Agricultural Aid and Food Security in Africa[1]

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Abstract

This paper investigates the effects of agricultural aid on food security in African countries during the the 1990 to 2012 period. Defining food security as increases in agricultural productivity and controlling for a large number of covariates, we find that agricultural aid, at the aggregate level, aid to the agricultural sector has positive and statistically significant effect on food security in African countries. Disaggregating agricultural aid, we find that all components of agricultural aid have significant effects on several indices of food security although the strength of the effect vary across indices of food security. The results are robust to several specifications and different estimation methodologies.

KEY WORDS: AGRICULTURAL AID, FOOD SECURITY, AFRICA

JEL: F35, I15, O, 019, O55

give a child fish and he will eat for a day; teach a child to fish and he will eat always

ancient proverb.

1 Introduction

This paper uses panel data from African countries over the 1990-2012 period to investigate the effects of non-food agricultural aid on food security in Africa countries. We employ a dynamic panel data estimator to investigate the effects of total agricultural aid (*totalagraid*) on several measures of food security as well as the effects of various components of non-food agricultural aid on the different measures of food security we employ. We focus on non-food agricultural aid because we are concerned with medium to long term food security as opposed to the immediate short term effect which food aid provides. In spite of the role that non-food agricultural aid could play in ensuring the medium to long term food security in Africa, most studies of the the effect of agricultural aid in food security in Africa focuses on food aid which does not address the medium to long term food security.

Improving food security and reducing hunger in developing countries has been an important goal of policy makers in Developing Countries as well as development partners in high income countries. Indeed, the just ended Millennium Development Goals (MDGs) made food security (reducing hunger) the number 1 Goal while the newly adopted Sustainable Development Goals (SDGs) makes it the second Development Goal. That reducing hunger ranks so high on the development agenda is understandable. Apart from the need for food as energy to go about everyday physical activities, the World Health Organization (WHO) notes that food (in)security is highly correlated with the risk of serious infectious diseases and malnutrition, which if occurs at some critical development stages (early childhood), may lead to irreversible loss of cognitive capabilities.[1]

The Food and Agriculture Organization's (FAO) 2014 Food Security Report indicates an increasing trend in food security around the world with wide regional variation.[2] While food security has increased in every part of the world, Africa and Oceania provide a complicated picture. For example, while the prevalence of under-nourishment in Africa decreased from 27.6% to 20.0% between 1992 and 2014, the number of people under-nourished increased from 182 million to 233

million over the same period.[3] This suggests that in spite of the progress made, food (in)security still remain an important and critical development issue in Africa. Within Sub-Saharan Africa (SSA), there are wide variations in food security across sub-regions. While there was a 25.2% increase in the number of people under-nourished in Sub-Saharan Africa during the period, West Africa saw a 24.5% reduction in the number of people under-nourished, all other sub-regions in SSA saw increases (led by Middle Africa's 143.7%) in the number of people under-nourished during the period.

Improving food security and reducing poverty in Africa is one of the major priorities of the development agenda of this region. The agricultural sector plays an important role in improving food insecurity, food production and rural livelihoods in African countries given that on average 63% of the population lives in rural areas and are dependent on agriculture directly or indirectly.[4] However, increases in agricultural productivity in African countries have been slow. Average agricultural productivity has grown by less than 1% annually in the last decade compared to 2% in other developing regions of the world. Partly as a result of low agricultural productivity, Africa remains the world's most food insecure continent despite the current high economic growth rate.

There is no general agreement on the definition and measurement of food security; while some researchers focus on the supply of food, others focus on the availability of food to households; still others focus on food access.[5] None of these measures is likely to be an adequate reflection of food security since food security must not only imply the availability of food in sufficient quantity and quality (nutritional content) but must also be accessible to most people, especially vulnerable people. The FAO (2008) defines food security as a situation

> "... when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and health life".

This definition encompasses four major components of food security—availability, access, utilization, and stability of food availability. In this sense, food security may require not only access to adequate amount of food, it may also require other resources such as clean water, sanitation and health care to properly utilize food to meet physiological well being. This highlight the importance of non food inputs into food security. Stability stresses the need for access to adequate and nutritious food at *all times* and not be vulnerable to shocks, such as income or weather. We adopt

this broader definition of food security because it captures most of the essential elements of food security. Because of the multi-dimensional nature of this definition of food security, it may not be possible to adequately capture it with one index/measure. Therefore we use several alternative components of food security as our representation in this study.

It is possible that agricultural aid could reverse the declining trend in agricultural productivity by creating opportunities for growth and development in agriculture through transformation of the food systems (von Braun, 2013, Cohen: 2013, Herman: 2009, Norton *et al*: 1992, among others). While total aid to Africa has increased over the past forty years, agriculture aid fell in the 1980s and 1990s by 43% before increasing in recent years triggered by the 2007/2008 and 2011 food crises (Islam 2011, Umbadda and Elgizouli, 2013). Despite the decline, Sub-Saharan Africa still received the largest share of agricultural aid (34%) in 2010/2011. In 2009-10, agricultural aid to Sub-Saharan Africa from both DAC and multilateral agencies was USD 9.3 billion, more than a 100% increase from the USD 4.45 billion that was giving in 2005-06 (OECD 2014)[6] . In 2010/2011, the sub-sectoral breakdown of agricultural and rural aid commitments show that agricultural production had the highest (30%) followed by rural development (19%) and then agricultural policy (16%).[7]

An inspection of data on agricultural aid to Africa shows an increase in investment in short-term food aid compared long-term investment in agricultural production (FAO, 2014). While an increase in food aid is not likely to foster long term food security, most discussion of the relationship between agricultural aid and food security in Africa focuses on food aid (Abdulai, Barrett and Hoddinott 2005; Gelan, 2007; Gilligan and Hoddinott 2007; Kuhlgatz, Abdulai and Barrett, 2010; Smets, Tusiime and Renard, 2013; Broussard, Dercon and Samanathan 2014). Given the size of agricultural aid, it is surprising that few studies we are aware of has examined the impact of agricultural aid on food security, agricultural productivity and consumption in African recipient countries.

This paper takes a different path to study the impact of agricultural aid on food security in Africa. Because we are concerned with the effects of agricultural aid on medium to long term food security rather than the short term availability of food, we exclude food aid from the measure of agricultural aid in this paper. We investigate two questions; (i) Does non-food agricultural aid improve food security in Africa? (ii) Does the composition of non-food agricultural aid matter for the effectiveness of agricultural aid on food security. We make no strong claims to a causal relationships in this paper since we do not provide any strong and credible identification.

We define agricultural aid as total aid to the agricultural sector for our purposes. It is possible that different components of agricultural aid, such as aid for agricultural research or for land improvements may affect food security differently compared to the effects of total agricultural aid. It is also possible that a particular component of agricultural aid may affect one aspect of food security and not other aspects. Therefore, in addition to investigating the effects of total agricultural aid on food security, we also investigate the effects various components of agricultural aid on food security.

This paper makes some contributions to the literature on the relationship between agricultural aid and food security in developing countries. This is the only study we are aware of that uses panel data and a dynamic panel data estimator to investigate the relationship between non-food agricultural aid and food security in African countries instead of the usual emphasis on food aid. This paper also investigates the relationship between non-food agricultural aid and a large set of food security indicators instead of a focus on one or two measures of food security, thus allowing us to provide a broader view of the relationship between agricultural aid and food security. Third, the paper also investigates which components of agricultural aid affect food security, thus providing some guidance for better targeting of agricultural aid. Finally, this paper contributes to the general aid effectiveness debate in linking agricultural aid directly to an important development outcome.

The results of this paper can be summarized as follows: We find that conditional on other factors, total agricultural aid has statistically significant positive effect on all aspects of food security in African countries. However, the absolute magnitude of the effect differ across different indices of food security. In addition, we find that different components of agricultural aid have different effects on food security. Furthermore while different components of agricultural aid have generally positive effects on some indices of food security, some components of agricultural aid may have no impact at all on some measures of food security.

The rest of the paper is organized as follows: Section 2 provides a brief review of the literature on the relationship between aid to agriculture and food security in the developing world, section 3 discusses the data, section 4 introduces the equation to be estimated and the estimation method, while section 5 presents and discusses the statistical results. Section 6 concludes the paper.

2 Brief Review of the Literature

The literature on the relationship between aid, development, and food security in developing countries is very large but can be classified into three broad areas: the effect of food aid food on food security; the effect of aid generally on agricultural productivity, poverty reduction and food security, and the effect of agricultural aid on food security in recipient countries. While the first group of studies see aid as affecting food security indirectly, the last two broad sets of studies view the effect of aid on food security as an indirect one—through increased agricultural productivity, increased rural incomes and poverty reduction.

A large number of studies investigate the effects of food aid on food security in recipient countries. Though these countries find that food aid increases the availability of food supplies in the short run (Abdulai, Barrett, and Hoddinitt: 2005, Awokuse: 2011, Broussard: 2012, Smets, Tusiime and Renard: 2013, Yamano, Alderman, and Christiaensen: 2005, among others), there is a disagreement on the food security effects of such food aid in both the short and long runs. While some researchers argue that food aid leads to improved food security since availability does not guarantee access and utilization on account of agency issues (Kuhlgatz, Abdulai and Barrett: 2010, Broussaard, Dercon and Somanathan: 2014) or conflict, even in the short term, others argue that food aid has significant positive effects of food security in recipient countries, at least in the short term (Abdulai, Barrett, and Hoddinott: 2005, Awokuse: 2011, Broussard: 2012, Yamano, Alderman and Christiaensen: 2005). Nunn and Qian (2014) argue that U.S. food aid leads to the increased intensification and prolongation of civil conflicts.

In the long run, some researchers argue that food aid decreases food security in recipient countries because of disincentive effects leading to decreased agricultural production and increased dependence of recipient countries on food aid. However, other research do not find empirical support for this disincentive effects (Abdulai, Barrett and Hoddinott: 2005, Awokuse: 2011). However, regardless of where a particular researcher stands on the disincentive effect of food aid, there is a general agreement among these group of researchers that food aid does not lead to improved food security in the medium to long term period in recipient countries.

A second group of studies focuses on the effect of agricultural aid (aid generally) on food security in recipient countries. In these studies, aid affects food security indirectly through increased agricultural production (availability), lower food prices, higher incomes and poverty reduction

(increased access) and improved environmental health that leads to increased utilization of food. Two sub-strands of this line of studies can be identified: those that investigate the effects of aid on food security as a by-product of the general aid effectiveness studies and those that only look at the effects of aid on poverty reduction on food security.

A large number of studies investigate the the effects of general aid on poverty reduction and that aid has a relatively large positive and significant effects on rural income and poverty i=reduction in recipient countries (Addison, Singghal, and Tarp: 2013).[9] By extension, these studies imply that such reductions in poverty lead to increased availability, access, and utilization of food. Another sub-set of studies look specifically at the effect of agricultural aid on agricultural productivity and poverty reduction in that sector and finds a strong positive correlation between agricultural aid and by extension, food security (Akpokodje and Omojimite: 2008, Chimhowu: 2013, Islam: 2011, Mosley and Suleiman: 2007, Kaya, Kaya and Gunter: 2008, IYCN: 2011, Norton, Ortiz, and Pardey: 1992, Umbadda and Elgizouli: 2013, and Van Braum: 2013). We note that the objectives of these studies are not to investigate the effects of agricultural aid on food security *per se*.

A related literature does not look at the effects of aid (agricultural or general) on food security but rather investigates the *determinants* of food security in low income countries. These studies generally find that inclusive growth that leads to poverty reduction, food availability, access to sanitation and clean waters and social development are the major determinants of food security in low income countries (Heady: 2012, Christiaensen, Demery, and Kuhl: 2011). The food security effect of inclusive growth is even more powerful if growth is led by rapid increases in agricultural production and incomes (Christiaensen, Demery, and Kuhl: 2011). None of the studies mentioned above directly investigates the effects of agricultural aid on food security in recipient countries, especially in African countries.

The study that is closely related to our study is Petrikova (2015) who uses panel data and both a two stage least squares (2sls) estimator and a dynamic panel data estimator to investigate the effects of aid and its various components on food security proxied by under-nourishment and underweight in 85 developing countries. The paper finds that aid generally has small but significant effect on food security in recipient countries. While multilateral aid has a significant effect in its own right, bilateral aid has a significant effect food security only in countries with good governance. Finally, the paper finds that agricultural aid has a small but significant marginal effect on food security only in countries with good governance. We note that this paper does not focus on food security in

African countries, the region we are concerned with. Second, the paper's main concern is not the effect of agricultural aid on food security; the effect of agricultural aid was just a minor byproduct of the paper. Finally, and more important, the paper measures aid to agriculture to include food aid, which we have argued is not likely to impact long term food security—our interest in this paper. The paper also uses agricultural aid commitment rather than agricultural aid disbursement in the analysis. We account for these shortcomings in our paper.

3 Data

It may be impossible to get a single index/measure that completely captures all aspects of food security (FS), given the complexity of the concept. Besides any particular index of FS focuses on just one dimension that is of interest to the researcher or policy maker (Barrett: 2010, Jones *et al*: 2013, Carletto, Zezza and Barnejee: 2013). In this paper, we use several indices as proxies for various aspects (pillars) of food security. We proxy availability by average dietary energy supply adequacy ($avgesa$) and the prevalence of food inadequacy ($prvfdnind$); utilization is proxied by the prevalence of under-nourishment ($prunourish$) and the prevalence of anemia in pregnant women ($prvapw$) and children under 5 ($prvap5$) while accessibility and stability are proxied by depth of food deficit ($defd$), and per capita food supply variability ($pcapfsv$). We note that this list is not exhaustive and by no means the best proxies for food security. We also note that some of these proxies may be the result of food insecurity (e.g. prevalence of anemia) rather than food security itself. However, given data availability, this is the best we can do.

We measure $avgesa$, $prvap5$, $prvapw$, $prvunourish$, and $prvfdinad$ are measured as the percent of the population that do not have access to adequate daily food energy supply, the prevalence of anemia among children under 5 years and pregnant women, and undernourished and the percentage that do not have access to adequate food on a daily basis. $defd$ is measured as per capita kcal per day while $percapfsv$ and $avgfpv$ are measured as the coefficients of variation of per capita food availability and domestic food prices respectively. Most of the proxies we use in this paper are proxies for food *insecurity* rather than food security, hence a negative relationship between these indices and agricultural aid is indicative of a positive relationship between agricultural aid and food security.

The evolution of these proxies over the 1992-2012 period are presented in Figure 1, a–f. Figure 1

shows that food security in SSA generally improved during the period with undernourishment, food inadequacy and depth of food deficit all declining in every region of the world while dietary energy supply adequacy increased world wide. However, regardless of which index one focuses on, Africa and especially SSA does not fare so well compared to other regions of the world—in practically every indicator, SSA is at the bottom of the food security ladder. The rate of improvements in these indices are also slowest in Africa than elsewhere.

The variable of interest in this paper is external aid to the agricultural sector (*agricaid*). Theoretically *agricaid* encompasses several components including aid for agricultural research, agricultural inputs, land management, water resource management, extensions, and short term food aid. Be definition short term food aid has a direct effect on food availability, hence food security in the short run. However, we are not concerned about short term availability of food in this paper; rather we are concerned with how agricultural aid affects a country's intermediate and long term food security. We therefore exclude food aid from our measure of *agricaid*. In this paper, *agricaid* refers to non-food aid disbursement to the agricultural sector as opposed to aid commitment to the sector.

In this paper, we measure *agricaid* in two ways. First, we measure *agricaid* as total aid to the agricultural sector, net of food aid as a ratio to the agricultural sector budget ($totalagraid$). Second, we measure agricultural aid as the share of aid to specific sub-sectors of agriculture in the budget shares of those sub-sectors such as agrarian reforms, agricultural development including research and extensions, agricultural inputs. The components of agricultural aid we use in the analysis are aid to support agricultural research ($agres$), aid for agricultural education and training ($agedutr$), aid for agricultural land development ($aglsk$), aid for agricultural development ($agdev$), and aid for the provision of agricultural inputs, such as improved seed, fertilizer, and agricultural machinery ($agrncpin$). As indicated above, all these variables are measured as percentages of their respective budget shares. The evolution of the flows of *agricaid* and its components (in levels) are presented in Figures 2 a & b. The figure shows that *agricaid* flows to Africa over the period was, at best, uneven.

The control variables in the food security equation include per capita income ($gdpcap$), political stability ($polstab$), as well as access to improved water supply ($acciws$), the proportion of agricultural land that irrigated ($aleirri$) and government effectiveness ($goveffect$). $polsat$ represents political stability while $goveffect$ is a measure of government's ability to provide government ser-

vices effectively. *aglsk* is used as additional instrument in the estimation. *gdpcap* is measured as real per capita GDP in 2005 purchasing power parity units while *acciws* is the proportion of the population that has access to improved water supply. *polstab* is the presence of political stability and absence of terrorism in a country. *polstab* and $goveffect$ are indices that range between -2.5 and + 2.5 with low numbers indicating inefficiency while high numbers indicate higher efficiency.

The data for estimating the food security equations were obtained from a variety of sources. The food security, agricultural production indices, and agricultural land under irrigation data were obtained from the Food and Agricultural Organization of the United Nations, *Food Security Indicators, 2015*, and downloaded from http://www.fao.org/economics/ess/ess-fs/ess-fadata/en/#.V. Similarly, the agricultural aid data were obtained from FAO's ADAM project website at www.fao.org/tc /adam/data/index.html and supplemented with data from FAO's economic and social sector food security data archives and OECD's *Aid to the Forestry, Fishing, and Rural Development Sectors*, downloaded from www.oecd.org/agriculture. Data for *gdpcap*, and *acciws* were obtained from the World Bank's *World Development Indicators, 2015* downloaded from https://www.data.worldbank.org/products/w

Data for political stability and government effectiveness were obtained from the World Bank's *Worldwide Governance Indicators, 2015*, which was downloaded from http://databank.worldbank .org/data/reports.aspx?source=Worldwide-Governance-Indicators. The Governance Indicators series start in 1996 rather than in 1992 as the other series do. We therefore use a cubic spline to interpolate the *polstab* to 1992. The data are for 54 African countries over the 1992 to 2012 period.[10] To reduce the noise to signal ration in the annual data, we follow earlier researchers and take three year averages of the data. This gives a total of 312 observations for the study.

Summary statistics of the data are provided in table 1. The data shows that food security in African countries tend to be very low although highly variable. For example, the prevalence of under-nourishment, food inadequacy, and prevalence of anemia among children under 5 years averages 26.27, 32.69, and 63.34 percent respectively with vitamin A deficiency ranging from 23.9% to a high of 89.4%. Figure 1 indicates, however that food security in Africa improved over the sample period although there was a lot of regional variation and also variations across indices during the sample period. The mean value of aid to agriculture is relatively high during the sample period. The data and figure 2 also show that aid to the agricultural sector varied widely during the sample period, generally falling during periods of relative food availability and increasing sharply after periods of negative world food supply shocks. Overall however, aid to agriculture at the end

of the period was not significantly different from its volume at the beginning of the sample period.

4 Model and Estimation Method

4.1 Model

The effect of *agricaid* on food security can be considered as part of the general aid effectiveness debate. However, one has to consider the effectiveness of *agricaid* in a different way since the relationship between agricultural aid and food security is an indirect one and medium to long-term in nature. There are several reasons why aid to the agricultural sector (*agricaid*) will affect food security in recipient countries. However, the link between *agricaid* and food security is not a direct one but an indirect one. The closest direct mechanism through which *agricaid* can affect food security is the effect the former on agricultural productivity, affecting food security through the availability pillar. While increasing agricultural (food) productivity increases food supplies, it may not necessarily translate into food security since those who may need food may not have access to the food either on account of income or geographical location. Besides, food security depends on other complementary factors such as income, clean water and taste preferences.

There are several reasons why *agricaid*, if effective should have a positive effect on food security. First, if *agricaid* is effective, it should lead to an increase in food availability, lowering the cost of food. Second, increased agricultural productivity should lead to increased farmer incomes, and combined with increased availability, should lead to increased access to food and diversification of the diet, all things equal (Christensen, Demery and Kuhl: 2011, Cohen: 2015, Heady: 2012, Karya, Karya and Gunter: 2008, Norton *et al*: 2008, Kehrallah *et al*: 1994). Third, increased incomes allows for cleaner environment and sanitation and thus increase food security. Fourth if *agriaid* is successful, it may lead to an increase in the *stability* of food availability, this providing another dimension of food security.

Stads and Beintema (2015) argue that agricultural research and development (R & D) is critical to agricultural development and food security. In African countries, most of the funding for agricultural R & D comes from aid sources. Slow growth or the volatility in the flow of aid for agricultural research has negative consequences for agricultural development. Given that most people in Africa get their livelihoods from agriculture, the slow growth of agriculture results in low food production, high poverty rates, and with it food insecurity. Cohen (2015) notes that emphasis of

US agricultural aid has shifted away from food aid to long term food security as the current Feed the Future Program.

From the discussions above, we posit that FS depends on food availability as indicated by agricultural production, and other variables, including income, infrastructure, sanitation, and institutions that make the food useful for citizens. This relationship can be summarized formally as: $FS = FS(A, \mathbf{V})$ where FS is food security, A and $\mathbf{V}$ are food supply and a vector of other variables that affect food security. A depends mainly on the productivity of agriculture which, among other things, depends on non-food aid to the agricultural sector and other inputs. We write the A relationship in a general form as $A = \psi(agricaid, \mathbf{Z})$, where $\mathbf{Z}$ is a vector of other variables that affect the production of food in a country and $agricaid$ is non-food agricultural aid. Substituting the A equation into the FS equation, we can write the FS equation as: $FS = \varepsilon(agricaid, \mathbf{X})$ where $\mathbf{X}$ is a vector that is the union of $\mathbf{Z}$ and $\mathbf{V}$. The FS equation we present here is a reduced form relationship between agriculture and food security.

The FS is written in a very general form that cannot be estimated. We need to provide a specific functional form as well define the variables that enter the equation to make it estimable. Theory does not guide as to the specific functional form of the FS equation. We therefore choose a linear functional form for this equation. The variables in the $\mathbf{X}$ vector are those included as important in previous studies and include, The FS equation we estimate is written as:

$$\begin{aligned} FS_{i,t} &= \alpha_1 agricaid_{i,t} + \alpha_2 gdpcap_{i,t} + \alpha_3 acciws_{i,t} + \alpha_4 polstab_{i,t} \\ &+ \alpha_5 FS_{i,t-1} + \gamma_i + \tau_t + \varepsilon_{it} \end{aligned}$$

where $gdocap$ is per capita real income, $acciws$ is access to improved water supply, $polstab$ is political stability, γ is country fixed effect, τ_t is time trend, ε_{it} is a stochastic error term, α_is are coefficients to be estimated, and all other variables are as defined above. We have included a lagged dependent variable as a regressor in the FS equation on the assumption that the current level of food security is influenced by past levels of food insecurity.

If FS is positively related to non-food agricultural aid, income, political stability, and access to clean water, we expect the coefficients of these variables to be positive and significant, all things equal. In addition to estimating the relationship between food security and total agricultural aid, we use the same equation to investigate whether different components of agricultural aid has significant

effects on food security and if so, which index of food security it affects.

4.2 Estimation Method

The food security equation(s) we estimate has endogenous regressors (*gdpcap, agricaid*) as well as a lagged dependent variable. It is well known that in such cases, the fixed effect (FE) and the random effects (RE) estimators are not efficient or consistent. Under these circumstances, researchers have either used an instrumental variable (IV) or general method of moments (GMM) estimators to consistently estimate the coefficients of such equations. A consistent estimator that has been used by researchers to estimate cross-country growth and other such regressions where there are endogenous and correlated regressors in a panel format is Arellano and Bond's Dynamic Panel Data (DPD) estimator (Arellano and Bond: 1991). This estimator is a GMM estimator that uses lagged levels of endogenous and predetermined as well as all exogenous regressors as instruments in a difference equation. One can estimate a difference equation or a levels equation in which lagged differences are used as instruments for their levels counterparts. Arellano and Bond propose two estimators—one step and two step estimators with the two-step estimator being more efficient. We use the efficient two step estimator in our estimation of the *FS* equation.

The DPD estimator consistently estimates dynamic panel data equations. However when the series are persistent, as food security indices and income are likely to be, lagged levels of endogenous and predetermined regressors tend to be weakly correlated with their subsequent first differences, thus leading to biased estimates on account of weak instruments. Blundell and Bond (1998) have introduced the "systems DPD" estimator to correct this problem. The "systems estimator" adds a levels equation with lagged values of first differences of endogenous and predetermined regressors as instruments to the difference equation and jointly estimate the two equations as a system. This improves the efficiency of the estimates. We use the efficient two-step systems estimator with small sample correction to estimate the health outcome equations. We implement Windmeijer's (2005) finite sample correction of standard errors and the reported "t" statistics are computed from this robust standard errors.

A major concern with the systems DPD estimator is the proliferation of instruments that leads to inefficient estimates (Roodman: 2009). We therefore restrict the number of instruments in estimation by restricting the number of lags in creating the instrument vector. In addition to restricting the number of lags to be used as instruments to the 3rd and 4th lags, we test for the

validity of over-identifying restrictions using Hansen's **J** and **C** tests. As is normally done, we also test for the presence of second order serial correlation since the validity of the DPD estimates depend crucially on the absence of second order autocorrelated errors. All tests are based on small sample statistics.

5 Results

5.1 Initial Results

We used the Systems DPD estimator to estimate the various components of food security equations. The results of the estimates using total agricultural aid as our measure of agricultural aid are presented in table 2. Column 2 presents the estimates for the prevalence of under-nourishment (*prvunourish*), column 3 the estimates for the prevalence of food inadequacy (*prvfdinad*), column 4 the estimates for the prevalence of anemia among pregnant women (*prvapw*), column 5 the estimates for prevalence of anemia children under 5 years old *prvac5*, column 6 the estimates for per capita food supply variability (*pcapfsv*), column 7 the estimates for depth of food deficit (*defd*), while column 8 the estimates for average food price variability index (*avgfpv*). Regression statistics indicate relatively good fit for all food security equations. In particular, there is no second order serial correlation of the error terms, and F goodness of fit statistics lead us to reject the null hypothesis that all slope coefficients are jointly equal to zero at $\alpha = .01$ for all equations at $\alpha = .05$ or better. The Hansen J and C statistics do not reject the validity of the overidentifying restrictions for all food security equations. Finally, the Hausman m statistics indicates that not all variables in the regression are exogenous, hence the DPD estimator is the appropriate estimator for these equations.

The coefficient of *totalagraid* is negative, relatively large and significantly different from zero at $\alpha = .05$ in all food security equations. An increase in agricultural aid to African countries leads to reductions in the prevalence of malnutrition, food inadequacy, the prevalence of anemia among pregnant women and children under five years old, as well as a reduction in the depth of food inadequacy. The estimates also indicate that an increase in aid to the agricultural sector decreases the variability in food availability as well as the variability in food prices, all things equal. The estimates indicate that, all things equal, aid to the agricultural sector improved food security in African during the sample period.

The estimates of the effects of *totalagraid* on food security indices we find here are similar to the result of previous research that finds that agricultural aid increase food security (Petrikova: 2013). It is also consistent with the results of research that finds that aid to the agricultural sector increases agricultural productivity and/or production in recipient countries, all things equal.

The coefficient estimates of the control variables are of the expected signs and are, in most part significantly different from zero. The coefficient estimate of *gdpcap* is negative and significantly different from zero at $\alpha = .05$ or better in all the food security indicator equations, indicating that increased income increases food security in African countries. The coefficient of *acciws* is negative and significantly different from zero at $\alpha = .01$ in all *FS* equations, indicating that access to improved water supply improves all aspects of food security. The coefficient of *polstab* is negative, relatively large and, with the exception of the exception of the depth of food deficit equation, significant from zero at $\alpha = .05$ or better. This indicates the presence of political stability is associated with improved food security in African countries, during the sample period.

5.2 Robustness Tests

The results above indicates that aid to the agricultural sector has significantly positive effects on food security in African countries during the sample period we study. it is however possible that our results depend on the way we specify the model. In this section, we present a series of estimates to test the robustness of our results. Agricultural aid may affect food security only through increased agricultural productivity. However, the estimates in table 2 exclude agricultural productivity. It is possible that the estimates of the effects of agricultural aid on food security presented in table 2 is are just a reflection of the effects agricultural productivity we have excluded from the food security equation. To test this possibility, we estimate the FS equation but directly include an index of peer capita agricultural productivity (*agrncpin*) as an added regressor to see of agricultural aid affect food security only through increased agricultural production.

Estimates from this food security equation are presented in table 3. Column2 presents the estimates for the $prvunourish$ equation, column 3 the estimates for the$prvfdinad$ equation, column 4 the estimates for the $prvpw$ equation, column 5 the estimates for the $prvac5$ equation, column 6 the $pcapfsv$ equation, column column 7 the estimates for the $defd$ equation, while column 8 presents the estimates for the $avgvfp$ equation. As in table 2, regression statistics indicate very good fit to the data for all food security equations. Specifically, there is no second order serial correlation

of the error terms, the Hansen J statistics do not reject the over-identifying restrictions, the C statistics leads us to conclude that no endogenous regressor is included in the instrument vector, and the Hausman m statistic indicate not all variables in the model are exogenous. The coefficient estimate of *totalagraid* is negative and statistically significant at $\alpha = .05$ or better in all food security equations. In addition the absolute magnitude of the coefficient estimates of *totalagraid* in all equations in table 3 are similar to their counterparts in table 2. This suggests that agricultural aid has impact on food security outside of its effect on agricultural productivity.

The coefficient of *agrncpin* is negative and significant in the $prvfdiand$, $prvac5$, $defd$, and $avgvfp$ equations; it is not significant in the other equations. Moreover, the estimates of the control variables are similar to their counterparts in table 2. The estimates in table 3 suggests that including the index of per capita agricultural productivity in the food security equation does not change the effect of agricultural aid on food security in African countries. In addition tot he similarities of the coefficients in tables 2 and 3, tests of equality between the estimates in tables 2 and 3 produced χ^2 statistics of 2.81, 1.91, 1.07, 2.14, 2.63, 2.19, and 1.99 respectively, suggesting that the two sets of equations are not different from each other. We conclude from this exercise that whether we include agricultural productivity in the equation or not, aid to the agricultural sector has a significant effect on improving food security in Africa outside its effect on agricultural productivity.

As in the general aid effectiveness literature, it is possible that agricultural aid affects food security only in countries with good governance (conditional aid hypothesis). We therefore estimate a food security equation that include an interaction between good governance and agricultural aid as an added regressor. It is also possible that aid to agriculture affect food security with diminishing returns. We therefore estimate a food security equation that enters the agricultural aid in a quadratic form. Finally, it is possible that our results depend crucially on the DPD estimator we use to estimate the food security equation. To test this possibility, we present fixed effects (FE) estimates of the food security equation. The results of these estimates are presented in table 4.[11] Panel A presents the estimates for conditional effects equation, Panel B presents the estimates for the quadratic specification, while Panel C presents the FE estimates.

Regression statistics (not reported for space considerations) indicate a good fit for all the food security equations in all specifications. The coefficient of *totalagraid* in Panel A is negative and significantly different from zero at $\alpha = .05$ or better in all food security equations. In addition, the

coefficient of the interaction term between *totalagraid* and *governance* is negative, relatively large and significantly different from zero at $\alpha = .01$ in all food security equations. The estimates suggest that agricultural aid improved food security in better governance environment than in countries without good governance.

In Panel B, the coefficient of *totalagraid* is negative and significantly different from zero at $\alpha = .05$ in all food security equations. On the other hand, the coefficient of the quadratic term of agricultural aid is positive but not significant in any of the food security equations, suggesting that there is no diminishing returns to agricultural aid in this sample. In Panel C, the coefficient of *totalagraid* is negative and significant at $\alpha = .05$ indicating that a fixed effects estimator suggests that agricultural aid significantly improves food security in African countries. However, the magnitude of the FE estimates are much different from their DPD counterparts which are also much more precisely estimated compared to the FE estimates. Moreover, the regression statistics suggest high correlation between the error term and vector of regressors suggesting that the FE estimates may be inconsistent. We conclude from these exercises that our results do not depend on the way we specify the model or estimator used to estimate the model.

5.3 Components of Agricultural Aid

The estimates presented above indicate total aid to the agricultural sector leads to improved food security in African countries during the sample period. It is possible that different components of aid to the agricultural sector, such as aid for agricultural research, may be more effective in improving food security than other components. It is also possible that components of agricultural aid may affect various strands of food security differently. We investigate this possibility by using the various components of agricultural aid, instead of total agricultural aid as the regressor in the food security equation. The results are presented in table 5. Column 2 presents the estimates for aid to agricultural research (*agres*), column 3 the estimates for aid for agricultural education and training (*agedutr*), column 4 the estimates for aid for agricultural land development (*aglsk*), column 5 presents the estimates for aid for agricultural development (*agdev*), while column 6 presents the estimates for aid to the provision of agricultural inputs (*aginp*).[12] Rows 1 through 7 in table represents the various components of food security discussed above. In table 5, each element in the table represents a unique effect a particular component of agriculture aid on a particular aspect of food security. For example, the intersection of *agres* and *prvunourish* shows the effects of

aid for agricultural aid on the prevalence of under-nourishment while the intersection of $agres$ and $prvfdinad$ represents the effects aid for agricultural research on the prevalence of food inadequacy.

Regression statistics (not reported here) indicate a very good fit to the data for all food security measures and for all components of agricultural aid. The coefficient estimates od $aglsk$ and $agdev$ for all elements of food security are negative, relatively large and significantly different from zero at $\alpha = .05$. This indicates that agricultural aid for land development and agricultural development significantly reduce all components of food insecurity in African countries, all things equal. Aid for agricultural research ($agres$) significantly decreases the prevalence of under-nourishment, the prevalence of food inadequacy, and depth of food inadequacy, but is has no significant impact on the prevalence of anemia among pregnant women or children under 5 years old, food price variability or per capita food energy supply. Aid for agricultural development and training ($agedutr$ and aid for agricultural inputs ($aginp$) significantly decrease the prevalence of malnutrition, the prevalence of food inadequacy, depth of food inadequacy, and the average food price volatility, but have no impact on the prevalence of anemia or per capita food supply variability. The estimates of the effects of the components of agricultural aid on food security in Africa are consistent with the results that total agricultural aid significantly improves food security in African countries. We note however, that the effect of the composition of agricultural aid on food security varies across various indicators of food security.

Our results are similar to the results of research that finds that agricultural aid has significant effects of food security in African countries (Petrikova: 2015, Umbadda and Elgizouli: 2013, Von Braun: 2013); it is also consistent with studies that conclude that increased growth in the agricultural sector in low income countries and poverty reduction generally leads to improved food security in those countries (Akpodje and Umojimite: 2008, Christiaensen, Demery and Kuhl: 2011, Heady: 2012, Islam: 2011, Norton, Ortiz, and Pardey: 1991, among others). It is also consistent with aid effectiveness study that find aid to have positive effects on development generally and food security in particular. The results are generally not consistent with the results of studies that conclude that aid generally do not have significant effect on development outcomes in developing countries.

Our results suggest that one way of improving food security in the medium to long term in Africa is the development of agriculture through support to the agricultural sector. The aid policy implication of our results may be the need to direct a large share of aid to support agriculture as a way of reducing long term food insecurity (Quartey: 2014), especially since the largest proportion

of Africa's population who may be the most food insecure derive their livelihood from agriculture. The need for increased non-food agricultural aid to increase food security in African is more urgent in the wake of accelerate climate change.

Our results have implications for food policy and external aid research. It suggests that food security research may also look at the role that non-food agricultural aid could play in the process of attaining food security instead of a fixation on short term food aid. More important, it may be necessary for researchers to look at how various components of non-food agricultural aid affect food security in order to find out the most effective way to make agricultural aid more effective.

The results of our study should, however, be interpreted with care. First, we provide only a reduced form relationship between non-food agricultural aid and food security rather a structural analysis. It is possible that a full structural model that accounts for the mechanisms through which agricultural aid affects food security may not arrive at similar results. Second, we do not provide any identification strategy, hence we cannot claim that the relationship we find can be interpreted as a causal relationship; it can only be interpreted as a correlation. Finally, given the quality of the data and the fact that we used proxies for food security indices to estimate the model suggest further caution in interpretation.

6 Conclusion

This paper uses panel data to investigate the effects of non-food agricultural aid on food security in African countries. Controlling for other variables, we find that increased total non-food aid to the agricultural sector is positively and significantly associated with improved security in African countries regardless of the food security index we consider. This effect is robust to model specification and estimation method. In addition to the effect of total agricultural aid, we also find that components of agricultural aid are significantly related to different indices of food aid although the strength of the association differ across food security indices and the components of agricultural aid.

Although our approach to the study of the relationship between agricultural aid and food security is different from those of previous research, our results are consistent with results of some of the earlier research that highlights the importance of agricultural development on medium- to long-term food security in low income countries. Our study also points to the role of non-food

agricultural aid to the development of agriculture in recipient countries. The results of our paper have policy as well as research implications. This is a first attempt to investigate the effects of non-food aid on food security directly.

7 Notes

1. See WHO, *Vitamin and Mineral Nutrition Information System, VMNIS*, www.who.int/vmnis/en/.

2. See FAO (2015a).

3. See FAO, (2015b).

4. See World Bank's *World Development Indicators, 2014*. This is an unweighted average.

5. See Barrett (2010), Carletto, Zezza and Banerjee (2013) and Jones *et al* (2013) for discussion of he complexities in defining and measuring food security.

6. See Islam (2011) and Chimhowu (2013) for more details on the flow of agricultural aid to Sub-Saharan Africa.

7. Aid for rural development is classified as multi-sectoral since it covers different aspects of development in rural areas, hence it will not be included in this analysis.

8. See Annex A for a full definition of all sub-sectors of agricultural aid.

9. This literature is too large to try to summarize here. Mosley and Suleiman (2007) gives a very brief summary.

10. The countries in the sample are: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Cote d'Ivoire, Comoros, Democratic Republic of Congo (DRC), Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Togo, Uganda, Tanzania, Tunisia, Zambia, and Zimbabwe. The sample used for this study are dictated by the availability of the requisite data.

11. We only present the coefficient estimates of *totalagaid* for space consideration. The full estimates are available from the authors upon request.

12. We only present the estimates for the coefficients of the various components of aid to the agricultural sector. As in table 4, we do not present regression statistics for any of the estimated equations for space considerations.

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9 Annex 1: Classification of Agricultural Aid by OECD

Agricultural Policy

Agricultural Policy and Administrative Management Agricultural Sector Policy, Aid to Agricultural Ministries; Institution Capacity Building and Advice.

Agricultural Land Resources including Soil Degradation control, improvement; Drainage; Desalination; Land Surveys; Reclamation; Erosion Control, Desertification control.

Agrarian Reform including Agricultural Sector Adjustment.

Agricultural Production

Agricultural Development Integrated projects; farm development.

Food crop production, including grains; horticulture; vegetables; fruit; other annual and perennial crops.

Industrial/Export Crops, including sugar; coffee, cocoa; oil seeds, nuts, kernels; fiber crops; tobacco; rubber.

Livestock, Animal husbandry; Animal feed aid.

Alternative Crop Development to reduce illicit drug cultivation through marketing and production opportunities.

Agricultural Water Resources

Agricultural Water Resources, Irrigation, Reservoirs, Hydraulic structures, Ground Water Exploitation.

Agricultural Inputs

Agricultural Inputs Supply of Seeds, Fertilizers, Agricultural Machinery/Equipment.

Agricultural Education/Research/Services

Agricultural Extension, Non-formal Training in Agriculture.

Agricultural Education and Training

Agricultural Services: Marketing Policies & Organization; Storage, Transportation, Strategic Reserves.

Plant and Post-harvest Protection and Pest Control, Biological Plant Protection, Supply and Management of Agrochemicals, Pesticides, Plant Protection Policy and Legislation.

Agricultural Financial Services; crop insurance.

Agricultural Co-operatives including Farmers Organizations.

Livestock/Veterinary Services, Animal health and management, genetic resources, feed resources.

Agricultural Research

Agricultural Research: Plant Breeding, Physiology, Genetic Resources, ecology, Taxonomy, Disease control, Agricultural bio-technology including livestock research (animal health, breeding and genetics, nutrition, physiology). **FORESTRY**

Forestry Policy and Administrative Management: Forestry Sector Policy, Planning and Programmes.

Forestry Development: Afforestation; exploitation and utilisation; desertification control; integrated projects.

Fuelwood/Charcoal: Forestry development for production of fuelwood and charcoal.

Forestry education/training

Forestry Research, genetic improvement, production methods, fertilizer, harvesting.

Forestry services

FISHERY

Fishing Policy & Administration: Fishing policy, capacity building; ocean coastal fishing; fish surveys; fishing boats/equipment.

Fishery Development: Exploitation and Utilization of fisheries; stock protection; aquaculture.

Fishery Education/training

Fishery Research: Pilot fish culture; Marine/freshwater biological research.

Fishery Services: Fishing Harbours; Fish markets; Fishery transport and cold storage.

Source: OECD 2014 *Agricultural Aid*.

Table 1: **Summary Statistics of Sample Data**

Variable	Mean*	Standard Deviation	Minimum	Maximum
	Food	**Security**	**Indices**	
prvunourish (%)	26.27	13.98	5.1	69.0
prvfdinad (%)	32.69	16.03	5.2	76.5
prvpw (%)	47.94	11.85	20.7	68.8
*prvac*5 (%)	63.34	16.42	23.9	89.4
pcapfsv (%)	36.44	19.98	6.0	114.0
defd (%)	175.52	119.84	4.0	593.0
avgvf (%)	151.75	60.22	58.0	338.0
avgesa (%)	108.99	15.19	77.0	152.0
Agricultural	**Aid**			
agres (%)	36.88	59.33	0.00	412.44
ageducatr (%)	40.02	60.77	0.02	413.89
aglsk ()	8.18	15.61	0.01	97.88
agdev (%)	10.15	23.92	0.00	253.93
agrncpin (%)	100.89	21.12	44.83	178.58
totalagricaid	20.27	40.99	0.00	395.82
Other	**Regressors**			
popgrow (%)	2.43	1.08	-7.91	9.80
gdpcap (PPP_{2000})	4433.67	5879	336.69	36059.20
gdpcapgr (%)	1.243	6.453	-17.08	17.13
aleirri (%)	11.44	22.97	0.10	100.00
goveffect	-0.548	0.891	-2.32	1.91
acciws	67.82	18.21	21.10	99.8
polsab	-0.55	0.924	-3.32	1.19
N	312			

* these are unweighted averages.

Table 2: **Estimates of Food Security Equation: Total Agricultural Aid**

Variable	*prvunourish*	*prvfdinad*	*prvpw*	*prvac5*	*pcapfsv*	*defd*	*avgvfp*	*fdncpin*
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
totagraid	-0.0495***	-0.0941***	-0.0331***	-0.0383**	-0.0695**	-0.52492***	-0.2708***	0.3956***
	(4.07)	(6.98)	(3.06)	(5.17)	(2.58)	(4.66)	(5.93)	(5.30)
acciws	-0.3916***	-0.5408***	-0.7167***	-0.6503***	-0.5982***	-0.2775***	0.0733***	0.2998***
	(11.28)	(14.11)	(8.34)	(8.52)	(14.83)	(11.71)	(3.33)	(7.73)
polstab	-0.9851***	-1.0429**	-0.2009***	-0.2436***	-1.0154	-0.2512**	-0.6143***	0.7057***
	(3.34)	(2.16)	(4.74)	(4.46)	(0.89)	(2.64)	(6.35)	(3.45)
gdpcap	-0.0022***	-0.0029***	-0.0026***	-0.0024***	-0.0035***	-0.0186***	0.0038**	-0.0009**
	(4.11)	(3.12)	(6.81)	(4.20)	(5.01)	(5.76)	(2.51)	(2.06)
lag.prvunouris	0.9182***	0.8119***	0.9016	0.8189***	0.8914***	0.7218***	0.8927***	0.7249***
	(42.89)	(41.08)	(38.13)	(48.78)	(51.08)	(28.15)	(28.07)	(28.97)
N	312							
F	220.58	356.12	333.14	388.92	460.94	193.80	406.53	302.33
2nd ord. ser. cor.	1.26	0.30	-1.39	1.12	-1.33	0.65	-1.28	-0.60
$p-value$	0.207	0.76	0.36	0.23	0.18	0.51		0.55
Hansen J test	24.92 [22]	23.50 [20]	17.40 [20]	23.81 [21]	19.90 [16]	20.82 [18]	22.40 [23]	28.61 [21]
$p--value$	0.12	0.19	0.22	0.18	0.23	0.19		0.102
C statistic	6.70 [9]	8.62	5.86 [8]	8.81 [6]	9.41 [12]	15.11 [10]	7.53 [14]	14.11 [12]
$p--value$	0.34	0.42	0.17	0.28	0.67	7	0.12	0.19
Hausman m	52.08 [5]	62.14 [5]	62.18 [5]	[5]	28.28 [5]	49.52 [5]	43.21 [5]	48.52 [5]

Dependent Variable: Food Security

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 3: **Estimates of Food Security Equation: Including Agricultural Productivity**

Variable	*prvunourish*	*prvfdinad*	*prvpw*	*prvac5*	*pcapfsv*	*defd*	*avgvfp*
	(2)	(3)	(4)	(5)	(6)	(7)	(8)
totagraid	-0.0486***	-0.0998***	-0.0361**	-0.2575***	-0.0719**	-0.5992***	-0.2708***
	(4.59)	(6.33)	(2.73)	(5.17)	(2.37)	(6.05)	(5.93)
agrncpin	0.0231	-0.0889**	-0.0371	-0.3421***	0.0330	-0.5042**	-0.7904***
	(0.75)	(2.13)	(0.65)	(3.60)	(0.69)	(1.93)	(7.14)
acciws	-0.3742***	-0.4251***	-0.8006***	-0.4944***	-0.5411***	-0.2775***	0.0733***
	(7.78)	(4.78)	(8.34)	(3.91)	(6.84)	(5.75)	(3.33)
polstab	-0.3221***	-0.2122**	-0.8136***	-0.0815***	-0.4193*	-0.8187***	-0.6143***
	(4.12)	(2.63)	(4.74)	(4.18)	(1.67)	(3.28)	(6.35)
gdpcap	-0.0024***	-0.0030***	-0.0027***	-0.0024***	-0.0015***	-0.0192***	0.0038**
	(5.11)	(7.78)	(5.95)	(4.20)	(3.96)	(8.23)	(2.51)
lag.fdsecurity	0.8713***	0.8992***	0.7813***	0.7618***	0.9126***	0.8618***	0.8367***
	(32.98)	(29.88)	(39.68)	(41.65)	(48.21)	(31.98)	(29.01)
N	312						
F	288.11	213.00	345.75	437.24	378.65	490.92	406.53
2nd ord. ser. cor.	1.31	0.60	-1.39	0.31	1.31	0.55	-1.28
$p-value$	0.29	0.65	0.28	0.68	0.25	0.62	0.32
Hansen J test	28.27 [23]	28.61 [23]	16.85 [14]	18.04 [14]	23.53 [23]	26.71 [23]	22.40 [23]
$p--value$	0.17	0.34	0.24	0.17	0.12	0.12	0.32
C statistic	10.59 [9]	12.82 [9]	9.27 [8]	12.36 [8]	15.16 [14]	15.63 [14]	7.53 [14]
$p--value$	0.39	0.42	0.52	0.34	0.21	0.65	0.49
Hausman m	65.28 [6]	28.92 [6]	54.11 [6]	[6] 39.89	61.21 [6]	49.52 [6]	43.21 [6]

Dependent Variable: Food Security

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 4: **Estimates of Food Security Equation: Alternative Specifications**

Variable	*prvunourish*	*prvfdinad*	*prvpw*	*prvac5*	*pcapfsv*	*defd*	*avgvfp*	*fdncpin*
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A:	**Conditional**	**Agricultural**	**Aid**	**Effectiveness**				
totagraid	-0.0640**	-0.1135***	-0.4292***	-0.4051**	-0.5846***	-0.52492***	-0.2708***	0.3956***
	(1.99)	(4.21)	(4.67)	(3.84)	(1.98)	(3.53)	(5.93)	(5.30)
$agraid * gov$	-0.0726**	-0.0943***	-0.2924***	-0.3372***	-0.6048**	-0.52492***	-0.2708***	0.3956***
	(2.66)	(6.06)	(3.77)	(3.55)	(1.73)	(4.93)	(5.93)	(5.30)
Panel B:	**Quadratic**	**Specification**						
totagraid	-0.0504***	-0.0286***	-0.2953***	-0.5991***	-0.5982***	-0.3772***	-0.1335***	0.2194***
	(4.22)	(6.8)	(3.47)	(4.78)	(14.83)	(3.27)	(4.00)	(4.18)
$totagraid^2$	0.0003***	-0.0003	-0.0031**	-0.0072	-0.0695**	-0.0028	0.0005	0.0218
	(3.93)	(1.21)	(2.79)	(1.70)	(2.58)	(1.63)	(1.68)	(1.30)
Panel C:	**Fixed**	**Effects**	**Estimates**					
totagraid	-0.0285	-0.0352*	-0.0003	-0.0265	-0.0276	-0.1933	-0.0639*	0.3956***
	(1.40)	(1.74)	(1.61)	(0.70)	(0.89)	(1.43)	(1.84)	(5.30)
N	312							

Dependent Variable: Food Security

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 5: **Estimates of Food Security: Agric. Aid Components**

Variable	$agres$	$agedutr$	$aglsk$	$agdev$	$aginp$
	(2)	(3)	(4)	(5)	(6)
$prvunourish$	-0.0218***	-0.0197**	-0.1080**	-0.1614***	-0.3906***
	(2.98)	(2.57)	(2.03)	(6.61)	(5.09)
$prvfdinad$	-0.0420***	-0.0401***	-0.0318***	-0.2376***	-0.5411***
	(5.05)	(4.56)	(3.89)	(5.86)	(8.70)
$prvapw$	-0.512	0.0383	-0.2869**	-0.1927***	-0.3249
	(1.59)	(1.61)	(2.07)	(4.35)	(0.50)
$prvac5$	-0.0440	0.0097	-0.3902**	-0.5224***	0.1183
	(1.54)	(0.33)	(2.14)	(4.51)	(0.27)
$pcapfsv$	-0.0350	-0.0115	0.1914	-0.1587**	-0.0214
	(1.44)	(0.48)	(1.53)	(2.50)	(0.31)
$defd$	-0.2340***	-0.2368***	-0.3033**	-0.4926***	-0566***
	(3.99)	(4.02)	(3.40)	(5.84)	(5.89)
$avgvfp$	0.0246	0.0894***	0.6606***	-0.7291***	-0.5859**
	(1.07)	(2.89)	(3.02)	(6.61)	(3.54)
N	312				

Dependent Variable: Food Security

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$