Implementation dilemma of agricultural policies: Trade-offs or synergies? Food and nutrition security implications of extension services and farm input subsidies.

L. Sibande;

Palladium International, , Malawi

Corresponding author email: lonestersibande@gmail.com

Abstract:

The dilemma most governments face is how to balance implementation of various policies in the absence of research-based evidence of their impact. For the Malawi Government, the dilemma is how to balance budgetary support to farm input subsidies and other policies in the agricultural sector. This article estimates the effects of the residence of an agricultural extension officer in the community, receipt of extension advice and subsidised fertiliser on household dietary diversity, dietary variety and per capita consumption of macro and micro nutrients using the Intergrated Household Panel Survey data of 2010 and 2013 for Malawi. Empirical analyses employ fixed effects models and the results suggests that the residence of an agricultural extension officer in the community has positive effects on food and nutrition security. The results also show consistently insignificant effects of subsidised fertiliser and receipt of extension advice. However, subsidised fertiliser is found to have positive effects only on food security when it is combined with receipt of extension advice. These results suggests that policies which focus on promoting availability of agricultural extension officers in the community might be more effective and efficient in addressing food and nutrition insecurity and demonstrate the importance of synergies in policies' implementation.

Acknowledegment:

JEL Codes: Q16, Q13

#1193

Implementation dilemma of agricultural policies: Trade-offs or synergies? Food and nutrition security implications of extension services and farm input subsidies.

Abstract

The dilemma most governments face is how to balance the implementation of various policies in the absence of research-based evidence on the impact of each of the policies. For the Malawi Government, the dilemma is how to balance the budgetary support to farm input subsidies and other policies in the agricultural sector. This article estimates the effects of the residence of an agricultural extension officer in the community, receipt of extension advice and subsidised fertilizer on household dietary diversity score,, household dietary variety score and per capita consumption of macro and micro-nutrients using the nationally representative two-wave Integrated Household Panel Survey data of 2010 and 2013 for Malawi. Empirical analyses employ fixed effect models and the results suggest that the residence of an agricultural extension officer in the community has positive effects on food and nutrition security. The results also show consistently insignificant effects of subsidised fertilizer and receipt of extension advice. However, subsidised fertilizer is found to have positive effects only on food security when it is combined with receipt of extension advice. These results suggest that policies which focus on promoting availability of agricultural extension officers in the community might be more effective and efficient in addressing food and nutrition insecurity and demonstrate the importance of synergies in policies' implementation.

Key words: Agricultural extension services, Food and nutrition security, Agricultural policies.

JEL Classification: Q1, Q16, Q18

1. Introduction

Addressing food insecurity, acute malnutrition and poverty, especially among the rural population, which depends on agricultural production as the main livelihood strategy, are some of the priorities for most governments in developing countries. This makes agriculture a strategic sector for improving household welfare and achieving economic growth (GOM, 2011; GOM, 2012; Wold Bank, 2007). In terms of human nutrition, agriculture is also known as the main contributor (FAO, 2013).

Although it is commonly acknowledged that there has been a remarkable progress in technology development in agriculture and improved productivity, FAO (2013) estimates that 13 per cent of the world populations' calorific intake is insufficient. Furthermore, micronutrients deficiencies are estimated to be prevalent in about two billion people (FAO, 2012). The world is also experiencing high proportions of stunting (low height-for-age) under five children, especially in developing countries were the prevalence rate of stunting is at 28 per cent (FAO, 2013).

Despite the widely known status of food insecurity and malnutrition at global and national levels, the challenges continuously facing governments and policy makers are the development of policies and strategies which are effective and efficient. A wide range of policies have been implemented by various governments in developing countries with the aim of addressing food insecurity and malnutrition. However, differences in the support which is provided in the implementation of the various policies may affects the effectiveness and efficiencies of such policies. Prioritisation of budgetary support on the implementation of various policies based on their perceived expected impact has led to low budgetary support on the implementation of some policies. The dilemma most governments face is how to balance the implementation of various policies in the absence of research-based evidence on the impact of each of the policies, and given the pervasive budget constraints. For the Malawi Government, the current dilemma is how to balance the budgetary support to farm input subsidies and other policies in the agricultural sector. This is evidenced by a number of studies which have shown that despite that the Malawi Government provide substantial budgetary support to the agricultural sector, sub-sector specific support to agricultural extension services is dwindling overtime. For instance, evidence of inadequate support to agricultural extension provision include the high vacancy rates in agricultural frontline extension workers, inadequate accommodation and transportation for frontline extension workers.

A wide range of literature on the effects of agricultural extension and subsidised farm inputs on food security exists, however, to the best of our knowledge, no study has estimated the impact of having a resident agricultural extension officer in the community on food and nutrition security; the effects of fertilizer subsidies and receipt of agricultural extension services; and their interaction on food and nutrition security. The results of this study contributes to new knowledge on implementation of policies in the agricultural sector. The results provide research based evidence of whether or not to support the filling in the existing vacancies and provision of good accommodation and transportation facilities to frontline extension workers; the effects of policies trade-offs or synergies in the implementation farm input subsidy programme (FISP).

This study attempts to bridge this knowledge gap by assessing the effects of the residence of an agricultural extension officer in the community, receipt of agricultural extension services and fertilizer subsidies on food and nutrition security using the Malawi's nationally representative Integrated Household Panel Survey of 2010/2011 and 2013. This is a novice data and provides opportunities to generate new insights on the effects of agricultural extension services and fertilizer subsidies on food and nutrition security in Malawi. Specifically, the study estimates the effects on household dietary diversity score (HDDS), household dietary variety score (HDVS), per capita and per day consumption of macro-nutrients (proteins, fats, carbohydrates and calories) and micro-nutrients (iron, zinc, folate and vitamin A). The results of this study are important to researchers, policy makers and governments implementing several policies in order to inform and guide in allocation of scarce resources for effective and efficient achievement of the various policy goals. The availability of the panel data provides opportunities to assess households' food and nutrition security and control for observed and unobserved time-invariant heterogeneity in empirical estimations. Furthermore, Malawi's neighbouring countries and several developing countries are also implementing similar agricultural policies such as farm input subsidy policy; agricultural extension policy and strategies and therefore lessons and research results using the Malawi data can be widely applied.

Recent studies which have analysed food diversity and food nutrients consumption and specific to Malawi include Ecker and Qaim (2011); and Verduzco-Gallo *et al.,* (2014). However, in these studies their empirical analyses do not directly focus on the causality relationships and effects of agricultural extension services. This study builds on this gap and

follows these studies on construction of some of the food, macro and micro-nutrient indicators used in the empirical analyses.

The next section presents an overview of food and nutrition security trends in Malawi. Conceptual framework is presented in section three. Empirical models of the study are included in section four. Section five presents data source, construction of indicators of food, non-food, macro and micro-nutrients and descriptive statistics. Econometric estimation strategies are included in section six. The discussion of empirical results is incorporated in section seven and section eight concludes.

2. Overview of food and nutrition security trends in Malawi

Nutritional statistics for Malawi show that undernutrition is much higher among the population, especially under five children and pregnant women. Based on the 2004 Malawi Demographic Health Survey, NSO & ORC Macro, (2005) report that among the under five children, about 50 per cent are stunted, while 5 per cent are wasted and 22 per cent are underweight. Using data from the 2001 National Micronutrient Survey, NSO & ORC Macro, (2005) finds that sub-clinical vitamin A deficiency and anaemia is prevalent in about 60 and 80 per cent of preschool children, respectively and, anaemia is prevalent in about 45 per cent of women compared to 17 per cent for men. A recent study for Malawi by Ecker and Qaim (2011) find that caloric deficiencies is prevalent in 35 per cent, iron deficiency in 47 per cent, zinc deficiency in 55 per cent and Vitamin A deficiency in 66 per cent of the population.

Furthermore, the 2014 Malawi Millennium Development Goals (MDG) end-line survey NSO (2015) indicates that among children under the age of five, 42 per cent are stunted (while 16 per cent are severe stunted); 4 per cent are wasted; 17 per cent are underweight (while 4 per cent are severe underweight); and 5 per cent are overweight. In comparison to the statistics reported in NSO (2015), the 2010 Malawi Demographic Health Survey, NSO and ICF Macro (2011) indicate that among the under five children, 47 per cent are stunted while 20 per cent are severe stunted, suggesting some improvement; while 4 per cent are wasted, indicating no significant changes; and 13 per cent are underweight, suggesting the situation has worsened during the two survey periods. Verduzco-Gallo *et al.,* (2014) using the 2010/11 integrated household survey data (IHS3) for Malawi find that calories deficiencies is prevalent in 34 per cent; iron deficiency in 49 per cent; zinc deficiency in 53 per cent; vitamin A deficiency in 70 per cent; and folate deficiency in 50 per cent of the population. Verduzco-Gallo *et al.,* (2014) also calculate calories and micro-nutrient deficiencies using the 2004/05 IHS2 data and

conclude that the prevalence of micro-nutrient deficiencies has increased, while calories deficiency has decreased among the population during the two survey periods. One of the reasons for such high rates of macro and micro-nutrient deficiencies among the population in developing countries is eating low diversified diets (Kearney, 2010). In terms of poverty and food security, NSO (2014) based on the IHPS 2013 reports that 39 per cent of the population is poor while 12 per cent is extremely poor; and 29 per cent of the population experience food insecurity on average for two months in a year.

Persistent use of conventional farming methods among small farmers in developing countries is one of the reasons attributed to the slow transformation of the agricultural sector (Morris, et al., 2007). Since the famous Green Revolution in India and Mexico in the 1960's, it is argued in literature that most developing countries, especially in Africa can experience agricultural revolution through increased use of improved farm inputs. But with the pervasive acute poverty among the small farmers, their income is limited to enable them invest in improved technologies (Druilhe and Barreiro-Hurle, 2012) and consequently most governments in developing countries have been using subsidies to support small farmers' use and facilitate uptake of modern agricultural technologies since the early 20th century (World Bank 2007). Furthermore, provision of agricultural extension services is argued to be a key catalyst in the up-take of new technologies by small farmers.

3. Conceptual framework

This study postulates the positive effects of farm input subsidies and agricultural extension services on food, macro and micro-nutrients consumption through three direct effects. One, through use of production extension advice from agricultural extension workers and purchased subsidies fertilizer to produce adequate and diversified food crops for household consumption and hence the household's other sources of income may be used to purchase other food types and non-food items for household consumption. Two, training on consumption of diversified food, food processing and utilization by the agricultural extension workers and hence reducing malnutrition. Three, training in agricultural business and use income from such income generating activities to purchases additional and variety of food for household consumption.

Four hypotheses are formulated in relation to food security, macro and micro-nutrients consumption based on the expected positive effects of farm input subsidies and agricultural extension services on cash and food crops production, income from crop sales and nutrition knowledge.

i. There is a positive relationship between fertilizer subsidy and household's and per capital consumption of a variety of food types and groups and macro- and micro-nutrients.
ii. There is a positive relationship between the residence of an agricultural extension officer in the community and household's and per capital consumption of a variety of food types and groups and macro- and micro-nutrients.
iii. There is a positive relationship between household receipt of agricultural and nutrition extension advice and household's and per capital consumption of a variety of food types and groups and macro- and micro-nutrients.
iv. There is a positive relationship between fertilizer subsidy and household's and per capital consumption of a variety of food types and groups and macro- and micro-nutrients if the fertilizer subsidy is provided in combination with agricultural and nutrition extension advice.

Assuming U represent overall expected utility to members of the household *i* after consumption of a variety of foods and of particular quantities. A rational household will choose consuming particular types and quantities of foods with the objective of maximising the expected utility, in which case the observed choices indicate greater utility. In this study we follow Greene (2003), in which the household's optimisation problem is assumed to make a decision that maximises the expected food consumption utility:

$$Max\{E[U(X, S, I, A)]\} \quad (1)$$

where X represent a vector of household characteristics, S represent a vector of quantities of subsidised fertilizer redeemed with coupons, I represent a vector of farm household access to agricultural and nutrition information and A represents a vector of the community characteristic of the residence of an agricultural extension officer.

4. Empirical models

This study uses the residence of an agricultural extension officer in the community or access to agricultural and nutrition extension advice and subsidised fertilizer in empirical analyses of the effects of agricultural and nutrition extension provision and quantity of

subsidised fertilizer redeemed on household dietary variety and diversity scores, macro and micro-nutrients consumption. The residence of an agricultural extension officer in the community is an important aspect in ensuring that the face to-face method, which is the most effective approach in agricultural and nutrition extension provision to households is used. Access to agricultural and nutrition extension advice takes into account all methods of extension service provision to households regardless of the residence of the extension officer such as the use of ICTs. Similarly, the fertilizer component of FISP is the main focus in the Malawi's subsidy policy because its proportion of the total costs is the largest (Lunduka, Ricker-Gilbert & Fisher, 2013) and that high unit costs of fertilizers is the main challenge facing small farmers. Due to differences in the degree of participation in FISP (i.e. receipt of heterogeneous coupon packages) among the beneficiaries, this study could not use programme participation as a treatment in the analyses.

4.1 Modelling linear panel data models for household food variety, diversity, macro and micro-nutrients consumption

The continuous household food, macro and micro-nutrients consumption are modelled in relation to the following indicators: (i) household dietary variety score, (ii) household dietary diversity score, (iii) calories, (iv) proteins, (v) fats, (vi) carbohydrates, (vii) iron, (viii) zinc, (ix) vitamin A, and (x) folate by applying fixed effects (FE) estimators from linear panel data models. The model of continuous household food, macro and micro-nutrients consumption indicators is of the following form (Wooldridge, 2010):

$$\log C_{it1} = \beta_1 hhc_{it1} + \beta_2 dist_{it1} + \beta_3 exagent_{it1} + \beta_4 subfertit_{it1} + \varphi_i + \mu_{it} \qquad (2)$$

where $\log C_{it1}$ denotes the continuous household food, macro and micro-nutrients consumption indicators for household *i* in natural logarithm; hhc_{it1} is a vector of household characteristics and include sex, age and education level of household head, land total, rural location, crop diversification, number of households and irrigation scheme present in the community; $exagent_{it1}$ is a vector of an agricultural extension officer present in the community (receipt of extension advice in different models) ; $dist_{it1}$ is a vector representing distance to daily market in natural logarithm; $subfert_{it1}$ is vector of quantity of subsidised fertilizer redeemed by the household; φ_i is the time-invariant unobserved heterogeneity of the household; μ_{it} is an idiosyncratic error term; and β are the parameters to be estimated.

5. Data sources, measurement of indicators and descriptive statistics

Data used is the nationally representative two-wave Integrated Household Panel Survey (IHPS) data for Malawi from the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) Project. The data was collected by the National Statistics Office of Malawi between March 2010 and March 2011 for the first wave and between April and December 2013 for the second wave, which included the farm input subsidy data for the 2009/2010 and 2012/2013 agricultural seasons, respectively. The IHPS data is a balanced panel sample of 4000 households and the current analyses use all households this sample.

5.1. Measurements of households' food, non-food, macro and micro-nutrients indicators

Consumption indicators of food and, macro and micro-nutrients used in estimations are constructed from various information on food consumption at household level as follows:

5.1.1. Macro and micro nutrients indicators:

Per capita and per day total consumed of macro and micro nutrients are calculated from food quantities consumed at household level from all sources covering a recall period of seven days. Both the first and second wave of the IHPS data collected information on household quantities consumed from a list of 123 food items and categorised into 10 food groups. Calculations of food nutrients from the consumed food quantities are based on the West African Food Composition Table (FAO 2012). This is the most recent Food Composition Table covering more African countries. However, some food in the list of consumed items are missing in the West African Food Composition Table and in this case we use the Tanzanian Food Composition Table (Lukmanji *et al.,* 2008). Despite having full information on the reported food quantities consumed, some of the measurement units the households reported on are non-standard and this requires conversion into standard measurement units. The World Bank and the Malawi National Statistics Office collected data on conversion factors of the non-standard measurement units. However, some of the conversion factors are missing for some food items, especially for the IHS3 data (first wave panel) and this is also reported by Verduzco-Gallo *et al.,* (2014), who use the IHS2 and IHS3 data in their studies. In order to ensure reasonably correct conversion of non-standard measurement units into standard units, Ecker and Qaim (2011); and Verduzco-Gallo *et al.,* (2014) constructed new conversion factors.

This study uses the new constructed conversion factors by Verduzco-Gallo *et al.,* (2014) with their permission. The study uses the World Bank conversion factors only on a small

proportion of the consumed food items, where there is no clear link between the non-standard measurement units and the newly constructed conversion factors by Verduzco-Gallo *et al.,* (2014). The final household food quantities consumed are adjusted for the non-edible portions before calculating the macro and micro nutrients consumed at household level using the adjustment factors in the West African Food Composition Table. For this study, the macro nutrients considered are proteins, fats and carbohydrates (FAO, 2013). But we also include calories despite that they are not food nutrients to capture total energy consumption at household level, which is converted from proteins, fats, carbohydrates, fibre and ash. The inclusion of calories in this study will help to assess the contribution of the farm input subsidies on meeting household food energy consumption, which is of importance in nutritional studies. On micro nutrients we consider iron (fe), zinc, vitamin A and folate, which are also considered important in human nutrition because of the long term effects consumption deficiencies have on body heath and economic development of the nation (FAO, 2013).

5.1.2 Household Dietary Variety Score Indicator:

This refers to the number of different types of food items the household consumed and in this study refers to the recall period of seven days (Verduzco-Gallo *et al.,* (2014). Therefore, the Household Dietary Variety Score (HDVS) is the number of food items consumed in a period of seven days preceding the surveys.

5.1.3 Household Dietary Diversity Score Indicator:

This indicator is calculated based on the number of food groups the household consumed and in this study also refers to the recall in a period of seven days preceding the surveys. The Food and Nutrition Technical Assistance (FANTA) Project under United States Agency of International Development (USAID) developed the Household Dietary Diversity Score (HDDS) as an indicator of nutritional quality of food consumed at household level. The HDDS as developed by the FANTA Project categorizes the items consumed at the household level into twelve food groups and therefore, the score for a 24 hours (1 day) recall ranges from 0-12 (Swindale and Bilinsky, 2006a; 2006b). However, the data used in this study contains ten food groups and therefore, for this study ten food groups are used in the calculation of the HDDS. The HDDS is calculated by multiplying the number of food groups the household consumed per day by the number of days in consideration. Since the recall period in this study is seven days, the maximum HDDS is 70 (Kennedy, *et al.*, 2013).

5.2 Descriptive statistics for dependent variables

Table 1 presents descriptive statistics of dependent variables used in this study. The results show on average a household consumed 19 of the 123 total food items per week (i.e. 3 food items per day) and this represents about 15 percent of the total listed food items. Furthermore, the results show that on average a household consumed 40 of the 70 total food groups per week (i.e. 6 of the 10 food groups) and this represents about 60 percent of the total food groups. These results suggest low household consumption of diversified food in Malawi.

On consumption of macronutrients, the results show that per capita per day consumption of calories is 2870 kilocalories, protein is 7.9 g, fat is 5.5 g, carbohydrate is 48.1 g. These results suggest that on average the minimum consumption of macronutrients per capita per day is met in Malawi. However, there are significant variations between the lowest and highest quantiles of macronutrients consumption, which show very low and very high consumption respectively.

On the other hand, the results on consumption of micronutrients show the per capita per day consumption of iron is 20.9 mg, zinc is 13.3 mg, Vitamin A is 259 RE mcg and folate is 500.1 mg. These results also show that on average the minimum consumption of micronutrients is met in Malawi, with the exception of Vitamin A.

5.3 Descriptive statistics for independent variables

We present descriptive statistics for independent variables in Table 2. The results show that 33 per cent of the households report to have a resident agricultural extension officer. This suggests that most communities do not have access to extension advice or rely on extension workers from other communities and other sources of extension advice such as through ICT methods (21 per cent of the households), which coupled with challenges associated with mobility of extension workers and access to ICT devices, may not be effective and efficient. This is supported by results which show that 54 per cent of the households reported to have received any agriculture and or nutrition extension advice in the past 12 months preceding the surveys. In terms of quantities of redeemed fertilizer and considering the full sample, the average is 30 kg, while considering beneficiaries only, the average is 80 kg per beneficiary and this is less than the standard FISP package of 100 kg.

The average age of the household heads is 43 years, which is above the age limit of the youth category of 35 years and suggesting that most households are headed by the elderly.

Furthermore, the proportion of female headed households is 23 per cent and this is consistent with several studies for Malawi. Education level of most household heads is low and the results show that most of them have primary education (about 53 per cent), 24 per cent have secondary education, 6 per cent have tertiary education and about 17 per cent have no formal education.

The results also show that land, which is one of the most important productive assets in agricultural production, is a constraint for most of the households in this study as the results show that the average landholding size is less than one hectare (0.6 hectare) and this may be one of the reasons for the low crop diversification (about two crops) during the rainy season. About 73 per cent for the households are located in rural areas and daily markets are located far from where the farmers reside with an average distance of about 7 km. This may suggest that most households face challenges in accessing markets to purchase food for households' consumption. Irrigation scheme availability in the community is reported by 14 percent of the households, which indicates low integration of development activities in the community. The average number of households in each of the communities is 1081, suggesting a high extension worker to farmer ratio in Malawi.

6.0 Econometric estimation strategy and endogeneity tests

Empirical analyses in this study employ fixed effects (FE) estimators from linear panel data models. However, under the FISP, subsidised fertilizer coupons are not randomly distributed and hence the observed and unobserved time-invariant household heterogeneity may be correlated with the household's food consumption decisions, thereby making the subsidised fertilizer in the estimations endogenous. Since some households did not receive coupons to buy subsidised fertilizer and hence have zero quantities of subsidised fertilizer; and those that received the coupons the quantities also varied because of the differences in the number of coupons they received, the data on quantity of subsidised fertilizer is discrete characterised by both continuous and large number of zero data points. Therefore, its endogeneity is tested by using the control function approach (CF) of the IV methods, and employ the correlated random effects (CRE) Tobit model in the estimation of the reduced form equation (Wooldridge, 2010).

Application of the CF approach follows a two-step procedure. In the first step, a reduced form CRE Tobit model of the quantity of subsidised fertilizer is estimated in the reduced form equation and the generalised residuals, ν_{it} is generated and included as an additional covariate in the structural equation. The endogeneity of subsidised fertilizer is tested in all estimations using a Member of Parliament (MP) residence or visit in the past three months preceding the surveys in the community as an instrument for subsidised fertilizer (Sibande et al., 2017). Endogeneity test results on food consumption decisions show that subsidised fertilizer is not endogenous in all the estimated models.

Receipt of extension advice by the households through specific methods may not be randomised and hence such advice may be endogenous in estimated models. However, receipt of extension advice by households through different methods is likely to be randomised and therefore, in this study we use the covariate receipt of extension advice by the households taking into account of different methods of extension provision as an exogenous variable in our estimation. The randomised methods of receipt of the extension advice by the households ensures that the covariate is exogenous in our estimation models.

We also consider that residence on an agricultural extension officer in the community may be endogenous. We test if the characteristics of communities which have an agricultural extension officer resident within their community are statistically and significantly different from those without a resident agriculture extension officer. The results show that the differences are not statistically and significantly different, and therefore suggesting that there is no likelihood of endogeneity of the residence of an agricultural extension officer in the community. Besides, the covariate the residence of an agricultural extension officer is at a higher community level and the unit of analyses is the household and hence supporting the assumption that it is exogenous in our estimation models.

7. Results and discussion

In this section we discuss the empirical results and our focus is on the effects of the residence of an agricultural extension officer in the community, receipt of extension advice and use of subsidised fertilizer on household food, macro and micro nutrients consumption. This section is grouped into three sub-sections. In section 7.1 we focus our discussion on the impact on household dietary variety and diversity consumption. We discuss the impact on macro and micronutrients per capita per day consumption in sections 7.2 and 7.3, respectively.

7.1. The impact of the residence of an agricultural extension officer in the community, receipt of extension advice and use of subsidised fertilizer on household dietary variety and diversity consumption.

Table 3 presents regression results of factors influencing household dietary variety and diversity consumption and both models control for time-invariant unobserved household heterogeneity. Based on the robust Hausman model selection tests result, the random effect (RE) models are rejected. Therefore, we discuss results of the fixed effect (FE) models (I) and (II) for household dietary variety score (HDVS) (i.e. number of food items consumed) and household dietary diversity score (HDDS) (i.e. food groups consumed), respectively. We also present results of Table 6 (FE models I and II), with a focus on receipt of extension services, use of subsidised fertilizer and the interaction term of these two covariates.

Residence of an agricultural extension officer in the community is associated with increased HDVS and HDDS by four and three per cent, respectively, compared to households with no resident agricultural extension officer. The results highlight the importance of agricultural extension services on crop productivity, diversification, food processing and utilization, which has significant effect on household food consumption. On the other hand, subsidised fertilizer has the expected positive effects, however, with weak statistical significance (10 % significance level) on HDVS and is insignificant HDDS and this explains the persistent food insecurity and malnutrition experienced by most rural households despite the implementation of the farm input subsidy programme. Furthermore, accessing extension advice through ICT increases the HDVS and HDDS by two per cent, although with weak statistical significance on HDVS (10 % significance level).

Furthermore, results in Table 6 show that receipt of extension advice and use of subsidised fertilizer are statistically insignificant. However, the interaction term between these two

covariates is statistically significant, suggesting the importance of synergies in the implementation of the farm input subsidy programme and provision of extension services to subsidy beneficiaries. The results show that a kilogramme of subsidised fertilizer increases HDVS and HDDS by 0.07 and 0.05 per cent, respectively, and thus, translating to seven and five per cent, respectively for a standard FISP package of 100 kg of subsidised fertilizer.

7.2 The impact of the residence of an agricultural extension officer in the community, receipt of extension advice and use of subsidised fertilizer on consumption of food macro-nutrients.

We present fixed effect (FE) models' regression results on factors influencing household consumption of food macro-nutrients per capita per day in Table 4. Based on the robust Hausman model selection tests result, the random effect (RE) models are rejected. We also present results of Table 7 (FE models I and II), with a focus on receipt of extension services, use of subsidised fertilizer and the interaction term of these two covariates.

The presence of an agricultural extension officer in the community increases household consumption of all the four macro nutrients. Consumption of calories and proteins increases by eight per cent, while consumption of fats and carbohydrates increases by six and seven per cent respectively. The effects of the presence of an agricultural extension officer is a result of increased productivity; improved knowledge on food preparation and utilisation, and adoption of new technologies associated with farmers' trainings facilitated by agricultural extension officers. However, the results show that subsidised fertilizer has no statistically significant effects on household consumption of all the four macronutrients despite the positive effect of subsidised fertilizer on maize production (Chibwana *et al*., 2010; Holden and Lunduka, 2012). These results highlight the importance of using the correct food and nutrition security indicators in assessing the effects of policies. The increased production of maize due to the implementation of the FISP may mistakenly be used as an indicator suggesting also improved household food security. On the other hand, accessing extension advice through ICT is found to have positive effects on per capita per day consumption of proteins and fats by five and seven per cent, respectively. However, results in Table 7 show that receipt of extension advice and use of subsidised fertilizer are statistically insignificant, although the interaction term between these two covariates is statistically significant for per capita per day consumption of calories (10 % significance level), proteins and fats (5 % significance level), suggesting the importance of synergies in the implementation of the farm input subsidy programme and provision of extension services to subsidy beneficiaries. The results show that a kilogramme

of subsidised fertilizer increases per capita per day consumption of calories, proteins and fats by 0.06; 0.09 and 0.10 per cent, respectively, and thus, translating to 6; 9 and 10 per cent, respectively for a standard FISP package of 100 kg of subsidised fertilizer.

Higher education attainment of the household head leads to increased household consumption of proteins and fats. Having secondary school education level increases household consumption of proteins and facts by 10 and 16 per cent respectively; while having tertiary education level increases consumption of protein and fats by 15 and 31 per cent respectively, compared to households with heads who have no formal education. This effect could be due to the increased knowledge on good health and nutrition practices and higher income from off-farm enterprises associated with higher education, which is used to buy food of high in protein and fats content. Large household size is associated with lower per capita per day consumption of all the four macronutrients, which may lead to severe malnutrition.

7.3. The impact of the residence of an agricultural extension officer in the community, receipt of extension advice and use of subsidised fertilizer on consumption of food micro-nutrients.

Regression results concerning factors determining household consumption of food micro-nutrients per capita per day are presented in Table 5 and the discussion is based on the results of the fixed effect (FE) models. The random effect (RE) models are rejected based on the robust Hausman model selection tests. We also present results of Table 8 (FE models I and II), with a focus on receipt of extension services, use of subsidised fertilizer and the interaction term of these two covariates.

The results show that availability of agricultural extension services, which might include crops production, health and nutrition information to farmers has positive effects on household consumption of all the four micro-nutrients. This highlights the importance of access to agricultural production information and services in increasing productivity. But interestingly, the magnitude of the effect is higher on vitamin A compared with other micro-nutrients, providing more evidence on the importance of information of household consumption of food rich in vitamin A. The results show that households in communities which have a resident agricultural extension officer consume 9 per cent more of iron and zinc; 23 and 15 per cent more of vitamin A and folate, respectively compared with those in communities which have no such officers. However, the results show that subsidised fertilizer has no statistically significant effects on the households' consumption of all micro-nutrients (i.e. iron, zinc, vitamin A and folate). These results suggest that despite the positive effect of subsidised

fertilizer on household maize production (Chibwana *et al.*, 2010; Holden and Lunduka, 2012), the contribution of the fertilizer subsidy programme to consumption of micro-nutrients is minimal. Therefore, the prevalence of high micro-nutrients deficiency among households in Malawi (Ecker and Qaim, 2011) is likely to undermine food utilisation from increased maize production as a result of usage of subsidised fertilizer. Although one of the objectives of the FISP is to improve household food security, but this objective may not be achieved if micro-nutrients deficiencies are not addressed and this calls for additional strategies to complement the effects of FISP on crop production. Furthermore, results in Table 8 show that receipt of extension advice and use of subsidised fertilizer are statistically insignificant, and the interaction term between these two covariates is also statistically insignificant in all, but one model of per capita per day consumption of iron (5 % significance level). This suggests the importance of synergies in the implementation of farm input subsidies with other programmes in order to promote consumption of adequate micro-nutrients.

8. Conclusion

The results of this study suggest that the residence of an agricultural extension officer in the community has positive effects on food and nutrition security. The results also show consistently insignificant effects of subsidised fertilizer and receipt of extension advice on all indicators of food and nutrition security used in this study. However, we find that subsidised fertilizer has positive effects on food security and consumption of some macro and micro-nutrients if it is combined with receipt of extension advice by the household.

From policy perspective, the results in this study have important implications. First, the results suggest positive effects of the residence of an agricultural extension officer on household food, macro and micro nutrients consumption. These results suggest that policies which focus on promoting availability of agricultural extension officers in the community might be more effective and efficient in addressing food and nutrition insecurity in developing countries compared to other policies. This highlight the importance of supporting provision of face-to-face agricultural extension advisory services to farmers in order to contribute to achieving household and per capital food and nutrition security in agro-based developing countries.

Second, although maize is synonymous to food security in Malawi because it is the main staple crop, focusing and allocating more resources on one crop and neglecting other crops and

agricultural and nutrition extension advice in particular may render such programmes less useful when the main policy objective is to achieve food and nutrition security. This is because consumption of maize only cannot provide adequate diversified food, macro and micro nutrients.

Third, promotion of complementary interventions or policies in addition to agricultural and nutrition extension advice is important in order to improve household consumption of food, macro and micro nutrients. Policies which promote formal education, use of ICT in extension provision and crop diversification can significantly contribute to increased productivity and knowledge on health and nutritious food processing, preparations and utilisation, which can help to reduce household food insecurity, macro and micro nutrients deficiencies. Family planning interventions which can contribute to reduction of household sizes will have significant increased contribution to per capita consumption of all macro and micro nutrients.

Fourth, targeting remote areas with development interventions especially infrastructure developments such as roads will open up the rural community to modern technologies, information and adoption of new interventions which could have significant positive effects on household consumption of food, macro and micro nutrients.

Overall, the results in this study demonstrate the importance of synergies in the implementation of agricultural policies in order to contribute to achieving food and nutrition security in agro-based developing countries.

8. References

Chibwana, C., Fisher, M., Jumbe, C., Masters, W. and Shively, G. (2010). *Measuring the impacts of Malawi's farm Input Subsidy Programme*. Paper presented at the 2010 meeting of the African Agricultural Economics Association, September 20-23, 2010. Available at: http://ssrn.com/abstract=1860867 (accessed on 25th January, 2014)

Druilhe, Z. and Barreiro-Hurle, J. (2012). *Fertilizer subsidies in sub-Saharan Africa.* ESA Working paper No. 12-04, Rome, *FAO.*

Ecker, O., and Qaim, M. (2011). Analyzing nutritional impacts of policies: An empirical study for Malawi. *World Development*, 39 (3), 412-428.

Food and Agriculture Organisation (FAO, 2012). *West African Food Composition Table*. Food and Agriculture Organisation of the United Nations, Rome, Italy.

Food and Agriculture Organisation (FAO, 2013). *The State of Food and Agriculture: Sustainable Food Systems for Food Security and Nutrition*. Conference, Thirty-eighth Session, Rome, 15-22 June, 2013, Food and Agriculture Organisation of the United Nations, Rome, Italy

Government of Malawi, (2011). Malawi Agricultural Sector Wide Approach. A prioritised and harmonised Agricultural Development Agenda: 2011-2015. *Ministry of Agriculture and Food Security.*

Government of Malawi, (2012). *Malawi Growth and Development Strategy II: 2011-2016.* International Monetary Fund, Washington, DC. IMF Country Report No.12/222.

Greene, W.H, (2003). Econometric Analysis. New York University, Pearson Education International, USA.

Holden, S. T. and Lunduka, R.W. (2012). Who Benefits from Malawi's Targeted Farm Input Subsidy Program? *Forum for Development Studies*.

Kearney, J., (2010). Review: Food consumption trends and drivers, *Phil. Trans. R. Soc. B*, 365, 2793-2807. Available on: http://rstb.royalsocietypublishing.org/. Accessed on March17, 2015.

Kennedy, G., Ballard, T., and Dop, M.C., (2013). *Guidelines for measuring household and individual dietary diversity*. Nutrition and Consumer Protection Division, Food and Agriculture Organisation of the United Nations.

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., Fawzi, W., (2008). *Tanzania food composition Tables*. MUHAS- TFNC, HSPH, Dar es Salaam Tanzania.

Lunduka, R., Ricker-Gilbert, J. and Fisher, M. (2013). What are the farm level impact of Malawi's farm input subsidy program? A critical Review. *Agri. Econ. 44, 563-579.*

Morris, M., Kelly, V.A., Kopicki, R., and Byerlee, D. (2007). *Fertilizer use in African Agriculture: Lessons Learned and Good Practice Guidelines*, Washington, DC: World Bank.

National Statistics Office and ICF Macro, (2005). *Malawi Demographic and Health Survey 2004*, Zomba, Malawi, and Calverton, Maryland, USA: NSO and ICF Macro

National Statistics Office and ICF Macro, (2011). *Malawi Demographic and Health Survey 2010*, Zomba, Malawi, and Calverton, Maryland, USA: NSO and ICF Macro.

National Statistics Office, (2014). *Integrated Household Panel Survey 2010-2013: Household Socio-Economic Characteristics Report*, Zomba, Malawi. National Statistics Office.

National Statistics Office, (2015). *Malawi MGD Endline Survey 2014*. Zomba, Malawi. National Statistics Office.

Sibande, L., Bailey, A., and Davidova, S. (2017). The impact of farm input subsidies on maize marketing in Malawi. *Food Policy*, (69), 190-206.

Swindale, A., and Bilinsky, P. (2006a). *Household dietary diversity measurement of household food access: Indicator guide, version 2*. Washington D.C: Food and Nutrition Technical Assistance Project.

Swindale, A., and Bilinsky, P. (2006b). Development of a universally applicable household food insecurity measurement tool: process, current status and outstanding issues. *Journal of Nutrition*, 136(5), 14495-14525

Verduzgo-Gallo, I., Ecker, O., and Pauw, K. (2014). *Changes in food and nutritional security in Malawi: Analysis of recent survey evidence*. Working Paper 06, Washington D.C., International Food Policy Research Institute.

Wooldridge, J.M. (2010). *Econometric Analysis of Cross Section and Panel Data*, MIT Press Books, The MIT Press, 2nd Edition, Vol.1.

World Bank, (2007). Agriculture *for Development, World Development Report 2008*, The International Bank for Reconstruction and Development, Washington, DC: World Bank.

Table 1: Descriptive Statistics (the mean represents the two survey waves' average).

Dependent Variables	Observations	Mean	Std. Dev.
Household Food Security Indicators:			
Household Dietary Variety Score (Food Items)/7 days	8,000	19.13	8.42
Household Dietary Diversity Score (Food Groups)/7days	8,000	40.39	11.03
Macronutrients Indicators:			
Calories total per capita per day consumed (kcal)	8,000	2870.77	2080.37
Proteins total per capita per day consumed (g)	8,000	7.91	5.28
Fats total per capita per day consumed (g)	8,000	5.46	5.08
Carbohydrates total per capita per day consumed (g)	8,000	48.09	28.40
Micronutrients Indicators:			
Iron total per capita per day consumed (mg)	8,000	20.87	18.17
Zinc total per capita per day consumed (mg)	8,000	13.31	9.93
Vitamin A total per capita per day consumed (RE mcg)	8,000	259.03	404.16
Folate total per capita per day consumed (DFE mcg)	8,000	500.14	390.25

Source: Authors based on IHPS 2010/11 and 2013 data

Table 2. Descriptive statistics for Independent Variables (the mean represents two survey waves' average).

Independent Variables	Observations	Mean	Std. Dev.
Residence of an Extension Officer in the community	8,000	0.33	0.47
Received agricultural and or nutrition extension advice	8,000	0.54	0.49
Subsidised fertilizer (Kg)	8,000	29.63	42.22
Household head (female)	8,000	0.226	0.42
Household head age (years)	8,000	42.81	15.77
Household head no education	8,000	0.17	0.38
Household head primary education	8,000	0.53	0.50
Household head secondary education	8,000	0.24	0.43
Household head tertiary education	8,000	0.06	0.23
Household size (adult equivalent)	8,000	4.34	2.05
Total landholding size (hectares)	8,000	0.60	0.67
Rural location of the household	8,000	0.73	0.44
Crop diversification	8,000	1.61	1.25
Distance daily market (Km)	8,000	7.10	16.37
Irrigation scheme in the community	8,000	0.14	0.34
Log number of households	8,000	1081	1675
Household received extension advice through ICT	8,000	0.21	0.41

Source: Authors based on IHPS 2010/11 and 2013 data

Table 3: Regression results on factors determining household food consumption

Independent Variables	Dependent Variables: Household Food Security	
	Log HDVS (Food Items) FE Model (I)	Log HDDS (Food Groups) FE Model (II)
	Coef./SE	Coef./SE
Residence of an Extension Officer in the community	0.04***	0.03***
	(0.01)	(0.01)
Subsidised fertilizer (kg)	0.0003*	0.0001
	(0.0002)	(0.0001)
Household head (female)	-0.02	-0.04***
	(0.02)	(0.01)
Household head age (yrs)	-0.003***	-0.001
	(0.001)	(0.001)
Household head primary edu	0.07***	0.01
	(0.02)	(0.01)
Household head secondary e	0.17***	0.08***
	(0.03)	(0.02)
Household head tertiary educ	0.29***	0.12***
	(0.04)	(0.03)
Household size (adult equiv.)	0.01***	0.01*
	(0.004)	(0.003)
Landholding size (hectare)	0.04***	0.03***
	(0.01)	(0.01)
Rural location	-0.23***	-0.14***
	(0.03)	(0.02)
Crop diversification	0.03***	0.001
	(0.01)	(0.005)
Log distance to daily market	0.003	0.004
	(0.01)	(0.004)
Irrigation scheme	0.02	0.02*
	(0.02)	(0.01)
Log total of households	0.02***	0.003
	(0.01)	(0.003)
Extension advice through ICT	0.02*	0.02**
	(0.01)	(0.01)
Year 2013 dummy	0.12***	0.04***
	(0.01)	(0.01)
Constant	2.69***	3.67***
	(0.05)	(0.03)
Number of observations	8000	8000
F-Statistic / Wald chi2	33.17	14.29
Prob > F/ chi2	0.0000	0.0000
Overall R-squared/PseudoR2	0.25	0.25
rho	0.48	0.47
Correctly classified		
Robust Hausman test:	75.74***	104.38***

Note: *, **, *** represents statistically significant at 10%, 5% and 1% significance level, respectively; robust cluster standard errors (SE) are in parentheses.

Table 4: Regression results on factors determining household consumption of food macro-nutrients per day. Dependent variable: Log total per capita per day macro-nutrients consumed

Explanatory Variables	Dependent Variables: Log per total per capita per day macro-nutrients consumed			
	Calories	Proteins	Fats	Carbohydrates
	FE Model	FE Model	FE Model	FE Model
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Residence of an Extension Officer in the community	0.08***	0.08***	0.06**	0.07***
	(0.02)	(0.02)	(0.03)	(0.02)
Subsidised fertilizer (Kg)	0.0002	0.0001	0.0004	0.0001
	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Household head (female)	-0.05	-0.07**	-0.08**	-0.03
	(0.03)	(0.03)	(0.04)	(0.03)
Household head age (years)	0.002*	0.003***	0.002	0.002***
	(0.001)	(0.001)	(0.002)	(0.001)
Household head primary education	-0.001	0.01	0.04	-0.01
	(0.03)	(0.03)	(0.04)	(0.03)
Household head secondary education	0.03	0.06	0.12**	0.03
	(0.04)	(0.04)	(0.05)	(0.04)
Household head tertiary education	0.10*	0.15***	0.31***	0.10*
	(0.05)	(0.05)	(0.07)	(0.05)
Household size (adult equivalent.)	-0.13***	-0.14***	-0.15***	-0.13***
	(0.01)	(0.01)	(0.01)	(0.01)
Total landholding size (hectares)	0.06***	0.06***	0.08***	0.06***
	(0.02)	(0.02)	(0.02)	(0.02)
Rural location of the household	-0.13***	-0.12***	-0.28***	-0.11***
	(0.04)	(0.04)	(0.05)	(0.04)
Crop diversification	0.002	0.01	0.01	-0.003
	(0.01)	(0.01)	(0.01)	(0.01)
Log distance daily market (Km)	0.01*	0.01	-0.001	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
Irrigation scheme in the community	-0.05**	-0.04	-0.07**	-0.02
	(0.02)	(0.03)	(0.03)	(0.02)
Log number of households	0.01*	0.02**	0.04***	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Extension advice through ICT	0.02	0.05**	0.07***	0.01
	(0.02)	(0.02)	(0.02)	(0.02)
Year 2013 dummy	0.11***	0.13***	0.15***	0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	8.16***	2.20***	1.75***	4.09***
	(0.07)	(0.07)	(0.09)	(0.07)
Number of observations	8000	8000	8000	8000
F-Statistic	41.98	46.02	41.32	39.70
Prob > F	0.0000	0.0000	0.0000	0.0000
Overall R-squared	0.23	0.25	0.25	0.22
rho	0.40	0.38	0.42	0.39
Robust Hausman test: Sargan-Hans	57.60***	54.09***	84.03***	57.85***

Note: *, **, *** represents statistically significant at 10%, 5% and 1% significance level, respectively; robust cluster standard errors (SE) are in parentheses.

Table 5: Regression results on factors determining household consumption of food micro-nutrients per capita per day. Dependent variables: Log total per capita per day micro-nutrients consumed

Explanatory Variables	Dependent Variables: Log total per capita per day micro-nutrients consumed			
	Iron	Zinc	Vitamin A	Folate
	FE Model	FE Model	FE Model	FE Model
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Residence of an Extension Officer in the community	0.09***	0.09***	0.23***	0.15***
	(0.02)	(0.02)	(0.05)	(0.02)
Subsidised fertilizer (Kg)	0.0001	0.0001	-0.0004	0.0001
	(0.0003)	(0.0002)	(0.0006)	(0.0003)
Household head (female)	-0.07**	-0.06*	-0.08	-0.08**
	(0.03)	(0.03)	(0.08)	(0.04)
Household head age (years)	0.002*	0.002**	0.01***	0.002*
	(0.001)	(0.001)	(0.003)	(0.001)
Household head primary education	-0.03	-0.01	0.25***	0.01
	(0.03)	(0.03)	(0.08)	(0.04)
Household head secondary education	-0.06	0.03	0.40***	0.07
	(0.04)	(0.04)	(0.11)	(0.05)
Household head tertiary education	0.01	0.09	0.53***	0.10
	(0.06)	(0.05)	(0.14)	(0.06)
Household size (adult equivalent)	-0.14***	-0.13***	-0.15***	-0.13***
	(0.01)	(0.01)	(0.02)	(0.01)
Total landholding size (hectares)	0.03**	0.05***	0.04	0.05**
	(0.02)	(0.02)	(0.05)	(0.02)
Rural location of the household	-0.04	-0.08**	-0.31***	-0.08
	(0.04)	(0.04)	(0.10)	(0.05)
Crop diversification	0.01	0.01	0.05**	0.05***
	(0.01)	(0.01)	(0.02)	(0.01)
Log distance daily market (Km)	0.02**	0.01	0.001	-0.02*
	(0.01)	(0.01)	(0.02)	(0.01)
Irrigation scheme in the community	-0.04	-0.04*	0.11	-0.01
	(0.03)	(0.03)	(0.07)	(0.03)
Log number of households	0.01	0.01*	0.01	0.02
	(0.01)	(0.01)	(0.02)	(0.01)
Extension advice through ICT	0.05**	0.03	0.04	0.06**
	(0.02)	(0.02)	(0.05)	(0.02)
Year 2013 dummy	0.15***	0.13***	0.13***	0.20***
	(0.01)	(0.01)	(0.03)	(0.01)
Constant	3.18***	2.73***	4.72***	6.16***
	(0.08)	(0.07)	(0.19)	(0.09)
Number of observations	8000	8000	8000	8000
F-Statistic	40.49	43.70	11.52	48.91
Prob > F	0.0000	0.0000	0.0000	0.0000
Overall R-squared	0.18	0.23	0.08	0.18
rho	0.39	0.38	0.40	0.38
Robust Hausman test: Sargan-Hansen	73.21***	48.31***	46.28***	59.82***

Note: *, **, *** represents statistically significant at 10%, 5% and 1% significance level, respectively; robust cluster standard errors (SE) are in parentheses.

Table 6: Regression results on factors determining household food consumption

Independent Variables	Dependent Variables: Household Food Security	
	Log HDVS (Food Items) FE Model (I)	Log HDDS (Food Groups) FE Model (II)
	Coef./SE	Coef./SE
Access to extension services	0.002	-0.01
	(0.02)	(0.01)
Subsidised fertilizer (kg)	-0.009	0.0002
	(0.02)	(0.0002)
Access to extension services # Subsidised fertilizer (Kg)	0.0007**	0.0005***
	(0.0003)	(0.0002)
Household head (female)	-0.03	-0.04***
	(0.02)	(0.01)
Household head age (yrs)	-0.003***	-0.001*
	(0.001)	(0.001)
Household head primary edu	0.07***	0.01
	(0.02)	(0.01)
Household head secondary e	0.17***	0.08***
	(0.03)	(0.02)
Household head tertiary educ	0.29***	0.12***
	(0.04)	(0.03)
Household size (adult equiv.)	0.01***	0.01**
	(0.004)	(0.003)
Landholding size (hectare)	0.04***	0.03***
	(0.01)	(0.01)
Rural location	-0.23***	-0.14***
	(0.03)	(0.02)
Crop diversification	0.03***	0.001
	(0.01)	(0.005)
Log distance to daily market	0.003	0.006
	(0.01)	(0.004)
Irrigation scheme	0.02	0.02**
	(0.02)	(0.01)
Log total of households	0.02***	0.005
	(0.01)	(0.003)
Market extension advice through ICT	0.01	0.02*
	(0.02)	(0.01)
Year 2013 dummy	0.12***	0.04***
	(0.01)	(0.01)
Constant	2.69***	3.67***
	(0.05)	(0.03)
Number of observations	8000	8000
F-Statistic / Wald chi2	31.65	13.60
Prob > F/ chi2	0.0000	0.0000
Overall R-squared/PseudoR2	0.25	0.25
rho	0.48	0.47
Robust Hausman test:	75.74***	104.38***

Note: *, **, *** represents statistically significant at 10%, 5% and 1% significance level, respectively; robust cluster standard errors (SE) are in parentheses.

Table 7: Regression results on factors determining household consumption of food macro-nutrients per day

Explanatory Variables	Dependent Variables: Log per total per capita per day macro-nutrients consumed			
	Calories	Proteins	Fats	Carbohydrates
	FE Model	FE Model	FE Model	FE Model
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Access to extension services	-0.01	-0.03	-0.03	-0.01
	(0.02)	(0.03)	(0.03)	(0.02)
Subsidised fertilizer (Kg)	-0.0002	-0.0004	-0.0001	-0.0001
	(0.0003)	(0.0003)	(0.0004)	(0.0003)
Access to extension service # Subsidised fertilizer (Kg)	0.0006*	0.0009**	0.0010**	0.0004
	(0.0004)	(0.0004)	(0.0004)	(0.0003)
Household head (female)	-0.05*	-0.08**	-0.08**	-0.03
	(0.03)	(0.03)	(0.04)	(0.03)
Household head age (years)	0.002*	0.002*	0.002	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Household head primary education	0.002	-0.03	0.04	-0.01
	(0.03)	(0.03)	(0.04)	(0.03)
Household head secondary education	0.03	-0.06	0.12**	0.03
	(0.04)	(0.05)	(0.05)	(0.04)
Household head tertiary education	0.10*	0.001	0.30***	0.09*
	(0.05)	(0.06)	(0.07)	(0.05)
Household size (adult equivalent.)	-0.13***	-0.14***	-0.15***	-0.13***
	(0.01)	(0.01)	(0.01)	(0.01)
Total landholding size (hectares)	0.06***	0.03*	0.08***	0.05***
	(0.02)	(0.02)	(0.02)	(0.02)
Rural location of the household	-0.13***	-0.03	-0.27***	-0.11***
	(0.04)	(0.04)	(0.05)	(0.04)
Crop diversification	0.001	0.01	0.01	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)
Log distance daily market (Km)	0.02**	0.02**	0.002	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)
Irrigation scheme in the community	-0.04*	-0.03	-0.07**	-0.02
	(0.02)	(0.03)	(0.03)	(0.02)
Log number of households	0.02***	0.02**	0.04***	0.01**
	(0.01)	(0.01)	(0.01)	(0.01)
Market extension advice through ICT	0.02	0.06**	0.07**	0.01
	(0.02)	(0.03)	(0.03)	(0.02)
Year 2013 dummy	0.11***	0.15***	0.15***	0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	8.15***	3.17***	1.74***	4.08***
	(0.07)	(0.08)	(0.09)	(0.07)
Number of observations	8000	8000	8000	8000
F-Statistic	39.59	37.49	39.07	37.78
Prob > F	0.0000	0.0000	0.0000	0.0000
Overall R-squared	0.23	0.18	0.25	0.22
rho	0.40	0.39	0.42	0.39
Robust Hausman test: Sargan-Hans	57.60***	54.09***	84.03***	57.85***

Note: *, **, *** represents statistically significant at 10%, 5% and 1% significance level, respectively; robust cluster standard errors (SE) are in parentheses.

Table 8: Regression results on factors determining household consumption of food micro-nutrients per capita per day

Explanatory Variables	Dependent Variables: Log total per capita per day micro-nutrients consumed			
	Iron	Zinc	Vitamin A	Folate
	FE Model	FE Model	FE Model	FE Model
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
Access to extension services	-0.03	-0.01	-0.04	0.04
	(0.03)	(0.03)	(0.07)	(0.03)
Subsidised fertilizer (Kg)	-0.0004	-0.0002	-0.0013	-0.0003
	(0.0003)	(0.0003)	(0.001)	(0.0004)
Access to extension services # Subsidised fertilizer (Kg)	0.0009**	0.0006	0.0016	0.0006
	(0.0004)	(0.0004)	(0.001)	(0.0005)
Household head (female)	-0.07**	-0.07**	-0.09	-0.09**
	(0.03)	(0.03)	(0.08)	(0.04)
Household head age (years)	0.002*	0.002**	0.01***	0.002*
	(0.001)	(0.001)	(0.003)	(0.001)
Household head primary education	-0.03	-0.01	0.26***	0.02
	(0.03)	(0.03)	(0.08)	(0.04)
Household head secondary education	-0.06	0.03	0.39***	0.07
	(0.05)	(0.04)	(0.11)	(0.05)
Household head tertiary education	0.01	0.08	0.51***	0.09
	(0.06)	(0.05)	(0.14)	(0.06)
Household size (adult equivalent)	-0.14***	-0.13***	-0.15***	-0.13***
	(0.01)	(0.01)	(0.02)	(0.01)
Total landholding size (hectares)	0.03*	0.05***	0.03	0.04**
	(0.02)	(0.02)	(0.05)	(0.02)
Rural location of the household	-0.03	-0.08**	-0.31***	-0.09*
	(0.04)	(0.04)	(0.10)	(0.05)
Crop diversification	0.01	0.01	0.05**	0.04***
	(0.01)	(0.01)	(0.02)	(0.01)
Log distance daily market (Km)	0.02**	0.02**	0.03	-0.01
	(0.01)	(0.01)	(0.02)	(0.01)
Irrigation scheme in the community	-0.03	-0.04	0.13*	-0.01
	(0.03)	(0.03)	(0.07)	(0.03)
Log number of households	0.02**	0.02***	0.02	0.03***
	(0.01)	(0.01)	(0.02)	(0.01)
Market extension advice through ICT	0.06**	0.02	0.04	0.03
	(0.03)	(0.02)	(0.06)	(0.03)
Year 2013 dummy	0.15***	0.13***	0.14***	0.20***
	(0.01)	(0.01)	(0.03)	(0.01)
Constant	3.17***	2.72***	4.69***	6.15***
	(0.08)	(0.07)	(0.19)	(0.09)
Number of observations	8000	8000	8000	8000
F-Statistic	37.49	40.79	9.87	43.93
Prob > F	0.0000	0.0000	0.0000	0.0000
Overall R-squared	0.18	0.23	0.08	0.18
rho	0.39	0.38	0.40	0.37
Robust Hausman test: Sargan-Hansen	73.21***	48.31***	46.28***	59.82***

Note: *, **, *** represents statistically significant at 10%, 5% and 1% significance level, respectively; robust cluster standard errors (SE) are in parentheses.