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Impact of a Multi-Sectoral Intervention Program on the Dietary Diversity of Smallholder Farmers in Uganda[1]

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Nutritional deficiencies are a major contributor to lost productivity, impaired physical and mental development, susceptibility to various diseases, and premature deaths. Increasing dietary diversity is therefore an important strategy to improve development outcomes. This study investigates the impact of the Uganda Community Connector Project (UCCP) integrated nutrition, water-sanitation-hygiene (WaSH), rural credit and agriculture program on the dietary quality of smallholder farm households in Uganda. We use a longitudinal panel data set, generated using a cross-sectional Randomized Control Trial (RCT) study design that was implemented in six randomly selected districts in southwestern and northern Uganda to estimate a panel ordered logistic regression model, using demographic, socioeconomic, cultural and geographical factors as covariates, and dietary diversity score as a proxy measure of nutrition security. Households located in the UCCP sub-county showed a significant increased probability of attaining a more diverse diet. Location and key socio-demographic factors including livestock ownership were found to positively and significantly influence the dietary diversity of the household. Meanwhile, frequency of pregnancies of the caregiver negatively and significantly influenced diet diversity. The findings suggest that an integrated multi-sectoral approach to nutrition improvement (via diet quality) can be effective, particularly where pre-program socio-demographic, cultural and agro-climatic factors predispose successful outcomes. Beyond technical program interventions, an effective policy mix is also critical for successful improvement of dietary diversity of smallholder farmers.

Keywords: Dietary diversity, Nutrition, Agriculture, Water-sanitation-hygiene, Uganda, Panel ordered logistic regression

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INTRODUCTION

Inadequate nutrition can lead to various physical and mental health impairments with negative consequences for the victim's productivity and immune system (Sibhatu et al., 2015). Uganda is presented as a potential re-

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gional food basket in the Eastern Africa region and indeed a variety of food stuffs can be found in most markets across the country. However, the country still experiences hunger with an average per capita energy consumption of 1,860 kcal falling short of the recommended 2,200 kcal per person per day. The diet diversity of 8.2 food groups also falls short of the recommended level of 9.2 food groups (NPA, 2017). According to Uganda's second national development plan (NDPII), the key interventions to end hunger, achieve food security and improved nutrition include enhancement of consumption of diverse diets at household level, fortification of common staple foods and control of pests, diseases and vectors, among others (Republic of Uganda, 2015).

Aside from the quantity of food consumed, nutritional deficiencies can also result from poor diet quality and diversity. As such, increasing dietary diversity can be an important pathway to improve nutrition and health of households (Sibhatu et al., 2015). The Food and Agriculture Organisation (FAO) (2011), defines such dietary diversity as "a qualitative measure of food consumption that reflects household access to a variety of foods". Dietary diversity is associated with socio-economic status and household food security (FAO, 2010). Diverse diets are therefore believed to increase the likelihood of meeting nutrient requirements by providing a variety of nutrient sources, and that interactions between foods can have added benefits. It can therefore serve as a proxy for an adequate intake of nutrients.

Recent research has gone beyond measurement of dietary diversity to understanding the determinants of dietary diversity in multiple cultures and settings. Sibhatu et al. (2015) recently analyzed the relationship between dietary diversity and farm production diversity and market access (including their interactions) across four countries, three in Africa and one in Asia. Their main finding was that "on-farm production diversity is positively associated with dietary diversity in some situations but not in all". The authors recommended additional research to better understand how agriculture can be made more nutrition-sensitive and the need to take into account institutional and cultural aspects at the local level. The present study examines, among other covariates, the association between livestock production and dietary diversity.

This better understanding can benefit from improved methods. Sibhatu et al. (2015) used a Poisson distribution that suffers from the problem of equi dispersion (as explained below). There is therefore a need to analyze dietary diversity in a more rigorous manner. Furthermore, many studies have relied on generating and interpreting coefficient estimates. However, as noted by Hilmer and Hilmer (2014), estimated slope coefficients indicating the log-odds ratio lack a simple intuitive economic interpretation, necessitating their conversion into estimated marginal effects (dy/dx) for interpretation. Here, we convert estimated coefficients into marginal effects that are easier to interpret.

Another relevant study is one by Shively and Sununtnasuk (2015) that examines the correlations between agricultural diversity and child stunting in Nepal. The key findings of that study were that in children over 24 months, increases in overall crop yields are associated with significant improvements in height-for-age Z scores (HAZ) (the key nutrition indicator used in this study) and with decreased probability of stunting (the second nutrition indicator analyzed). Against conventional wisdom, the authors found that higher ratios of own consumption were associated with lower HAZ and with increased probability of stunting. With regard to different food groups, their study established that higher shares of root crops were associated with reduced probability of stunting, while the production of animal products improves HAZ. Increases in vegetable and root crop production were also found to be associated with decreased probability of stunting among children younger than 24 months and those older than 24 months, respectively. The authors concluded that efforts to strengthen agricultural diversification and overall agricultural performance would be beneficial to children.

Our contribution to this debate is to recast the analysis by focusing on an innovative integrated agriculture, nutrition and health approach adopted by the Uganda Community Connector Project (UCCP) to improve nutrition among rural households in Uganda. This study specifically asks whether UCCP's set of individual or combined interventions is correlated with dietary diversity as a proxy measure of nutrition security. Unlike many other studies that use single period cross sectional data, we analyze a rich longitudinal panel data set, generated using a cross-sectional Randomized Control Trial (RCT) study design that was implemented in six randomly

selected districts in southwestern and northern Uganda. The RCT happens to be the most rigorous and robust research design of determining whether a cause-effect relationship exists between an intervention and an outcome. The RCT method avoids evidence based on observational data that tends to be biased. We also apply the most recent panel data analytical methods that are more rigorous and insightful.

The overall objective of this study is hence to examine the impact of UCCP's integrated multi-sectoral approach to nutrition improvement together with relevant demographic, socioeconomic, cultural and geographical factors on the nutritional outcomes of rural households in Uganda.

METHODOLOGY

Study Setting

Uganda has a higher population density than most of its neighbors (Uganda Bureau of Statistics, 2019). Most Ugandans (over 75 percent) live in rural areas and depend on agriculture as their main source of livelihood, with 69 percent of all farming households living via subsistence agriculture for income and food. Uganda has a high and diversified agricultural potential but surprisingly also suffers unprecedented high rates of undernutrition and food insecurity. The recent Uganda Demographic and Health Survey indicated that 29 percent of children under-five were stunted while 11 percent were considered underweight. Fifty two percent of children under-five and 32 percent of reproductive women were anemic (UBoS and ICF, 2017). Moreover, a large section of the population is unable to access nutrient-dense foods, and are vulnerable to both income poverty and food insecurity.

Even though the western region has a large overall food production, it has some of the highest rates of child undernutrition compared to other regions of Uganda. Recent research has shown that integrating nutritional concerns in agricultural policies and ensuring proper allocation of household resources can increase access to diverse nutrient-dense diets in rural agrarian settings (Ruel and Alderman, 2013). Thus, for sustainable gains in welfare, health and nutrition outcomes, implementation of multi-sectoral approaches that integrate agriculture, nutrition and health interventions is paramount. The Uganda Community Connector Project (UCCP) was initiated by the USAID Feed the Future as a flagship program to provide a comprehensive and multi-sectoral approach to solving problems related to poverty, food insecurity and undernutrition in rural Uganda (fhi360, 2016). The UCCP's integrated approach comprised a wide range of interventions targeting intra-household gender dynamics, nutrition and health behaviors, farming as a business, water, sanitation and hygiene (WaSH), as well as savings and a range of agricultural-based enterprises to improve disposable income. The program worked with local governments in 15 districts: 9 in northern Uganda and 6 in southwestern Uganda.

Data and Sources

A cross-sectional Randomized Control Trial (RCT) study design was implemented in six randomly selected districts in southwestern and northern Uganda. The analysis is based on 3,600 randomly selected households sampled for the baseline study in 2012 and two follow up surveys in 2014 and 2016. Sample selection followed a step-wise process. Six (out of 15) districts that would subsequently benefit from Uganda Community Connector Program (UCCP) interventions were randomly selected by region with equal probability. Four districts we eventually selected from northern Uganda and two districts from southwestern Uganda. Prior to the baseline survey, UCCP had identified three (out of an average nine) sub-counties in each of the UCCP districts that would benefit from the interventions. These were purposively included as study sub-counties. In addition, one extra sub-county was randomly selected to act as a purely non-UCCP participating sub-county (or control). This in total makes four study sub-counties per district. The research team obtained a list of all parishes (for each of the selected sub-counties), and the number of villages and households in each study parish, from the Uganda Bureau of Statistics (UBOS). All parishes were qualified to participate in the study. However, due to high costs involved in covering multiple villages, it was agreed that 25 percent of villages in each parish be randomly selected to participate in the study. Villages within town councils were deliberately excluded from the study.

To determine a minimum detectable difference between UCCP and counterfactual (control) parishes, a sample size of 600 households was necessary at the district level. Using population proportional to size (PPS) methods, the number of households to be interviewed within each parish was calculated and allocated equally across all qualifying villages within the parish.

At village level, field teams (trained enumerators) worked with local leaders to construct household sampling frames by compiling a complete list of household heads in a selected village. Field supervisors randomly selected the predetermined number of potential households to be surveyed. At the time of data collection, local guides were used to trace the selected households to be interviewed. The target survey respondents were primary mothers of the randomly selected child aged 0-23 months, or women of child-bearing age.

Study enumerators were hence required to collect data on one child aged 0 to 23 months (index child) and a woman of reproductive age (18-49 years) referred to as the primary caregiver. However, for the purpose of understanding the effects of UCCP interventions on other age groups, data were collected on all children under five. If there was more than one potential index child, the children's names were listed and one child randomly selected as the index child. While it was possible to have almost all households at baseline with a caregiver and an index child, subsequent rounds in 2014 and 2016 faced some sample losses because households were not meant to be replaced. Generally, the household attrition rate was seven percent, which is statistically acceptable. The survey tool was translated into the local languages for ease of comprehension. Data were collected using pretested questionnaires uploaded on Android Tablets using Open Data Kit (ODK) software to capture all information, including details on GPS location for easy tracing and future reference. The focus of data collection ranged from demographics (including education) and socio-economic status of the household to include diet and health status of mothers/primary caregiver, anthropometric and hemoglobin measurements in the primary caregiver/mother, the index child and all other children in the household under 5 years of age. The caregiver diet module inquired about consumption of 10 major food groups including cereals, roots/tubers/plantain, legumes, oil seeds, vegetables, fruits/juices, meats, dairy products, fats/oils, and others (sugar, coffee, tea, condiments, soda, alcohol) over a 24-hour recall period. A food security assessment was conducted using two tools: i) the Household Food Insecurity Access Scale and ii) a tool to estimate months of adequate household food provisioning. The agriculture module included an in-depth survey of the past year's production by crop, livestock activities and household consumption versus sales. Data were also collected on gender, decision-making and time allocation, access to information and infrastructure and use of agricultural technologies and management practices.

Analytical Model

Our dependent variable—household dietary diversity—was defined as the number of food groups consumed by a household over the 24-hour food recall period (Feed The Future, 2016). Since it is a non-negative count variable with integer values from 1 to 10, the application of standard ordinary least-squares regression (which assumes a continuous dependent variable) is not appropriate. Household dietary diversity is measured by a three-point scale (1-4 food groups for low dietary diversity; 5-8 food groups for medium dietary diversity and 9-10 food groups for high dietary diversity) and thus a categorical and ordinal nature variable. Because the dependent variable has three ordinal categories, and we have a three-period panel, we estimated a random effects panel ordered logit model as explained below. Muris (2016) presents an excellent summary of empirical studies that use panel data with ordered responses covering various disciplines of applied economics.

Random Effects Panel Data Models

We use the random effects model (Hilmer and Hilmer 2014) to study the impact of the Community Connector (CC) interventions (combined with other important covariates) on the dietary diversity of households- a proxy for household nutrition security. The underlying population regression model we estimated is presented in equation 1 below:

$$\tilde{y}_{it} = \beta_0 + \beta_1 \tilde{x}_{1,it} + \beta_2 \tilde{x}_{2,it} + \cdots \beta_k \tilde{x}_{k,it} + \tilde{u}_{it} \quad (1)$$

Table 1. Hypothesized explanatory variables and a priori sign expectations

Variable	Description	Expected sign	Reason
Location	Dummy variable for region (northern region = 1, southwestern region = 0)	+	The northern region has better nutrition indicators compared to the western region. It is hypothesized that the northern region would equally have better dietary diversity scores
Age	Age of participant/index woman in years	+	Age, until at least up to some point, is expected to increase household resources and experience translating into better nutrition outcomes
Sex	Sex of the household head (Male = 1; Female = 0)	+	In agrarian Uganda, men have better access to resources and opportunities with better provisioning for household nutrition and hence diet
Educ	Education (years of completed education) of caregiver/index woman	+	Education is expected to equip the mother with better nutrition information
Nut Info	Dummy for access to nutrition information by caretaker (dummy variable) with Access to nutrition information = 1 and No access to nutrition information = 0.	+	Access to nutrition information is hypothesized to improve nutrition knowledge and result in high levels of dietary diversity
FIns	Reported household food Insecurity Access Prevalence; categorical variable with 4 categories. Created 3 dummy variables for mildly food insecure, moderately food insecure and severely food insecure with food secure as the omitted/base or comparison category.	+(–)	It is hypothesized that the higher the severity of food insecurity the lower the levels of dietary diversity
PProv	Adequacy of food provisioning in the last 12 months (Household had enough food = 1, Household didn't have enough food = 0)	+	Adequate food provisioning is hypothesized to be directly correlated with high dietary diversity
UCCP project	Location in a community connector sub-county dummy variable (community connector sub-county = 1, Otherwise = 0)	+	Community connector interventions are expected to increase nutrition knowledge and awareness and improve dietary diversity
Marital	Marital status (categorical variable with 7 categories). We modeled 6 dummy variables to avoid perfect collinearity using the omitted/base or comparison category	+(–)	Whereas marital status is expected to affect the dietary behavior of the household, the direction of causation is largely indeterminate Polygamy is hypothesized to result in increased competition for joint resources and hence reduced child care capacity
Illness	Dummy variable with yes = 1 and no = 0	+	Frequent illness is expected to lead to lost work time and negatively impact household food provisioning and diets
Npregna	Number of pregnancies ever had	–	Many pregnancies and attendant child care are hypothesized to compromise time for productivity hence negatively impacting household nutrition security and diet
Livestock	Farming type (categorical variable with 2 categories). mixed farming = 1. crops only = 0.	+	We expect households engaged in mixed farming to have more diverse diets than households engaged in purely crop farming only
FPmethod	Usage of any family planning method	+	Usage of family planning is expected to control birth and hence release mother time for productive activities and lead to higher food availability and better diets

where:

$\tilde{y}_{it}$ is the dietary diversity score category of household i in time t (with three ordinal categories) $\tilde{x}_{1,it}$-----$\tilde{x}_{k,it}$ is a set of 13 hypothesised explanatory variables as presented in Table 1.

β_0-----β_k is the set of parameters to be estimated, and $\tilde{u}_{it}$ is the residual error term.

Table 1 presents a listing and description of the explanatory variables, based on economic theory and literature, that are hypothesised to be associated with household level nutrition security together with their a priori sign expectations.

The quantitative data from the household questionnaire were analyzed using the STATA Econometrics program.

RESULTS AND DISCUSSION

Descriptive Results

Table 2 presents descriptive statistics for selected variables used in the study. As shown, a majority of the households (58.15%) have a high dietary diversity score followed by households with medium dietary diversity score at 31 percent. Mean years of education for both the household head and for the caregiver follow a similar trend averaging about 7 years and 4 years of formal education for (high dietary diversity) household heads and caregivers, respectively. Households with a high dietary diversity score also have a higher proportion of male headship at close to 90 percent compared with the other two dietary diversity categories. Meanwhile, households with low dietary diversity are headed (on average) by older persons compared to the other two categories with mean age of household heads about the same at 29 years. The highly significant F (Chi-square) values indicate that the three sample means (percentages) are not equal and we reject the null hypothesis that all the three means (percentages) are equal. The descriptive results suggest that education, male and younger household headship contribute to high household diet diversity.

Determinants of Dietary Diversity

Because the estimated slope coefficients indicating the log-odds ratio lack a simple intuitive economic meaning (Hilmer and Hilmer, 2014), they were converted into estimated marginal effects (dy/dx) that are presented in Table 3 and discussed below.

Results in Table 3 show that all other variables constant, being located in northern Uganda instead of southwestern Uganda additively increases the probability of attaining a more diverse diet by 5.2 percentage points. This is consistent with previous studies in Uganda which showed that western Uganda has persistently registered highest levels of childhood malnutrition despite being referred to as "the food basket" of the country (Kikafunda et al., 2014) and also because households in northern Uganda are said to have richer food cooking habits and to accept more diverse foods in their menu.

Similarly, the head of the household being older additively and significantly increases the probability of having

Table 2. Descriptive statistics of selected variables used in the model by dietary diversity score

Level of dietary diversity	Low HDDS (n = 1,096)	Medium HDDS (n = 3,092)	High HDDS (n = 5,819)	Chi/F-value	p-value
Proportion of households (%)	10.95	30.90	58.15	110.996	0.000
Education of household head (mean)	4.93 (3.29)	5.53 (3.31)	6.60 (3.31)	96.55	0.000
Education of caregiver (mean years of schooling)	2.98 (2.94)	3.48 (2.93)	4.43 (3.09)	76.15	0.000
Sex of the household head (% male)	82.02	85.94	89.69	35.407	0.000
Age of the household head (mean years)	34.02 (12.90)	29.99 (12.45)	29.47 (12.38)	29.16	0.000

Figures in parentheses are standard errors.

Table 3. Estimated marginal effects from the panel ordered logit estimation of dietary diversity

Variable	Level of household dietary diversity score (HDDS)					
	Low HDDS		Medium HDDS		High HDDS	
	dy/dx	p-value	dy/dx	p-value	dy/dx	p-value
Location (region)	–0.04	0.00	–0.01	0.00	0.05	0.00
Age of the household head	–0.00	0.00	–0.00	0.00	0.00319	0.00
Sex of the household head	–0.01	0.74	–0.00	0.74	0.01109	0.74
Education of caregiver	–0.01	0.00	–0.00	0.00	0.01450	0.00
Access to nutrition info.	–0.07	0.00	–0.02	0.00	0.09282	0.00
Mildly food insecure	0.01	0.48	0.00	0.44	–0.01646	0.47
Moderately food insecure	0.03	0.04	0.01	0.03	–0.04	0.03
Severely food insecure	0.12	0.00	0.02	0.00	–0.15	0.00
Food provisioning	0.00	0.85	0.00	0.85	–0.00	0.85
UCCP sub-county	–0.10	0.00	–0.04	0.00	0.14	0.00
Married monogamous	–0.03	0.49	–0.01	0.43	0.04	0.48
Married polygamous	–0.02	0.62	–0.01	0.62	0.03	0.62
Cohabiting	0.14	0.06	0.00	0.83	–0.14	0.01
Single	0.07	0.44	0.01	0.00	–0.08	0.37
Widowed	–0.04	0.24	–0.02	0.36	0.06	0.28
Divorced	–0.04	0.44	–0.02	0.56	0.07	0.49
Had illness in past 2 weeks	0.01	0.40	0.00	0.40	–0.01	0.40
Number of pregnancies ever had	0.01	0.00	0.00	0.00	–0.01	0.00
Livestock ownership	0.03	0.02	0.01	0.05	0.04	0.03
Family planning method	–0.00	0.89	–0.00	0.89	0.00	0.89
LR Chi2 (20)				573.63		
Prob > Chi^2				0.00		
Log Likelihood				–6134.80		
Pseudo R^2				0.04		

Note: Dependent variable is dietary diversity score.

a more diverse diet by 0.3 percent points. Although contradicting the above noted descriptive result, age tends to positively correlate with accumulation of both production resources and financial means to afford a more diverse diet for the household. Conversely, households headed by younger people tend to be extremely vulnerable both in terms of access to productive resources and food provisioning most especially since Uganda lacks an effective food safety net program. Our results here contrast with the findings by Shively and Sununtnasuk (2015) in their analysis of child stunting in Nepal. They found that characteristics of the household such as age of the head, the household dependency ratio and father's education had little independent or joint influence in determining nutrition outcomes for children in their sample.

A household being headed by a man rather than a woman also positively but not significantly increases the probability of the household having a more diverse diet. In patriarchal societies of which Uganda is but one, males are more likely than females to access and control resources that can then be translated into food provisioning. Conversely, female headed households, just like child headed households, tend to have compromised food and nutrition security and diets. The role of gender in determining household food and nutrition security is well documented (Sraboni et al., 2014; Sibhatu et al., 2015).

The findings of this study shows the education level of the caregiver to be a strong predictor of the nutrition security of the household. All other variables constant, the caretaker having a comparatively higher education

level additively increases the probability of the household attaining a more diverse diet by 1.5 percentage points. Education not only enhances the household capacity to acquire adequate food but it also empowers the caregiver in terms of nutrition knowledge. The importance of maternal education can be influenced by gender roles in the household as well as socio-economic and other conditions (Reed et al., 1996; Frost et al., 2005).

Maternal education is also sometimes considered as a proxy variable for the socio-economic status of the household (Desai and Alva, 1998). Thomas et al. (1991) have urged that maternal education works primarily through the effect of education on improved access to health and nutrition information. Shively and Sununtnasuk (2015) also found material education to be a strong and robust predictor of HAZ and child stunting in Nepal. Indeed, the results of our analysis also show that nutrition information is translating into richer household diets. All other variables constant, access to nutrition information by the caretaker compared to no access additively and significantly increases the probability of a household having a more diverse diet by 9.3 percentage points.

The present analysis also demonstrates that self-reported food insecurity is consistent with the nutrition status of the household. All other variables constant, relative to reporting to be food secure (the omitted group), a household reporting severe food insecurity additively increases the probability of having a low household diet diversity by 12.1 percent points, that of having a medium household diet diversity by 2 percentage points, and significantly decreases the probability of having a more diverse household diet by 14.6 percentage points. Reported mild food insecurity and food provisioning were not significant factors in the diets of the households.

The results show that the presence of the UCCP in the sub-county significantly and additively increased the probability of a household in that sub-county having a more diverse diet by 13.8 percentage points. This is because as earlier noted, the UCCP interventions included training components on nutrition and health behavioral change, farming as a business; water, sanitation and hygiene (WaSH), and introduction of a range of agricultural-based enterprises all with great potential to improve dietary diversity. This is a relatively high response and signals a high degree of effectiveness of the UCCP interventions in improving household diets. It must also be noted that both UCCP interventions and controls were in districts with adverse nutritional indicators so this percentage change is from a very low base. The beneficiaries of the UCCP project included all households located in the UCCP sub-counties in the selected districts.

Additionally, we also examined the impact of marital status and different types of marriage relationships on the diversity of household diets. This is because, at least in principle, different marriage relationships entail differences in power relations, and access to resources that we conjectured might translate into differing food security and diet situations. Our results (Table 3) show that marital status of all types did not significantly affect the diversity of rural household diets. The exception was being single. All other variables held constant, relative to being separated (omitted category) being unmarried (single) significantly increases the probability of a household attaining medium diet diversity status by 1.1 percentage points. Furthermore, all other variables held constant, recent illness on the part of the caregiver had no significant impact on the diversity of the household diet. It is not clear why marital status did not impact household diet diversity and we recommend further investigation of this particular aspect. Furthermore, there is a time lag for illness of the caretaker to manifest its impact on household diet diversity.

We hypothesized that frequency of pregnancy might negatively impact on the nutrition security of the household, because of the time lost in nursing and caring for infants. Indeed, the results reveal that the frequency of pregnancies does significantly and negatively affect household dietary diversity. All other variables held constant, the caregiver having more pregnancies compared to fewer pregnancies significantly decreases the probability of the household attaining a more diverse diet by 0.2 percentage points. This result underscores the importance of maternal education, household income and birth control in improving household diets. The method of family planning used by the caretaker was not significant. Spaced pregnancies clearly allow the mother more time for both agricultural production and for taking care of the nutritional needs of the household.

There is evidence that households engaged in mixed farming have lower poverty levels. We were interested in

establishing whether this aspect translates into household nutrition security as measured by dietary diversity. Indeed, our results show that livestock ownership by the household is highly correlated with the diversity of the household diet. All other variables held constant, livestock ownership additively and significantly increases the probability of a household having a high diverse diet by 3.9 percentage points. The percentages are 2.7 for a low diverse diet, and 1.2 for a medium diverse diet. This result corroborates Shively and Sununtnasuk (2015) who found that production of animal products (by the household) improves HAZ by nearly a quarter of a standard deviation and Sibhatu et al. (2015) who found on-farm production diversity to be positively associated with dietary diversity.

CONCLUSION

This study contributes to our understanding of how an integrated nutrition and agriculture program can perform in a smallholder farm setting in rural Africa. Panel data regression analysis results based on 3 rounds of household data show that the intervention's package positively and significantly improves household nutrition security by enhancing the dietary diversity of smallholder households. The results also highlight the role of socioeconomic, demographic and locational factors in realizing the desired outcomes. From a policy perspective, our results suggest that the success of efforts to strengthen household nutrition security and overall performance of nutrition programs and interventions will be enhanced if additional attention is given to the attendant household level factors as well, such as age, gender of the household head, household farming practices and the local socioeconomic context in as far it enables access to important social services such as nutrition information and birth control services. Additional leverage is obtainable by factoring into the program the agroecological context of the intervention area. The Feed the Future UCCP was a package of several interventions, hence more research is needed to isolate the specific elements of the program and analyze the precise nutritional benefits of each one of them.

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