a lesser extent, fruit and vegetables. Cereals provide almost two-thirds of the dietary energy supply. The dietary energy supply is not sufficient to meet population energy requirements; the prevalence of undernourishment increased to reach 48% in 2013-2014 from 45% in 2003-2005 (FAO, IFAD, and WFP. 2014). Figure 1 shows the food groups consumption among rural households in Zambia.

Studies indicate that majority of the population in Zambia, especially in rural areas, survive on diets that are deficient in a variety of micronutrients. However, particularly during a child's first 1,000 days, an improper supply with micronutrients can severely limit her further physical and mental development and result in long-term health damages such as stunted growth. The Alaofe (2014) conducted in Northern and Luapula Provinces revealed that the prevalence of inadequate intake of the various vitamins and minerals could vary widely, as well as among all other provinces. For the two provinces, the dietary patterns were generally found to be highly inadequate for vitamin A, vitamin B-12, folate, iron, zinc, and calcium. The dietary profile also featured low levels of consumption of milk, meat, fish, and dairy products. Almost all the children were deficient in vitamin B12, with many others also being deficient in folate. Almost 60% of the children were classified as anemic—a condition that, as for most African countries, is believed to be primarily caused by nutrition, malaria, and intestinal worms (Shaw and Friedman 2011; Alaofe (2014).

Table 1 shows how dietary diversity differs for different gender and land asset classes.[2] Given that a higher score indicates a more diverse food intake, the table shows that female-headed households have on average a less diverse diet compared to male-headed households.

Figure 1. Percentage of Household's Consumption of Food Groups in Zambia



Source: Author's own presentation using data from CSO/MAL/IAPRI 2015.

[2] Dietary diversity is measured as a score that summarizes the number of food groups eaten during the past 24 hours.

Table 1. Dietary Diversity across Gender and Land Holding Size

Gender of the household head	Score	Percentile 5	Percentile 25	Percentile 50	Percentile 75	Percentile 95
National	7	3	5	7	8	11
Female	6	2	4	6	8	10
Male	7	3	5	7	8	11
Landholding size (ha)	Score					
<0.5 ha	7	2	4	6	9	11
0.5- 1 ha	6	2	4	6	7	10
1-2 ha	6	3	4	6	8	10
2-5 ha	7	3	5	7	8	11
5-10 ha	7	3	5	7	8	11
10-20 ha	7	3	6	7	8	12

Source: Author's own presentation using data from CSO/MAL/IAPRI 2015.

This may be, however due to factors that are restricting female-headed households to provide a more diverse diet. Land asset ownership, for example is also correlated with dietary diversity, as farm households possessing more land are generally better able to provide a more diverse diet to its household members. This short investigation shows that the nutrient intake is an outcome of multiple factors, and a more complex method has to be applied to find out the root causes of differences in dietary intake.

Tables 2 shows the months of hunger distribution among the households. The differences in the number of months of inadequate food provisions between male and female-headed households is evident at the 50 percentile and higher. Similar to the HDDS, female-headed households experience more months of hunger than male-headed households. Equally, landholding size is correlated to number of months of hunger experienced by the household. Households with more land experience less months of hunger compared to households with less landholding size.

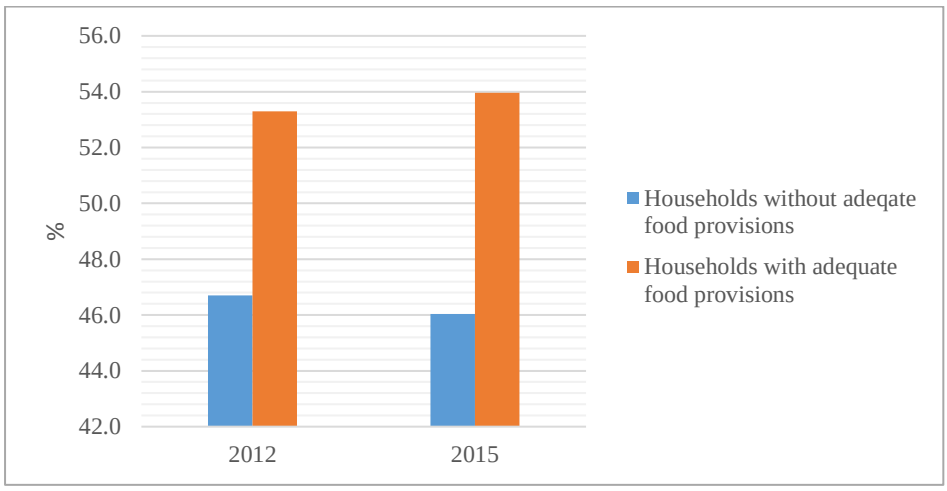
Table 2. Months of Hunger across Gender of Household Head and Landholding Size

Gender of the household head	Months of hunger	Percentile 5	Percentile 25	Percentile 50	Percentile 75	Percentile 95
National	2	0	0	1	3	6
Female	2	0	0	2	4	7
Male	2	0	0	0	3	6
Landholding size (ha)						
<0.5 ha	2	0	0	1	4	7
0.5- 1 ha	2	0	0	2	4	7
1-2 ha	2	0	0	2	3	7
2-5 ha	2	0	0	0	3	5
5-10 ha	1	0	0	0	3	5
10-20 ha	1	0	0	0	3	5

Source: Author's own presentation using data from CSO/MAL/IAPRI 2015.

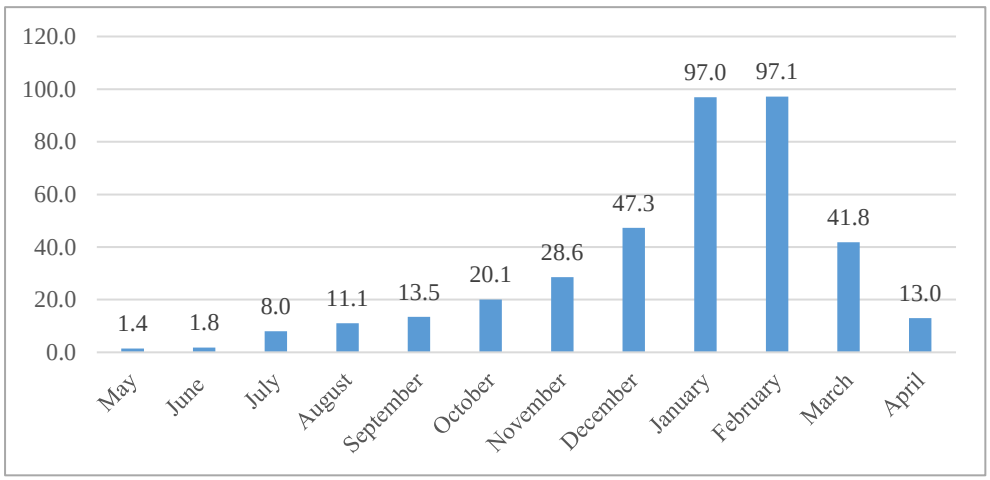
The Rural Agricultural Livelihood Survey (RALS) data shows that 47% of the households experienced inadequate food provisions in a least one month in 2012 and this figure only reduced marginally to 46% 2015 (Figure 2). In both cases, the Eastern Province records the highest prevalence with 20.6% in 2012 and 18.2% in 2015. Lusaka Province remains the lowest with 3.4% in 2012and 2.0% in 2015. Figure 3 shows that hunger is at its highest in January and February, when household stocks dwindle and food prices rise. Hunger is at its lowest in April through August, the main harvest period when household stocks are relatively large and food prices are relatively low.

Figure 2. Percent of Households Experiencing Hunger in 2012 and 2015



Source: CSO/MAL/IAPRI 2012 and 2015.

Figure 3. Percentage of Households Experiencing Hunger by Month in 2015 (among Households Experiencing Hunger in at Least One Month)



Source: CSO/MAL/IAPRI 2015.

3. CONCEPTUAL FRAMEWORK

3.1. Framework for Productive Assets and Food Security

Access to productive assets are habitually-cited factors for farmers achieving differential farming outcomes (Carter 2000). Sustainable Livelihood Approach (SLA) provides a framework for analyzing the relationship between assets and food security. Several studies have adopted SLA as an analytical framework to assess poverty and food insecurity (Krantz 2001; Scoon 1998; Carney 1999; Winters, Davis, and Carletto 2009; DFID 2015). SLA, which recognizes assets in terms of physical, natural, financial, social, and human suggests that carrying out economic activities demands utilization of specific assets to improve the wellbeing of households (Johnson et al. 2016). A household is, therefore, expected to improve food security and achieve general wellbeing if it has assets that it can utilize in satisfying wellbeing and food security needs.

According to Frankenberger et al. (2008), food security is a fundamental need which should not be treated as independent of wider livelihood consideration. Following wide evidence that food availability at national level does not necessarily translate into household and individual adequate and diverse food consumption, there has been a paradigm shift in overall thinking on food security from national level food *availability* to food accessibility at household and individual level (Maxwell 1996). Hence, the use of Household Dietary Diversity Score (HDDS) as an indicator of household access has increased widely in the last decade. HDDS is meant to measure access to a diverse range of food in terms of micronutrient provision (FANTA 2008). Household dietary diversity measures have become prominent measures of household food security given the evidence from several studies that have found a strong link between dietary diversity and household per capita consumption (Sraboni et al. 2014; FANTA 2008; Hatløy et al. 2000; Hoddinott and Yohannes 2002).

Investments in productive assets such as cattle can play a role as a buffer stock, and serve as collateral that can enhance access to credit markets. Thus, asset-poor households tend to be more restricted in receiving loans. The function of livestock as a buffer stock has been widely discussed, although evidence on its contribution on food security is mixed (e.g., Fafchamps 1998). In a recent study conducted in Tanzania with a focus on gendered headship structures and gendered ownership of resources, Mason et al. (2014) found that food consumption is significantly and positively impacted by education, physical assets, livestock resources, and a number of village-level effects.

Further, a study conducted among farm households in southern Ethiopia found that productive assets, in particular land and livestock, was associated with improved food security (Fisseha 2014). Specifically, three recent studies conducted in Zambia have shown varying effects of asset ownership on food security. A three-wave panel study by Wineman (2014) which focused on the multidimensional measurement of household food security in rural Zambia found that seasonal rainfall and temperature have a significant effect on food security. The study revealed that the value of productive assets (for example ownership of oxen or farm implements) and ownership of land are positively associated with food sufficiency and food security. Wineman (2014) further contends that participation in transfer networks, growing cash crops, and practicing in minimum tillage or conservation farming is also positively related to food sufficiency. These finding are similar to those by Tembo et al. (2014a and b).

3.2. Understanding Asset Accumulation

As a starting point to understanding factors that influence ownership of key productive assets, Alison (2005) developed a theoretical framework of processes driving food insecurity. These factors impact indirectly on food insecurity through their effect on availability and access to human, economic, biophysical, and social resources, which may include land, physical assets, and livestock. Using meta-analysis, Alison (2005) identified factors driving ownership of productive assets broadly as economic, social-political and government policies, cultural and religious, demographics, physical, biological and chemical, and scientific and technological factors. These factors affect both asset ownership and food security. However, scant empirical work elsewhere has shown that household male-headship, risk context, government policies such as land rights and territorial policies, access to credit, social norms, access to extension services, and crop and livestock diseases are among the main drivers of owning productive assets (Siegel 2005; Fisseha 2014; Winters, Davis, and Carletto 2009; Mason et al. 2014; Johnson et al. 2016). The study by Siegel (2005) conducted in Zambia, found that ownership of livestock is a function of agro-ecological zones (agricultural potential areas), proximity to the line-of-rail and access to the market. These factors explain why there are fewer households in Northwestern Province who own and are engaged in livestock and poultry compared to Eastern and Southern Province.

Poverty is also a major driver of asset ownership among rural households. Better-off household are non-liquid constrained and can therefore afford to purchase necessary assets needed for agricultural production. Siegel (2005) has noted that poor households in Zambia tend to be asset constrained because of poverty, which is further exacerbated by low-labor force and HIV/AIDS related ailments experienced among poor households. A study by Parker and Mwape (2004) on rural poverty and vulnerability in Zambia found that better-off households often have oxen and implements, as well as tractors, and cultivate larger portions of lands. Based on these findings, Siegel (2005) underscores the need for social protection programs and education in order to raise the rural asset base. These findings are consistent with those by Jayne et al. (2003) and C-SAFE (2003). C-SAFE (2003) baseline survey has shown that about 80% of rural households are classified as being asset poor and very poor. The survey further reveals that the poor are not only vulnerable because of poverty but they have fewer items and low value assets to divest should they be forced to spend money on food and any emergencies. To sum it up, Jayne et al. (2003) add that geographic area matters for ownership of land holding size, indicating that, the more densely populated an area is the smaller land size per hectare farmers cultivate. Additionally, the study revealed that female-headed households have 1.05 hectares less land than male-headed households and that education level of the household head is positively associated with access to land. Surprisingly, the study found non–linear association between animal assets and land access for both total land and land in per capita terms.

Related to social programs suggested by Siegel (2005) in agriculture-based intervention projects, researchers seem to all agree that land ownership is the most important asset for improving food security. Therefore, policies that promote asset growth need to be centered towards property and lands rights, as these give farmers control or decision making to use and dispose of or sell assets (Johnson et al. 2016).

4. DATA AND METHODS

4.1. Data

The study utilizes two waves of nationally representative data on Rural Agricultural Livelihoods carried out in 2012 and 2015 by the Indaba Agricultural Policy Research Institute (IAPRI) in collaboration with the Central Statistical Office and the Ministry of Agriculture. The 2012 RALS included 8,839 randomly selected households nation-wide and focused on the 2010/11 agricultural season. The 2015 RALS included 7,934 households covering the 2013/14 agricultural season. In total, 442 Standard Enumeration Areas (SEAs) were enumerated targeting 20 randomly selected households per SEA.[3]

Guided by the livelihood theoretical background, the study examined effects of different livelihood assets on productive asset accumulation. Specifically, the study examined the effect of human capital, financial capital, social capital, location, and policy environment. For impact on HDDS and MAHFP, similarly the analysis controlled for these livelihood assets.

As proxy for food security, the study use HDDS as the outcome variable. Information on household dietary diversity for calculating HDDS was only collected in 2015. According to FANTA (2008), the HDDS is calculated based on different numbers of food groups consumed by the household on a 24-hour recall period. The maximum number of food groups a household can consume is 16. Productive assets are values of farm implements, livestock, and land. Appendix 1 presents descriptive statistics of the variables included in this study.

4.2. Estimation Procedure

Given the above-mentioned links between household characteristics and asset accumulation, as well as between assets and food security, the analysis is done at two levels. First, we examine the factors that determine asset ownership in Zambia. We specify two models. One on the determinants of productive asset (livestock and farm implements) while the second model estimates the determinants of land ownership. The second level of analysis examines the impact of asset ownership on household food security measured by the HDDS indicator mentioned above.

To evaluate the determinants and impact of asset ownership using panel data from 2012 and 2015, this study applied the fractional response models with Mundlak (1978) correlated random effects. The CRE framework overcomes the shortcomings of the conventional fixed-effects specification that assumes that fixed effect factor is uncorrelated with the explanatory variables an assumption that is not plausible. The CRE model allows for differential treatment effects within a group and introduces parameter heterogeneity providing two overriding restrictions that can be tested in the data.

The conventional fixed effects model is specified as:

$$Y_{it} = a_i + X_{it}\beta + \mu_{it} \quad (1)$$

where Y_{it} is an indicator of food security (here: HDDS) and X_{it} are observed characteristics of the farm household that are relevant for its asset ownership or food security status. The variable α_i captures all the household unobserved, time-constant factors that affect Y_{it}, and

[3] SEAs are the lowest geographical sampling units used by CSO and were the primary sampling units. A SEA typically contains 100-200 households.

μ_{it} is an idiosyncratic error term. The underlying assumption in the fixed effects specification is the existence of correlation between independent variables and unobserved heterogeneity. If the unobserved heterogeneity is uncorrelated with any of the explanatory variables in all time periods, then estimating equation (1) using fixed effect is not efficient. Furthermore, time-constant variables cannot be included in X_{it} in a fixed effects model. Time-constant factors might nevertheless show important determinants of food security, thus ignoring them would leave such insights unnoticed. This calls for the estimation of the random effects model, which is specified as follows:

$$Y_{it} = \beta_0 + X_{it}\beta + \varepsilon_{it} \quad (2)$$

where $\varepsilon_{it} = \alpha_i + \mu_{it}$, and unobserved household heterogeneity is modelled as α_i, which is a random variable with zero mean that is normally distributed over the households i. Given that the random effects specification allows the inclusion of time-constant variables, the implicit assumption that α_i is uncorrelated with the explanatory variables in X_{it} is oversimplification. We overcome the shortcomings of both fixed and random effects estimators by using the correlated random effects (CRE) approach originally suggested by Mundlak (1978) and Chamberlain (1982, 1984). In the CRE setting, time average variables for all time variant explanatory variables are added to the equation. Using the CRE, α_i is modelled as follows:

$$\alpha_i = \bar{X}_i\,\delta + \tau_i, \quad \tau_i|{\sim}N(0, \sigma_\tau^2) \quad (3)$$

where $\overline{X}_i$ represents the time-averaged X_{it} over the various panel periods. This model allows the random effect τ_i to be correlated with the average conditions of the variables. Thus, it is a flexible approach that controls for unobserved time-constant heterogeneity and measures the effects of time-invariant independent variables. However, the CRE estimator requires the model to have a standard normal distribution, and strict exogeneity conditional on α_i.

5. RESULTS

Results of the econometric estimations are discussed in two parts. The first part discusses determinants of asset accumulation and the second part focuses on the results of impact of asset accumulation on household food security measured by HDDS and MAHFP. For both analyses, the study looks at productive assets with and without land.

5.1. Determinants of Asset Accumulation

Table 3 shows the regression results of determinants of agricultural productive asset accumulation. Based on the theoretical framework of sustainable livelihood approach, the analysis examined the factors that affect agricultural productive assets in the following categories of assets: Human capital, financial capital, social capital, location, technology adoption, and policy environment.

5.1.1. Human Capital

The results show that age of the household head has significant bearing on asset accumulation measured by value. Households with older heads are more likely to own productive assets compared to households with younger heads. With or without land, an increase in the age of the household head by one year, increases the probability of asset ownership by 0.1 percentage points. Asset accumulation over the years and human life cycle effects could be the cause of the positive relationship between assets and age of household members. Further, households with more adult members, as well as polygamous households, have a higher probability to own assets than those with less adult members and non-polygamous households. The results are the same for all assets with land included or excluded.

5.1.2. Financial Capital

Households who obtain an additional loan are more likely to increase their productive asset base without land by 0.09 percentage points and by 1.1 percentage points when land is included. Having a bank account increases the probability of accumulating assets by 1.2 percentage points when land is excluded. However, when land is included in the assets, having an account has no significant effect on asset ownership. The lagged poverty status of the households has significant bearing on assets accumulation. According to the results, poorer households with income of less than US$1.25 per day are less likely to accumulate assets. Being poor reduces the probability of accumulating assets by 1.1 percentage points without land and by 0.6 when land is included. In addition, participation in off farm activities plays a significant role in asset accumulation when land is not included. When land is included, participation in off farm activities has no significant effect. Overall, the analyzed financial capital has significant effect on asset accumulation. However, these factors appear to have less effect on land ownership.

5.1.3. Social Capital

Socio factors play an important role in productive asset accumulation. The results show that family ties to the local authority have a significant impact on accumulation of productive assets with or without land. In rural Zambia, like in many African cultures, social networks play a critical role in development. In Ghana, Cadger et al. (2016) found that social ties play an important role in agriculture knowledge exchange. Belonging to economic groups such as

cooperatives and women groups increases the likelihood of a household to own land. However, this has no significant impact on ownership of implements and livestock.

5.1.4. Location

For access to markets, the results show that reducing the number of hours to the nearest urban center with at least 500,000 inhabitants marginally increases the probability to increase the household asset. This is expected given that markets not only enable households to sell their produce, but also enable them to obtain agricultural inputs and implements. The value of land owned is also likely to be higher along the line of rail. These results show that when we include land as part of the assets, being in a town along the line of rail is significant for asset accumulation. This is expected given that land has higher value in the towns along the line of rail where most of the development is concentrated.

The analysis of asset accumulation across the provinces shows that being in Lusaka Province increases the probability of asset ownership; this probability reduces as one moves from Lusaka Province to Copperbelt, Luapula, Muchinga, Northern, Northwestern, Western and Southern Provinces. However, there is no significant difference in probability of asset ownership between Lusaka and Central Provinces. On the other hand, being in Southern Province has a high probability of asset accumulation when land is excluded. This result is expected given the large livestock population in Southern Province compared to other provinces.

5.1.5. Technology Adoption

Receiving crop diversification extension messages increases the probability to accumulate assets by 0.6 percentage points when land is excluded from the assets and by 0.9 percentage points when land is included. Households practicing minimum tillage are more likely to accumulate assets by 1.4 and 1.6 percentage points when land is included and excluded respectively.

5.1.6. Policy Environment

Government policies of providing a market for maize through the state-owned FRA appear to have a positive impact on increasing the asset base. This effect can be explained by the fact that the majority of the households that sell to FRA are the relatively well off who have surplus production (Mason and Myers 2013). These households tend to acquire additional assets after selling their produce to FRA. However, when the FRA variable is interacted with the poverty variable to look at the effect of FRA when poverty level of the household is taken into account, the effect of FRA is negative. A similar analysis was done for FISP and the results were significant for asset accumulation without land. However, when poverty is taken into account, the effect of FISP is not significant.

Table 3. Determinants of Asset Accumulation

Variables	(1) Asset Ownership No Land	(3) Asset Ownership With Land
Human Capital		
Age	0.0018***	0.0018***
=1 if female-headed household	-0.0110	-0.0138
Level of education HH head in years	0.0009	0.0009
Full time adult equivalents	0.0052***	0.0049***
=1 if the head is polygamously married	0.0086***	0.0101***
Financial Capital		
Number of loans obtained by HH	0.0090**	0.0110***
=1 if member has an account	0.0128*	0.0092
=1 if member of the HH belongs to a savings group	0.0074	0.0001
Per capita lagged income below the $1.25/day poverty line (=1; 2005 PPP exchange	-0.0113***	-0.0066***
=1 if HH participated in off-farm activities	0.0052*	0.0040
Social Capital		
=1 if head/spouse is related to the village authorities	0.0132***	0.0148***
=1 if any household member belongs to any group	0.0043	0.0090**
=1 if the HH is a civil servant	0.0049	0.0046
Location		
Hours to nearest urban center with at least 500,000 inhabitants	-0.0007***	-0.0004***
Rail/main road = 1, yes	-0.0021	-0.0109***
Distance to nearest tarred road in Km	-0.0000*	-0.0000
Province = 2, Central	-0.0093	-0.0097
Province = 3, Copperbelt	-0.0184***	-0.0247***
Province = 4, Eastern	-0.0057	-0.0187***
Province = 5, Luapula	-0.0620***	-0.0548***
Province = 6, Muchinga	-0.0528***	-0.0516***
Province = 7, Northern	-0.0596***	-0.0615***
Province = 8, Northwestern	-0.0064	0.0059
Province = 9, Southern	0.0151**	0.0077
Province = 10, Western	-0.0293***	-0.0057
Technology Adoption		
=1 if HH used minimum tillage	0.0146***	0.0162***
=1 if HH received crop diversification related extension advice	0.0064**	0.0092***
Policy Environment		
Log of lagged total HH FRA receipts	0.0043***	0.0066***
Log of lagged total HH FISP receipts	0.0006	0.0014**
Log of lagged total HH FISP receipts interacted with poverty	0.0003	-0.0000
Log of lagged FRA HH maize purchases interacted with poverty	-0.0008**	-0.0014***
Observations	14,472	14,472

Notes: For the sake of brevity, the time averages have been not included in the table but can be requested by the authors. HH is household.

5.2. Impact of Asset Accumulation on HDDS and MAHFP

The second part of the analysis examined the impact of asset accumulation on HDDS and MAHFP while controlling for other livelihood assets, market factors, technology adoption, and policy environment. Table 4 shows the results of this analysis. For the sake of brevity, we focus on interpreting the variables important for testing our hypotheses on the influence of assets on food security.

The value of productive assets has significant and positive impact on both HDDS and MAHFP. A unit increase in value of productive assets (land included) results in a 10 percentage point increase in HDDS and 13 percentage point increase in MAHFP.

However, productive assets when land is excluded have a positive and significant impact on HDDS, but have insignificant impact on food security as measured by MAHFP. An increase in the value of assets excluding land results is an increase in HDDS by 18 percentage points. The results indicate that households can utilize intensive food production methods to produce diverse foods regardless of the size land owned. On the other hand, to achieve adequate household food provisions, households require additional land. We can argue that land is necessary for large quantity production to enable the household have adequate food provisions for the greater part of the year.

Table 4. Impact of Productive Assets on Food Security

VARIABLES	(1) Impact_HDDS	(2) se	(3) Impact_MAHFP	(4) se
Productive Assets				
Proportional value of all productive assets	0.1020*	0.054	0.1306***	0.050
Proportion value of assets without land	0.1802***	0.058	-0.0242	0.053
Human Capital				
Age	-0.0009	0.001	-0.0003	0.001
=1 if female-headed household = 1	-0.0493**	0.020	-0.0312	0.019
Level of education HH head in years	0.0010	0.002	0.0030*	0.002
Count of members	-0.0021	0.002	-0.0064***	0.002
=1 if the head is polygamously married = 1, Yes	0.0106	0.007	0.0089	0.006
Financial Capital				
Number of loans obtained by HH	0.0061	0.008	-0.0130*	0.008
=1 if member has a bank account = 1	-0.0069	0.013	0.0146	0.014
=1 if member of the HH belongs to a savings group = 1	0.0361**	0.015	-0.0215	0.017
Per capita lagged income below the $1.25/day poverty line (=1; 2005 PPP exchange	-0.0129***	0.004	-0.0058*	0.003
=1 if HH participated in off-farm activities	0.0108	0.007	-0.0214***	0.006
Social Capital				
=1 if head/spouse is related to the village authorities = 1	0.0245***	0.007	-0.0004	0.007
=1 if belong to any farmer's group = 1	0.0244***	0.008	0.0086	0.007
=1 if the HH is a civil servant = 1	0.0501	0.038	-0.0070	0.045

Table 4 cont.

VARIABLES	(1) Impact_HDDS	(2) se	(3) Impact_MAHFP	(4) se
Location				
Hours to nearest urban center with at least 500,000 inhabitants	-0.0012***	0.000	-0.0009***	0.000
Rail/main road = 1, yes	-0.0053	0.006	-0.0143**	0.006
Distance to nearest tarred road in Km	-0.0002***	0.000	0.0001**	0.000
Province = 2, Central[4]	0.0082	0.012	0.0342***	0.010
Province = 3, Copperbelt	0.0593***	0.012	-0.0040	0.010
Province = 4, Eastern	0.0424***	0.011	-0.0088	0.010
Province = 5, Luapula	-0.0126	0.012	-0.0461***	0.011
Province = 6, Muchinga	-0.0025	0.015	-0.0274**	0.013
Province = 7, Northern	-0.0407***	0.014	-0.0127	0.013
Province = 8, Northwestern	-0.0053	0.014	0.0207*	0.011
Province = 9, Southern	-0.0285**	0.011	-0.0191*	0.011
Province = 10, Western	-0.0852***	0.013	-0.0855***	0.013
Technology Adoption				
Simpson Index of Crop Diversification	-0.0119	0.016	0.0122	0.014
Policy Environment				
Log of lagged total HH FRA receipts	0.0006	0.001	0.0052***	0.001
Log of lagged total HH FISP receipts	0.0014	0.001	0.0048***	0.002
Log of lagged total HH FISP receipts interacted with poverty	-0.0003	0.001	-0.0020*	0.001
Log of lagged FRA HH maize purchases interacted with poverty	0.0009	0.001	-0.0000	0.001
Observations	7,239		14,472	

[4] Lusaka Province is the base.

6. CONCLUSION AND RECOMMENDATIONS

This study has examined the determinants of agriculture asset accumulation and the impact on household food security measured by HDDS and MAHFP. The study analyzed the value of farm implements, livestock, and land owned on one hand, and on the other hand, the value of farm implements and livestock (without land) in order to find out differences of non-land assets. The separate analysis with and without land value is done due to the fact that land is an asset with a more long-term investment perspective, which might have implications on its determinants as well as its effects on household food security.

Both productive assets with land inclusive and excluding land have positive impact on HDDS, whereas MAHFP is only influenced by productive assets when land is included. Based on these results we can conclude that landholding size and value is a vital factor for achieving the stable household food provisions needed for the stability dimension of food security. Given that rural households in Zambia own a small landholding size of 2 hectares on average, the results provide an understanding of why nearly 50% of the households experience inadequate food provisions in at least one month. Temporal food insecurity is particularly troublesome for the development of small children—so much so, that a lack of productive assets can be one of the driving forces of high stunting rates in Zambian children.

Overall, the results show that the accumulation of agricultural productive assets and land is driven by many factors. High levels of poverty are one of the factors holding back rural households' investment in productive assets. Access to markets and extension services additionally play an integral role in promoting productive asset accumulation. Smallholder farmer's access to credit, market, and extension messaging allows them to utilize the available market opportunities to purchase livestock such as oxen and engage mechanized farming and irrigation that are vital for improved food security and poverty reduction in Zambia. Clearly, investment in assets is also highly influenced by location of the households. Therefore, government policy as well as other non-state interventions aimed at improving household food security must take into account the infrastructure development to improve access to markets. Ultimately, policies for improving rural livelihoods need to take into account key drivers and challenges constraining asset accumulation, especially among the female-headed households.

The study has shown that ownership of productive assets in the form of livestock and farm implements is necessary for achieving household food security. Thus, interventions to promote these assets remain imperative. Further, given the positive and significant impact of land on household adequate food provisions, it is necessary for policies to also focus on promoting access to land by the majority of the smallholder households.

APPENDIX

APPENDIX 1. DESCRIPTIVE STATISTICS

	2012				2015			
	Min	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**
Proportion value of assets without land	0	1	.48	.109	0	1	.50	.111
Proportional value of all productive assets	0	1	.56	.109	0	1	.57	.112
Month of Adequate Food Provisions	0	1	.89	.162	0	1	.87	.178
Household Dietary Diversity Score					1	16	6.87	2.544
Simpson Index of Crop Diversification	0	1	.41	.252	0	1	.39	.237
Age of household head	17	111	45.50	15.007	16	105	48.64	14.779
=1 if female-headed household	0	1	.19	.394	0	1	.21	.408
Level of education HH head in years	0	19	6.17	3.719	0	18	5.99	3.703
Full time adult equivalents	0	55	2.71	2.616	0	42	3.00	2.780
=1 if the head is polygamously married	0	1	.11	.314	0	1	.12	.321
number of loans obtained by HH	0	3	.18	.421	0	2	.20	.423
=1 if member of the HH belongs to a savings group	0	1	.03	.177	0	1	.06	.238
Per capita lagged income below the $1.25/day poverty line (=1; 2005 PPP exchange	0	1	.68	.466	0	2	1.37	.928
=1 if HH participated in off-farm activities	0	1	.72	.450	0	1	.76	.424
=1 if members of HH belong to any clubs or cooperatives	0	1	.45	.498	0	1	.51	.500
Hours to nearest urban Centre with at least 500,000 inhabitants	0	57	13.48	8.620	0	57	13.29	8.505
Rail/main road	0	1	.27	.442	0	1	.25	.432
Distance to nearest tarred road in Km	0	251	27.05	35.450	0	300	26.55	35.916
=1 if HH used minimum tillage	0	1	.03	.177	0	1	.14	.352
1= if HH received any extension services	0	1	.28	.449	0	1	.03	.162
Log of lagged total HH FRA receipts	0	12	2.73	3.767	0	12	2.28	3.848
Log of lagged total HH FISP receipts	0	9	2.09	2.705	0	9	2.08	2.964
Number of Observations			8,815				7,919	

Note: HH is household.

REFERENCES

Alaofe, H, L. Kohler, D. Taren, M.J. Mofu, J. Chileshe, and N. Kalungwana. 2014. Zambia Food Consumption and Micronutrient Status Survey Report. Lusaka: National Food and Nutrition Commission.

Alison, A. 2005. What Drives Food Insecurity in Southern Africa? A Meta-Analysis of Household Economy Studies. *Global Environmental Change* 15.1: 33-43.

Cadger, K., A.K. Quaicoo, E. Dawoe, and M.E. Isaac. 2016. Development Interventions and Agriculture Adaptation: A Social Network Analysis of Farmer Knowledge Transfer in Ghana. *Agriculture* 6.3: 32. Doi:10.3390/Agriculture6030032.

Carney, D. 1999. *Approaches to Sustainable Livelihoods for the Rural Poor*. ODI Poverty Briefing No. 2. London: ODI.

Carter, M.R. 2000. *Land Ownership Inequality and Income Distribution Consequences of Economic Growth.* The United Nations University World Institute for Development Research Working Papers No. 201. Helsinki, Finland: United Nations University World Institute for Development.

Coates, J., Edward A. Frongillo, Beatrice Lorge Rogers, Patrick Webb, Parke E. Wilde, and Robert Houser. 2006. Commonalities in the Experience of Household Food Insecurity Across Cultures: What Are Measures Missing? *The Journal of Nutrition* 136.5: 14438S-1448S.

C-SAFE. 2003. Zambia Baseline Survey: Report of Findings. Prepared by TANGO International, Inc., in Collaboration with C-SAFE M&E Team. Lusaka: TANGO.

Central Statistical Office (CSO). 2015. Living Conditions Monitoring Survey. Lusaka: CSO.

CSO/MAL/IAPRI (Central Statistical Office, Ministry Of Agriculture and Livestock and Indaba Agricultural Policy Research Institute). 2012, 2015. Rural Agricultural Livelihoods Survey Data (RALS). Lusaka, Zambia: CSO/MAL/IAPRI.

Central Statistical Office (CSO) and Ministry of Health (MOH), Zambia, and ICF International. 2014. Zambia Demographic and Health Survey 2013-14.Rockville, MD: Central Statistical Office, Ministry Of Health, and ICF International.

Central Statistical Office (CSO) and Ministry of Health (MOH), Zambia, and ICF International. 2007. Zambia Demographic and Health Survey 2007. Rockville, MD: Central Statistical Office, Ministry Of Health, and ICF International.

Chamberlain, G. 1982. Multivariate Regression Models For Panel Data. *Journal of Econometrics* 18.1: 5-46.

Chamberlain, G. 1984. Panel Data. In *Handbook of Econometrics, Vol. 2,* ed. Z. Griliches and M.D. Intriligator. Amsterdam, North Holland: Elsevier.

Department for International Development (DFID). 2015. DIFID's Conceptual Framework on Agriculture. London, UK: DFID.

Fafchamps, M. 1998. Drought and Saving in West Africa: Are Livestock a Buffer Stock? *Journal of Development Economics* 55.2: 273-305.

FAO, IFAD, and WFP. 2014. The State of Food Insecurity in the World: Strengthening the Enabling Environment for Food Security and Nutrition. Rome: FAO.

Fisseha, K. 2014. Food Insecurity and the Relative Importance of Various Household Assets : the Case of Farm Households in Southern Ethiopia. Second cycle, A2E. Uppsala: Swedish University of Agricultural Sciences.

Food and Nutrition Technical Assistance Project (FANTA). 2008. Guidelines for Measuring Household and Individual Dietary Diversity, Version 4. Rome, Italy: FAO Nutrition and Consumer Protection Division, EC/FAO Food Security Information for Action Program and the Project.

Frankenberger, T., P. Sutter, A. Teshome, A. Aberra, M. Tefera, M. Tefera, A.S. Taffesse, T. Bernard, T. Spangler, and Y. Ejigsemahu. 2007. Ethiopia: The Path to Self-Resiliency. Final Report prepared for CHF – Partners in Rural Development, on behalf of Canadian Network of NGOs in Ethiopia (CANGO).

Hatløy, A., J. Hallund, M. Diarra, and A. Oshug. 2000. Food Variety, Socioeconomic Status, and Nutrition in Urban and Rural Areas in Koutiala (Mali). *Public Health Nutrition* 3.1: 57-65.

Hoddinott, J. and Y. Johannes. 2002. *Dietary Diversity as a Food Security Indicator*. Food Consumption and Nutrition Division Discussion Paper No. 136. Washington, DC: International Food Policy Research Institute.

Jayne, T.S., T. Yamano, M.T. Weber, D. Tschirley, and R. Benfica. 2003. Smallholder Income and Land Distribution in Africa: Implications for Poverty Reduction Strategies. *Food Policy* 28, 2003: 253-275.

Johnson, N., C. Kovarik, R. Meinzen-Dick, and A. Quisumbing. 2016. Gender, Assets, and Agricultural Development: Lessons from Eight Projects. *World Development* 83.C: 294-311. Http://Dx.Doi.Org/10.1016/J.Worlddev.2016.01.009

Krantz, L. 2001. The Sustainable Livelihood Approach to Poverty Reduction: An Introduction. Stockholm, Sweden: SIDA, Division for Policy and Socio-Economic Analysis.

Mason, N.M. and R.J. Myers. 2013. The Effects of the Food Reserve Agency on Maize Market Prices in Zambia. *Agricultural Economics* 44.2: 203-16.

Mason, R., P. Ndlovu, J. Parkins, and M. Luckert. 2014. Determinants of Food Security in Tanzania: Gendered Dimensions of Household Headship and Control of Resources. *Journal of Agricultural Values* 32.3: 539-552.

Maxwell, D. 1996. Measuring Food Insecurity: The Frequency and Severity of "Coping Strategies". *Food Policy* 21.3: 291-303.

Mofya-Mukuka, R. and C.H. Kuhlgatz. 2015. *Child Nutrition, Agricultural Diversification, and Commercialization among Smallholders in Eastern Zambia*. IAPRI Working Paper 90. Lusaka, Zambia: IAPRI.

Mundlak, Y. 1978. On the Pooling of Time Series and Cross Section Data. *Econometrica* 46.1: 69-85.

NFNC. 2006. Annual Report on the Food and Nutrition Situation in Zambia. Lusaka, Zambia: National Food and Nutrition Commission.

Parker, B. and F. Mwape. 2004. Rural Poverty and Vulnerability in Zambia, 2004: A Qualitative Study. Paper Prepared for the World Bank and DFID. Social Protection Unit. Mimeo.

Scoon, I. 1998. *Sustainable Rural Livelihoods: A Framework for Analysis*. IDS Working Paper No. 72. Brighton, UK: IDS.

Siegel. P.B. 2005. Poverty Reducing Potential of Smallholder Agriculture in Zambia: Dualism and Dualism within Dualism. Prepared for Social Development Department. Washington, DC: The World Bank. Mimeo.

Shaw, J.G. and J.F. Friedman. 2011. Iron Deficiency Anemia: Focus on Infectious Diseases in Lesser Developed Countries. *Anemia* 2011, Article ID 260380. Doi:10.1155/2011/260380.

Sraboni, E., H.J. Malapit, and A. Quisumbing, in addition, A.U. Ahmed. 2014. Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh? *World Development* 6, September: 1-52.

Tembo, G., A. Tembo, F. Goma, E. Kapekele, and J. Sambo. 2014a. Livelihood Activities the Role of Livestock in Smallholder Farming Communities of Southern Zambia. *Open Journal of Social Sciences* 2.4: Article ID:44561, 8 pages.

Tembo, G., A. Tembo, F. Goma, E. Kapekele, and J. Sambo. 2014b. Livestock Husbandly and Small Response to Shocks in Southern Zambia. *Journal of Agricultural Studies* 8.1: 1-11.

Wineman, A. 2014. Multidimensional Household Food Security Measurement in Rural Zambia. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, July 27-29. Minneapolis, MN.

Winters, P., B. Davis, and G. Carletto. 2009. Assets, Activities and Rural Income Generation: Evidence from a Multicounty Analysis. *World Developmen*t 37.9: 1435-1452. Doi:10.1016/J.Worlddev.2009.01.010.

Webb, P., J. Coates, E.A. Frongillo, B.L. Rogers, A. Swindale, and P. Bilinsky. 2006. Measuring Household Food Insecurity: Why It's So Important and Yet So Difficult to Do. *The Journal of Nutrition* 136.5: 1404-1408.