Cereal Banking Impacts on Food and Nutrition Security and Resilience building of rural households in The Gambia

By Raymond Jatta [1]

Abstract

Using Propensity score matching built on a stratification and randomisation, this paper attempts to evaluate the impact of cereal banking on Food and Nutrition Insecurity. Cereal Banking is a community-based risk management strategy which involves buying of food during harvest when prices are low and storing for consumption during the lean period when food prices are high. The purpose is to smooth consumption in rural communities and households through the year.

The results of our matching indicate that communities that are relative poorer, living further away from markets and are vulnerable to high inter-seasonal food price changes have a higher probability of adopting and sustaining cereal banking schemes.

Our impact evaluation show that cereal banking has far reaching positive impacts on food availability, accessibility and nutrition at individual, households and community level. In particular, the results show an average treatment effect of 25 – 30% reduction in both the food gap and inter-seasonal food price variability in treated villages. Cereal banking enhances food self-sufficiency by an average of 11.6%. The Difference in mean between children from households in treated villages and control villages show significant differences of more than 16 percentage points between the average rates of malnutrition of children in treated households and children from control villages. Like other studies, we observe that the literacy of household head significantly improves the nutritional status of children. Similarly, provision of farming implements has a significant impact on food and nutrition security of rural households.

However, the impact on wealth seems to indicate that for cereal banking to enhance wealth and other livelihood outcomes, it must be consistently operated for a while.

Introduction

Cereal banking is a community social safety net that is employed by communities in most arid and semiarid regions of the world, especially in food deficit countries or regions (Bosu et al 2012, Bhattamisha R 2012). It is defined as….."as an organization in a village or group of villages which buy, stores and sells food-grain in order to guarantee the food security of the village community, and it is managed by a management committee appointed by this community"…(Beer F 1990). The intuition behind cereal banks is that rural subsistent agricultural households tend to sell the bulk of their farm produce at low prices at harvest but during the lean period, they have to buy food (often the same products) at high prices. This

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inter-seasonal price variability tends to reduce income of farmers at harvest when they are net sellers and erode their purchasing power during the lean period when they are net buyers.

Whilst storing food as a means of smoothing consumption is an age-long practice (Sampson, 2012, AITP 2012), the evidence show that the evolution and practice of cereal banking in West Africa is closely linked with the drought that hit most of the region in the 1960s to the 1990s (SOS FAIM, 2009, Moussa 2010 p 3, Beer F 1990, CCAFS 2003). Recently, its importance is being reemphasised as a policy initiative to manage the increasing recurrent price and climate shocks negatively impacting on food and nutrition security of vulnerable people and countries. For example, as part of its emergency response, the ECOWAS region plans to operationalize more than 5000 cereal banking schemes in 12 member countries (Rural Hub 2012).

Our review of the literature indicates that beside reports by promoters of cereal banking (often aid organisations and NGOs), not much impact evaluation research has been conducted about the usefulness of the practice. Evaluating its usefulness and viability will provide tools on how to upscale, manage, redesign or upscale the scheme to build resilience to future shocks.

Our focus is to test if cereal banking is useful in reducing food and nutrition insecurity and enhance livelihood outcomes for participating households faced with the risk of price and climate variability. We use a mix of randomisation, stratification and propensity score matching to match treated and control villages and compare food and nutrition security drivers and outcomes overtime.

Seasonality of Production and Consumption

Food production, affordability and consumption in most developing countries follow the agricultural cycle (Bellemare and Barrett 2012). During harvest, food is in abundance and most households become net supplier. In The Gambia, this period ranges from October – February. Food supplies tend to move from rural areas following high demand and better prices in the urban areas (Barrett C 1996). However, approaching the rainy season, food is normally in short supply (FAO 2011, IFAD 2012). Rural households and communities become net buyers and often have to rely on imported food from the urban areas. A flow reversal of food occurs which is associated with higher prices in rural areas. Production constraints exacerbated by the absence of large storage schemes and credit constraints tend to worsen this spatial and temporal food availability and price changes (Barrett C, 1996). This dynamics affect rural households and communities more, eroding incomes and causing seasonal food and nutrition insecurity (CFSVA 2011). As a result food insecurity is much more seasonal than it is a chronic problem in rural areas of The Gambia.

The main purposes of cereal banking are in three folds

1. Provide food to food deficit households during the lean period, which also coincides with the farming period.

2. Preserve purchasing power of participating households due to high food prices during lean periods by providing loans food (often on loan or at low prices) to participating households
3. To act as first-to-reach emergency buffer stocks when disasters occur.

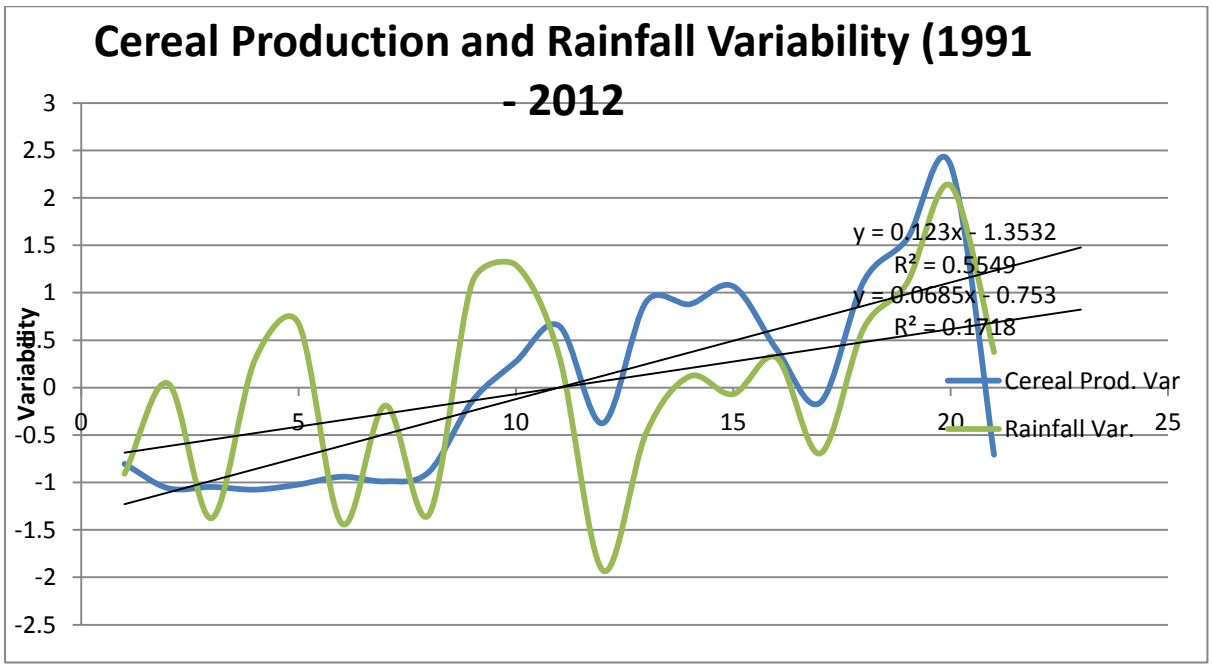
Context

We conduct our research in three of the rural regions of The Gambia; Central River North, Central Rive South and Upper River Regions. Beside their high poverty rates, malnutrition and proportion of food insecure households, these regions are located further away from the main export market, having relatively more adverse weather conditions and are home to more than 85% of cereal banking initiatives in The Gambia (MICS 2006, CFSVA 2011). Poverty rates in these regions are above the national average of 48% (IHS 2010). Price shocks and frequent weather-induced crop failures are common covariate shocks that affect livelihood and food security and are blamed for the countries inadequate progress in meeting its MDG1 (IFAD 2011, GoG MDGs Status Report 2007).

Like most other studies in The Gambia, the population distribution in the sample villages show a youthful population of 75% being below 30 years old (IHS 2010, NPHS 2008). Average household size is the sample communities is 12. The main economic activity is farming with 80% of respondents above 12 years indicating that they are engaged in crop farming, followed by livestock production and fishing respectively. The major crops cultivated are millet, groundnut, rice and maize. There is also a gender dimension of cropping system with men mainly cultivating upland crops; millet, maize and groundnut and women concentrated in the cultivation of the main staple food; rice (Von Braun et al 1989, Carney and Watts 2001).

The Gambia is characterised by arid and semi-arid zones with two seasons of about four months of rainy season (June – September) and eight months of dry season (Ceesay M 2004). Only less than 6% of arable land is irrigated (Von Braun et al 1989, Ceesay M 2004). In addition to reducing rainfall trend, one of the most striking occurrence of climate change is the increasing rainfall variability since the late 1960s exhibiting recurrent droughts and changes in onset and cessation of rainfall and dry spell.(Camberlin and Diop, 2003, Ndaiye and Batchiery 2005, Sima F 2010, CCAFS 2008). This is typical of the Sahel.

Agriculture is rainfed and as such production often varies with rainfall pattern (Rural Hub 2012). The figure below shows increasing variability of both rainfall and domestic food production.



Source: Author

The Analytical Framework

The practice of storage or food reserves is a precautionary savings mechanism which is practiced to smooth consumption (Sarris et al 2006). Whilst the practice may be located within the main theories of consumption and savings (Permanent Income Hypothesis and Life Cycle Hypothesis), the major difference is the frequency of inter-temporal utility maximisation objective. Communities in rural areas in arid countries employ savings as a risk management strategy (Bhattamshira and Barrette 2008) with decisions not limited to Life Cycles but more so frequent production, savings and consumption decisions across seasons of an agricultural cycle from one harvest to the next (Deaton A 1998, Udry et al 2012). The purpose is mainly to reduce the incidence of seasonal food insecurity and malnutrition.

It is commonly held as rational that consumers smooth consumption over their lifetime (see see Deaton 2005 on Modigliani's life cycle hypothesis). For agrarian households that produce once in a year but have to consume for the whole of the year, smoothing consumption within a single agricultural cycle is as important as the life cycle smoothing objective (Khandker, 2009, Basu and Wong 2012).
We can represent this in a simplified framework that allow us to show seasonal consumption variability, credit and savings constraints

$$\boldsymbol{Y(t) = Y(h) + Y(of)}\boldsymbol{\ldots\ldots\ldots\ldots(1)}$$

Where $Y(t)$ is Total Income, $Y(h)$ is Income at harvest and $Y(of)$) is Income off-farm

Assuming the household only produces during the farming season and does not have any off-farm income generating activities, then $Y(of) \approx$ zero

$$\boldsymbol{Y(t) = Y(h)}$$

Income during harvest will now have to be allocated to consumption at harvest time and during lean period

$$\boldsymbol{Y(h) = C(h) + C(l)} \text{ ..... } \boldsymbol{(2)}$$

where $C(h)$ is Consumption during harvest and $C(l)$ is Lean period Consumption

$$\boldsymbol{C(l) = Y(h) - C(h)}$$

When $\boldsymbol{Y(h)}$is lower than $\boldsymbol{C(h)}$, there is a food gap which may result in acute food insecurity even during the harvest period peaking up during the lean period. This situation can be partly addressed in situation where credit is available. Credit increases $\boldsymbol{Y(t)}$ which may then be used to fill the consumption gap. The timing for the disbursement of the credit also has important ramifications to production. For example, when food supplies are issued during the lean period which also coincides with the farming season, this can allow poor households to concentrate on their own farm work. In the absence of such loans, poor and food insecure household may adopt inefficient and costly coping strategies. These coping strategies may increase the indebtedness of households and lead to low production and productivity (ActionAid 2009).

However, where $\boldsymbol{Y(h) > C(h)}$ then this implies that the household has excess income during harvest. The decision then becomes what to do with this excess income during the harvest. One option is to save.

Where there are constraints on savings such as the absence of suitable warehouses, high loss due to infestation, high saving cost, absence of institutional arrangements to promote savings (Rashid and Lemma 2011), this may lead to no or low savings. Cereal banking provides an opportunity to save in kind.
Whilst some research findings suggest that there are potentials for high saving losses (von Braun et al 2009, 2012, FAO 2011), on the contrary, savings in-kind may depreciate less than savings in cash, especially during periods of high inflation (Basu and Wong, 2012, Bhattamshire and Barrett 2008). In addition, such in-kind savings hedges price volatility and a cushion to food crisis.

Yet still, where $\boldsymbol{Y(of) > 0}$ and a cereal saving scheme is in place then;

$$\boldsymbol{Y(t) = Y(h) + Y(of)}$$

But

$$\boldsymbol{Y(h) = C(h) + S(h)}$$

where $S(h)$ is savings during harvest

$$\boldsymbol{Y(t) = C(h) + S(h) + Y(of)} \ldots\ldots\ldots \textbf{(3)}$$

$$\text{Then } \boldsymbol{C(h) + S(h) + Y(of) = C(h) + C(l)}$$

$$\boldsymbol{C(l) = S(h) + Y(of)} \ldots\ldots\ldots\ldots \textbf{(4)}$$

This means that consumption during the lean period is financed by savings made at harvest and income from off-farm income sources.

Relating $\boldsymbol{C(l)}$, $\boldsymbol{S(h)}$, $\boldsymbol{Y(of)}$ and $\boldsymbol{Pl/Ph}$, being inter-seasonal food prices changes. High inter-seasonal food prices have the potential to reduce lean period consumption through lessening real incomes and cash savings.

Thus if $\boldsymbol{S(h)}$ is in cash and where $\boldsymbol{Pl/Ph}$ is significantly high, then it may pay for savings to be made in–kind than in cash. According to Von Braun at el 1989, AATG 2008, inter-seasonal food price changes can be up to 300 – 400% which invariably suggests the gains in physical food savings compared to savings in cash. The above is also true for off-farm income that is used to purchase food. High food price inflation reduces Y(of).

In addition, savings can either be made at household level (private savings) or by a community. The main difference between individual savings and community savings rests in the rules and regulations on period of savings and credit distribution in the case of community savings. In other words, whilst private stocks may be used anytime as the household prefers disbursements in the case of collective savings is only allowed at critical period of the hungry season (AATG 2009). In addition, cereal banking schemes tend to instil a type of "forced savings in collective action" and thus encourage a high savings rate in a community (Bhattmashira 2011). This notwithstanding, the risk of collective savings is mismanagement by committee members and potential reduction in real value of stored cereals due to poor storage when cereals are jointly stored (Beer F 1990, Kent 1989).

Methodology and Sampling Design

Our methodology is based on a World Bank implemented Community Driven Development Project (CDDP) in the Gambia 2008 - 2011. The project target rural communities across The Gambia. Due to high village subscription and eligibility relative to fund availability, selection of final beneficiary villages went through the following process (Arcand et al 2010).

1. Stratification
   Using the National Population Census data of 2003 on village characteristics for more than 930 villages in all seven of the eight regions of the Gambia[2], a Poverty Index was

[2] The number of regions are based on the Local Government Act of 2002

compiled for all the villages with a population of less than 10,000 inhabitants. The Poverty Index comprised the following varaibles

i. Proportion of household heads who cannot read or write
ii. Proportion of households without electricity
iii. Proportion of households with clean drinking water
iv. Proportion of households without own toilet facilities

This stratification process was meant to set criteria for eligibility which eliminated some villages. 950 out of more than 1800 villages were eligible

2. Randomisation
   Out of the eligible villages, a randomisation was undertaken (by simple lottery) to choose final set of 400 villages to be treated.

According to the Baseline report (Arcand et al 2010), a comparison of the characteristics of the villages that were selected and those that did not from the randomisation produced fairly similar average characteristics. As such evaluating such a project could employ Randomised Control Trial. Of the 400 villages that received funding from CDDP about 12% chose to implement cereal banking schemes from many possible subprojects based on community members voting (Arcand et al 2010, Jaimovich D 2012).

Four years into the implementation of the CDDP project, we undertake to evaluate the impact of cereal banking as a subproject on household food and nutrition security. Unlike, the randomised CDDP treatment, the choice of cereal banking was endogenous to village characteristics. The choice reflected the community members' valuations of risks, aspirations as well as the perceived benefits for which they expect cereal banking may address (Brooks 2009, Smit 2003). This risk could be that of food and nutrition insecurity caused by rainfall and inter-seasonal price changes. We argue that these characteristics formed the determinants to the choice of cereal banking and are most likely also going to influence the outcome. Thus, any impact evaluation must have to control for these possible confounding factors in order to eliminate selection bias (Angrist 2012, Baker, J. L., 2000, Rosenbaum and Robin 1983, Heckman et al 1998).

This implied that

1. We had to have a set of useful village characteristics that determined choice of cereal banking in other to answer the question, what are the determinants to the choice of cereal banking.
2. Given these determinants, we can select control villages that had similar characteristics with the treatment villages in terms of these determinants to choice of cereal banking.
3. By implication, this will enable the two groups to be similar at baseline based on the characteristics that determines the choice of cereal banking.
4. The assumption then is that given their similarities in these important observable characteristics, impact of the programme on these two groups would be similar. According to (Heckman and Ichimura 1997), the fulfilment of this assumption produces a comparison group that resembles the treated group of an experiment in one

key respect: conditional on village characteristics X, the distribution of treatment outcome Y_0 given treatment D = 1 is the same as the distribution of control outcome Y_0 given non-treatment D = 0. This eliminates the problem of section bias. After controlling for these confounding characteristics, the expected outcomes for the two groups is similar to being random (Duflo and Kramer 2003).

$$\mathbf{E(Y_0 \mid X;D = 1) = E(Y_0 \mid X;D = 0)} \quad \textbf{…} \ \textit{ie similar baseline averages}$$

5. Thus if one is given treatment and another used as a control (not given treatment) then difference in these two groups after treatment will be an unbiased estimator of the treatment effect.

The option was to used quasi experiments and in particular Propensity Score Matching (PSM) (Heckman and Ichimura 1997, Baker, J. L., 2000, Duflo and Saez 2002 Duflo and Kramer 2003). This was also necessary given data limitations.

Technically, PSM rely on the conditional independence assumption. If we can ascertain that the characteristics that compel communities or households receiving treatment or choosing a project are independent of the outcomes of interest, we can reasonably attribute changes. This assumption is called the unconfoundedness assumption, or conditional independence assumption (Rosenbaum and Rubin 1983):

$$\mathbf{(Y^Ti, Y^Ci) \perp Ti|Xi}$$

This is to say that if it can be reasonably ascertained that selection into treatment (Ti = 1) given the observable covariates (Xi) is uncorrelated or independent to the outcomes of interest; Y^T and Y^C, we can assume validity of the unconfoundedness assumption.

Determinants to Choice of Cereal Banking

Bottom-up participatory approach to development is increasingly being championed as an effective way to improved project performance and targeting for service delivery (Wong S 2012, Mansuri and Rao 2004). Despite the potentials to be affected by elite capture and free rider behaviours (Olken B 2012), it is increasing being applied in project delivery. This was the case of the CDDP (Arcand et al 2010). It is important to note that funding was allocated to the treatment villages but the choice of what community project to implement was left for community members to choose. An important question to ask therefore was; what determines the choice of one subproject in a community and another in another community, in particular cereal banking?

Several researches on such decision making posit that local information on risk, vulnerability, social capital factors coupled with the expected benefits of an intervention determine choice of an intervention (Brooks 2009). There is a likelihood that when presented with two options, a consumer will chose the option that is expected to yield the maximum benefits (Ravallion 2010). This intuition can also be applied to a group of individuals or a community. When faced with the option to choose from an array of possible interventions, the community will

choose the intervention which is expected to give the highest return. This is at the heart of economic thinking.

For example, (Smit 2003 and Brooks 2009) posit that the choice of an adaptation or risk management strategy is based on

1. A community valuation of risk occurrence and its possible impacts
2. The importance the community attaches on the adaptation or risk management strategy.

Cereal banking is a community risk management strategy and a social safety net that reduces the risk of food insecurity caused by rainfall variability and food price variability. Our choice of variables included factors such as price and rainfall variability, drivers and proxies of poverty and food insecurity, biophysical and demographic characteristics etc.

We use data on 27 pre-treatment village socioeconomic, climate, livelihood assets and demographic characteristics to construct our propensity score. In addition, we collect data on livelihood assets such as physical and natural assets/resources available for each village or area. These also include geographical location of a village with respect to main roads, forest resources and other important resources. Data on rainfall variability and price volatility are obtained from meteorological stations whilst data on prices of cereals were obtained at local markets nearest to each of the villages used in our PSM.

Mathematically, our model is expressed as;

$$\mathbf{P(CB) = \beta Vc(i) + \varepsilon(i) \dots\dots\dots\dots\dots\dots\dots (1)}$$

Where P(CB) is the probability of participating in a cereal bank, β represent parameter that must be estimated, Vc is a vector of pre-exposure control village level characteristics ; social, economic, livelihood, natural and market characteristics and ε is the error term of all factors that are not controlled for in our model.

In the case of the study, it was useful to generate control villages to each of the treated village so that a unique pair is mapped. One-to-One nearest neighbour matching algorithm without replacement (Caliendo and Kopeinig 2005, p.9) was applied for this study. An individual from the comparison group is chosen as a match for a treated individual based on the predicted probability to choose cereal banking (Sianesi B. 2010).

The Propensity Scores

Due to its binary nature, PSM is carried out using either a probit or logit model (Caliendo and Kopeinig 2005) as indicated in equation (1). Our PSM on both treated to partial control and pure control produced fairly similar results. We interpret the P-Values and the signs of the coefficients[3]

[3] The Coefficients are not marginal effects but on odd ratios.

	Partial Control PSM		*Pure Control PSM*	
Variable	*Coefficient*	*P>|z|*	*Coefficient*	*P>|z|*
Coeff of Variation (Rainfall)	*13.8706*	*0.286*	*16.076*	*0.246*
Coeff of Variation ()rice)	*660.3531*	*0.006***	*681.091*	*0.018**
Poverty	*7.2494*	*0.035**	*2.695*	*0.041**
Fruit Trees	*0.0512*	*0.033**	*0.043*	*0.102*
Millet grown	*0.00134*	*0.004***	*0.000***	*0.009***
Crop farmers	*46.2541*	*0.029**	*32.713*	*0.053*
Average HH size	*0.7248*	*0.209*	*0.283*	*0.501*
No daily mkt	*0.1836*	*0.046**	*0.152*	*0.058*
No improved trans	*0.5373*	*0.009***	*0.476*	*0.038**
Dominant ethnicity gr. 3	*14.6823*	*0.003***	*7.953*	*0.009***
Dominant ethnicity gr. 2	*7.4451*	*0.004***	*3.842*	*0.113*
Connect & lowland Villages	*1.1066*	*0.109*	*1.618*	*0.039**
Distance to market	*0.5274*	*0.038**	*0.446*	*0.033**
Proximity of the LGA	*33.20208*	*0.024**	*33.592*	*0.02***
Proximity of the District	*2.873271*	*0.021**	*-3.023*	*0.016**
Cov_Price2	*1128.559*	*0.004***	*-1157.499*	*0.016***
N. of 0bservations	*451*		*422*	
R2	*0.4549*		*0.3947*	

P<0.05*, P<0.01**

Our PSM results show the variables that are important determinants to choice of cereal banking. The price risk shown by the covariance of price calculated by the standard deviation over the mean prices of main food crops positively affects choice of cereal banking. Proximity to markets, poverty rates, cropping systems and infrastructure are also significant determinants to choice of cereal banking. These results are similar to (Bhattamishra 2012).

Villages that are relatively poorer, remote and poorly integrated in markets, having fewer infrastructures and suffer from rainfall and price volatility are more likely to choose and sustain cereal banking schemes.

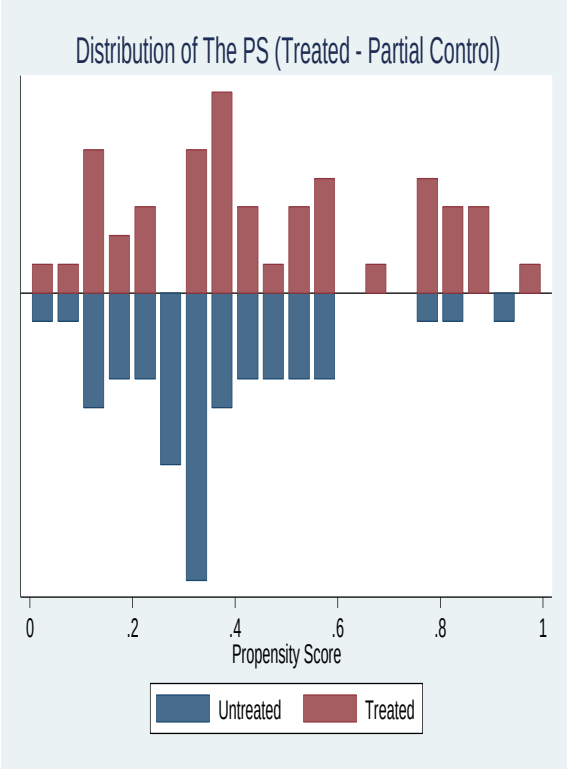
The results of the PSM point to the fact that self-assessment of risk and vulnerability of events to livelihood outcomes drives choices of adaptation or risk management strategy (Smit 2003). Targeting on the basis of need and likelihood for survival is important for cereal banking and safety nets in general.

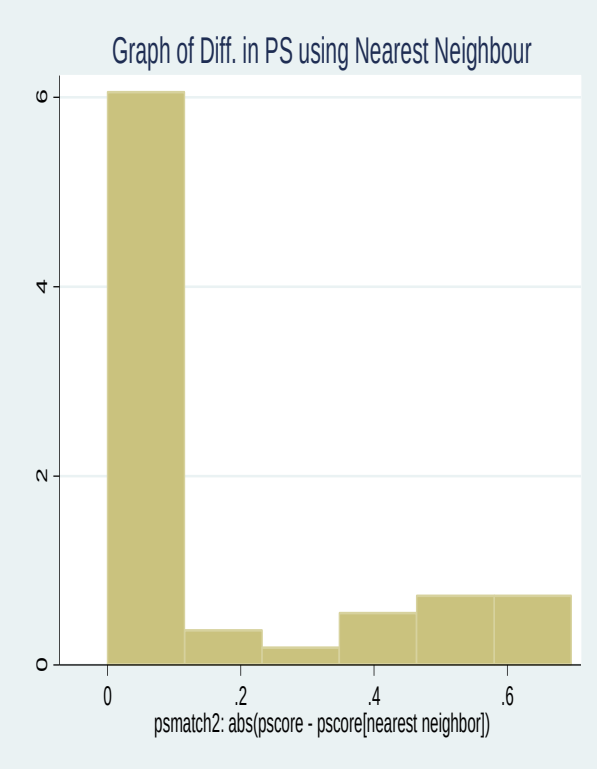
To test the robustness of out propensity score matching and setting a solid foundation for the impact evaluation, we test our PSM. The test show that the matched treated and control villages have similar propensity scores and that there is no significant difference between the treated and control villages before cereal banking.

Variable	*Sample*	*Treated*	*Partial Control*	*T-stat*
Coefficient of Variation (price)	*Unmatched*	*0.2647*	*0.2428*	*2.92*
	Matched	*0.2644*	*0.2625*	*0.19*
Poverty Index	*Unmatched*	*0.7061*	*0.6543*	*2.7*
	Matched	*0.7061*	*0.732*	*-1.23*
Millet per cap	*Unmatched*	*227.289*	*148.82*	*2.15*
	Matched	*227.289*	*221.77*	*0.08*
HHs with Fruit trees	*Unmatched*	*4332.19*	*5795.61*	*-1.61*
	Matched	*4332.19*	*3811.68*	*0.76*
Crop farmers	*Unmatched*	*0.9657*	*0.921*	*4.14*
	Matched	*0.96574*	*0.9681*	*-0.41*
Av. HH Size	*Unmatched*	*11.419*	*11.12*	*0.62*
	Matched	*11.419*	*11.64*	*-0.33*
No daily market	*Unmatched*	*81.476*	*62.65*	*4.24*
	Matched	*81.47*	*82.54*	*-0.27*
Distance from market	*Unmatched*	*43.308*	*41.83*	*0.55*
	Matched	*43.3*	*45.168*	*-0.77*
No Improved transport	*Unmatched*	*98.22*	*91.72*	*3.43*
	Matched	*98.229*	*97.668*	*0.54*
Remote & Upland Villages	*Unmatched*	*0.5106*	*0.4108*	*1.31*
	Matched	*0.5106*	*0.5106*	*0.00*

In addition, the graph indicates the possibility of a common support and that the distribution of the difference in the matched treated and control villages shows that more 70% of the difference is between 0 – 0.1.

PSM Results								
Treated and Pure Control					*Treated and Partial Control*			
Variable	*Obs*	*Mean*	*Min*	*Max*	*Obs*	*Mean*	*Min*	*Max*
Propensity score	*422*	*0.1836*	*0.0000*	*0.9842*	*451*	*0.1042*	*0.0000*	*0.9614*
Diff in matched neighbours	*47*	*0.1464*	*0.0001*	*0.5198*	*47*	*0.1514*	*0.0001*	*0.496*





Thus, we can conclude that with the propensity-score nearest-neighbour matching it is possible to generate a control group which is similar enough to the treatment group to be used for the impact evolution.

The result of the propensity score formed the basis of the matching at the village level. Impact can then be measured on the changes overtime between the matched treated and control villages.

Based on an appropriate sample size and power determination (see Gertler et al 2009), we use a unique set of data of 134 villages;

- 35 are treated villages (having cereal banking schemes)
- 51 are partial control villages (CDDP funded villages that chose to implement other subprojects instead of cereal banking.
- 48 are pure control villages (neither funded by CDDP nor had cereal banking activities)

Empirical Strategy

In the first set of analysis, we provide comparison of difference in means (DIM) between treated and control villages, households and individual on some of the set of outcome variables. The mean difference between households in treated and control villages is the average treatment effect (ATE) (Becker and Ichino 2002, Olken B 2012).

In this paper we focus on household effects of cereal banking. In most communities in The Gambia and also in The Sahel, participation in cereal banking is often by all households in villages where the scheme exists (Rural Hub 2012, Cortès and Carrasco, 2012). Generally,

there is a more likelihood of homogeneity among households within a village than households across villages. Information on a random sample of households within a village can reasonably be used to represent on average village characteristics especially when analysing community-based practices. The table below show some of the differences in means and the test of significance between households in treated and control villages.

Differences in Means (DIM)

	Treated	*Pure control*	*Test*	*Partial Control*	*Test*
Food gap	*2.170*	*2.830*	*0.000*	*2.490*	*0.047*
Variation in cash crop price-Harvest	*-178.180*	*-192.910*	*0.350*	*-246.660*	*0.026*
Variation in food crop price - Lean	*114.280*	*262.640*	*0.000*	*238.630*	*0.000*
Farming implements	*11.991*	*7.888*	*0.000*	*11.879*	*0.539*
Livestock Assets	*18.280*	*17.100*	*0.574*	*22.270*	*0.054*
Wealth Index	*0.040*	*0.034*	*0.078*	*0.048*	*0.014*
Fertilizer Used	*3.000*	*1.700*	*0.047*	*2.300*	*0.230*
Feeding from own production	*1.817*	*1.586*	*0.007*	*1.774*	*0.677*
Pp. of Hh hiring out own labour	*0.210*	*0.360*	*0.008*	*0.320*	*0.034*
Pp. of Educ. Expenditure	*7.440*	*7.970*	*0.268*	*7.340*	*0.456*
On farm income/tot income	*65.130*	*59.190*	*0.028*	*65.680*	*0.576*
Changes in HH Food Availability	*2.710*	*3.280*	*0.002*	*3.580*	*0.000*
Children skipping meals	*0.100*	*0.320*	*0.000*	*0.209*	*0.013*
Average MUAC score	*15.010*	*13.770*	*0.000*	*14.460*	*0.009*
Prop of severely malnourished (<11.5)	*8.7*	*21.82*	*0.000*	*11.20*	*0.002*
Malnourished (11.5 – 12.5)	*12.19*	*26.17*	*0.000*	*17.40*	*0.000*
Last year Yields (in bags)	*14.890*	*12.730*	*0.174*	*14.080*	*0.341*
No. of coping strategies employed	*1.560*	*2.270*	*0.000*	*2.050*	*0.000*

Food Availability

Food Gap

The food gap is an important measure of food availability in rural areas of the Gambia. Otherwise called the lean period or hungry season, the food gap represents the number of months in the year in which households reported difficulty in providing adequate food or money to buy food for consumption (WFP 2011, FAO 2012, IFAD 2011, ActionAid 2009, Khanker 2009, Bosu and Wong 2012).

From a baseline of 2.8 months of food gap suffered by households in pure control villages, households in treated villages suffer 25% less of the food gap (2.1 months). There is also a significant difference between households in treated households and those in partial control villages.

Price variations are higher in control villages than they are in pure control villages. The results show that households in control villages sell their farm produce at lower prices and buy food at higher prices compared to households in treated villages. Surprisingly, this is much more significant in partial control villages. Thus, it can be argued that households in

control villages suffer more from season price fluctuations which can inhibit their access to food and increase income poverty. .

Yields and Investments

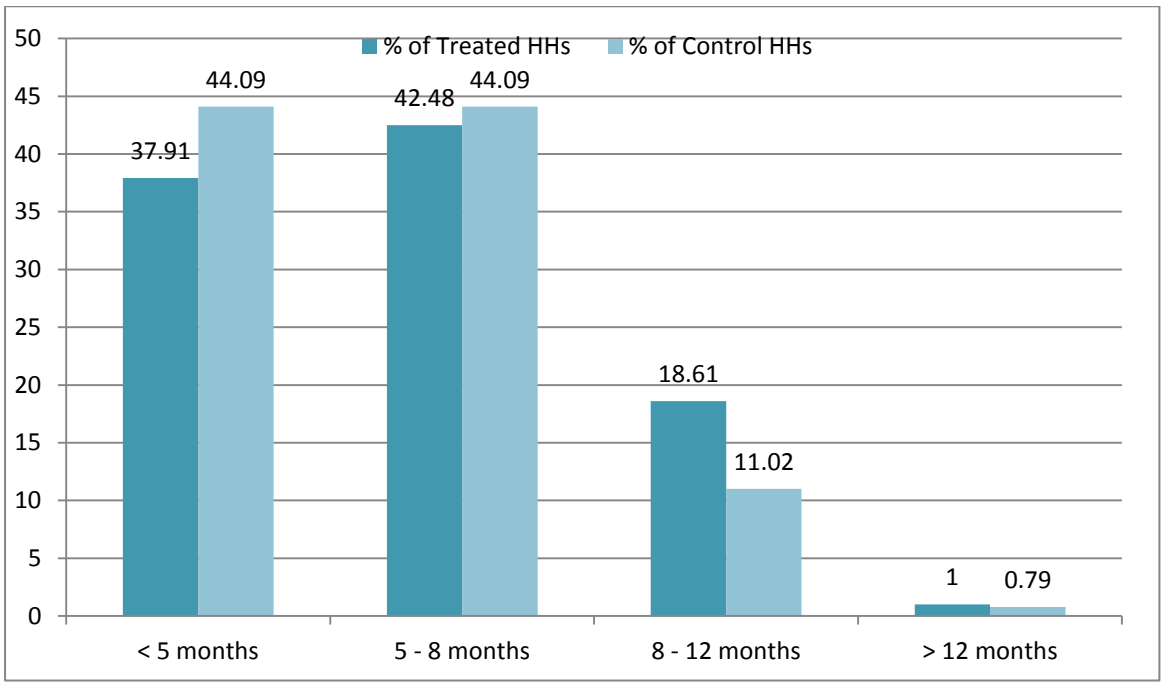
Researcher argue that increasing own-production is one of the most effective ways of reducing hunger in rural communities. For example, Ramirez conclude that a 1% increase in yields is associated with a 0.12% increase in the Human Development Index (Ramírez R, 2002 p7). The results shows that average crop yield in 2012 were better in treated households than control households. The difference may be explained given that when food is available or is secured, households can afford to invest more in inputs such as fertilizer. The above is in line with the risk aversion literature which postulates that the higher the income smoothing options, the higher the willingness to invest in riskier (less risk averse) but higher return investments (Yesuf and Bluffstone 2007, Karlan D 2012, Cole et al 2012, Modruch 2009, Heltberg R 2008).

Similarly, several studies suggest that yields of crops and profitability of farming activities respond positive to fertilizer application (Xu Z 2006, Akponikpe P 2008). Our results show that whilst households that participate in cereal banking reported purchasing and applying 3 bags of inorganic fertilizer in the last cropping season, households in partial and pure control villages apply only 2.3 and 1.7 bags of fertilizer respectively. This represents a difference of 30 – 40% fertilizer application. It must be noted that a bag of fertilizer costs as much as a bag of rice and may be worth as much as 4 weeks of feeding for an average 12 member household.

Ability to store food as in cereal banking reduce time spent in search for food during periods of scarcity at the expense of concentrating on own production (ActionAid 2009, OXFAM 2013). Coupled with adoption of inefficient coping strategies such as taking loans at high interest, giving out own labour for payment, investments in inputs influences the ability of households to produce enough food to meet their consumption. Such investments enhance the timely completion of farming activities, production and yields. Evidently, households in treated villages are able to produce more food to feed their households for a longer period of the year than households in control villages[4].

Table 1: Months of Feeding from Own Production

[4] Feeding from own production is a categorical variable (1 being producing less than 5 months and 4 being producing food enough for more than 12 months of household food needs)



Vividly, whilst only 55.01% of households in control villages claim to be able to produce more than half of their food needs from their own production, as much as 62.09% of households in treated villages produce more than half of their food needs in a year.

Stability

Changes in Food Availability – (From Harvest to Lean)

Several studies are on a consensus that in the Gambia, during the lean period, both the quantity and quality of food for most rural households reduces significantly (CFSVA2011, IFAD 2011, FAO 2012). This however varies for different households given their accumulated livelihood assets/endowments and also access to credit schemes such as cereal banking. From the analysis, it is observed that a significantly larger proportion of households in control villages reported significant reduction in both food quantity and quality of food in control villages than in treated villages. Reduction in food quantity and quality from harvest to the lean period shows the extent of seasonal food insecurity among rural households in the Gambia (Bosu and Wong 2012, Khander 2009, CFSVA 2011).

Food Accessibility

From the data, it can be shown that about 75% of household expenditure is on food. Income spent on Health and Education accounts for about 11% and 7.5% of household expenditure respectively. Research suggests that poor households spend a higher percentage of their income on food and less on other livelihood needs (FAO 2011, Wright and Cafiero 2012). This is linked to the theory of marginal propensity to consumption and savings (Deaton A 1989). This implies that among such food deficit households, any increase in food prices affect them the most as they spend relatively a higher percentage of their income on food (Kalkuhl M et al 2013). In addition, it is also argued that once the ability of meeting household food demands are threatened, other needs suffer first (AATG 2008). Unlike food availability indicators, cereal banking does not have as much impact on income sources

diversification and expenditure. We observe that households which participate in cereal banking tend to use most of their income on food and have less diversified income sources. Although these differences are not significant, they tend to explain the level of vulnerability to rainfall dependent livelihood activities (Warner, K. et al 2013 p1).

Wealth Index

The wealth index which sums up livestock, housing, farming implements and domestic assets is higher in partial control villages than in both treated and pure control villages though the difference is not statistically significant. The above indicators are used as proxy for wealth oi food security assessments (Morris S 1999, Doocy and Burnham 2009, Saaka and Osman 2013, CFSVA 2011). This suggests that cereal banking has little impact or that the significant impact of cereal banking on wealth may only be realised after implementing the scheme for a while. This is uncommon for such community-based interventions. In rural communities where the constraint is on safety or suitable private storage infrastructure relative to the risk of fires, theft or borrowing from other, the presence of cereal banking schemes provide a security against the risks. From the graph, it can be observed that treated households have slightly a higher proportion of households having corrugated and cement buildings than control villages.

Nutrition

Anthropometric Analysis

The Mid Upper Arm Circumference (MUAC) is one of the anthropometric measures of food and nutrition security but in particular, level of malnourishment among children. The recently published WHO guideline 2013 reported that the anthropometric assessments methods of weight-to height and MUAC were good and consistent methods for measuring wasting (WHO 2013). It is applied to children under five years as they are observed to respond more quickly to short term changes in food intake and quality (Pangaribowo E et al 2013).

The WHO guideline of 1995 revised in 2013 suggest that in children who are aged 6 – 59 months, severe malnutrition be defined as

1. Weight-for-height of ≤-3 Z score or
2. MUAC of < 11.5cm
3. Presence of bilateral oedema

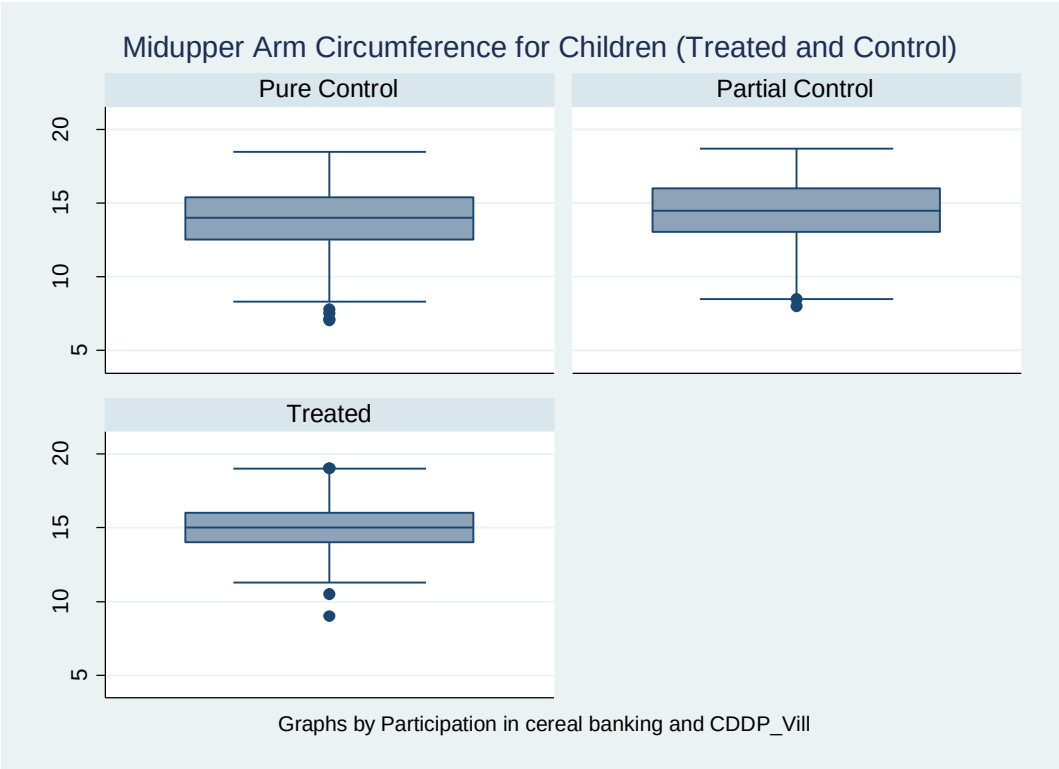
Whilst weight–to-height measure may be more appropriate for measuring age specific differences, MUAC is simpler and has a superior correlation to risk of death (WHO 2013, p25). It is also cheaper to use especially in measuring short term and emergency phenomena than other measures of malnutrition. According to Myatt et al, 2006, MUAC is less prone to mistakes and interviewers influence when compared to weight for child measure of malnutrition. Despite the absence of generally agreeable standard or cut off points, most researchers adopt the 1995 WHO recommended cut off points (Biswas S et al 2013).

MUAC Reading	Colour	Description
Below 11.5 cm	Red	Severe acute malnutrition
11.5 – 12.5	Red	Moderate acute malnutrition
12.5 – 13.5	Yellow	Risk of malnutrition
Above 13.5	Green	Well nourished

Source: WHO 1995

We use a dataset of 980 children aged between 1 – 5 years old from the sampled households. The average MUAC reading for the children in our sampled villages is 14.0cm which using the WHO 1995 recommended cut off points indicate that on average 65% of children in the sample areas are well nourished or that 35% of the children in our sample suffer from moderate to acute levels of malnutrition (MICS 2010, Mwangome Martha et al 2012). This is slightly above the national average of 22% in 2006 (MICS 2006). It would have been interesting to measure MUAC of children in different periods of the year (lean and post-harvest) to assess the impact of these seasonal food security differences.

Comparing children from households in treated villages to their counterparts in control villages, we observe that households in treated villages have higher MUAC averages and are thus better nourished. The results show that on average a higher percentage of children and adults skip meals in control villages than in treated villages which may adversely affect energy and micronutrient intake adequacy (Rolls B et al, 2002, 2010). This is reflected from the MUAC readings and the proportion of children who are severely malnourished, showing significant differences between households in treated, pure and partial control villages respectively. We also observe a higher deviation from the median MUAC reading for children in control households than their counterparts in treated households.



The results show that 8.7% of children in treated households are severely malnourished whilst 11.2% and 21.82% are severely malnourished in households from partial and pure control villages respectively. It is often observed that children respond quickly to even short term changes in food intake and as such these differences may be attributed to food availability, skipping of meals and intake differences across households in treated and control villages during the critical lean period (Pangaribowo E et al 2013)

It has recently been questioned whether MUAC is age- and sex dependent (NC Roy 2011, WHO 2013). After reviewing the scientific evidence underlying the use and interpretation of MUAC, a WHO Expert Committee established in the 1990s to review and report on assessment, monitoring and evaluation of FNS indicators recommended for an age and gender sensitive MUAC measure (Onis M et al 1997 WHO and UNICEF 2009).

We therefore compare MUAC readings among treated and control villages categorised according to their ages. Using the same 11.5cm cut of point; we observe that MUAC is age sensitive as fewer children suffer malnutrition the higher their ages; level of malnutrition reducing from 18.8% in less than two-year old to less than 1% among five-year old children This results supports earlier research findings supporting the need to adjust the MUAC cut-off point to respond to age as undertaken in some studies (Myatt M, 2006). However, we observe a slightly lower level of malnutrition in less than one year olds than 2-years old. Similar results in Mahgoub, Nnyepi and Bandeke 2006, were attributed to care giving (breastfeeding) being more in younger ages reducing the occurrence of underweight among children during breastfeeding. We found this argument plausible for our case though we do not have data to prove this claim.

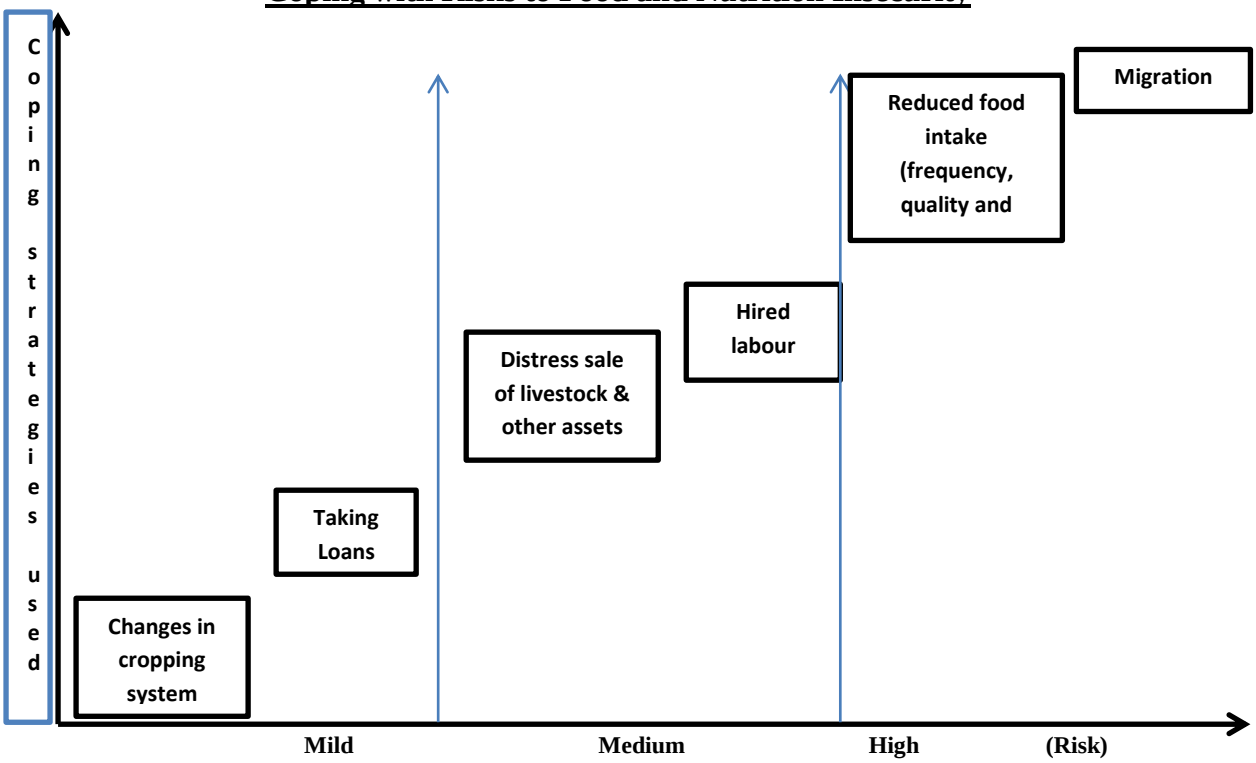
In addition to the MUAC for age categorisation, we also undertake a MUAC for sex comparison. Unlike (Choudhury K et al 2000) who found a significant MUAC gender gap in Bangladesh, our MUAC - gender interactions results were not dissimilar among male and female under-five year old children.

Coping Strategies

Rural agricultural households have often learnt to adapt with exogenous changes that threaten their livelihoods (Boko M et al 2007) such as price and rainfall risk. These coping strategies are short term means of hedging the impact of a risk factor. The impact of price and rainfall variability which can range from increasing poverty, hunger or mortality can either be mild, medium or high. This will depend among other things on;

1. The probability of severity of the shock (hazard)
2. The degree to which livelihoods are dependent on the shock (exposure)
3. Household access or stock of these livelihood assets and coping strategies (Maxwell D 1995 IPCC, 2007).

Coping with Risks to Food and Nutrition Insecurity



Changing Cropping Systems

When both the probability of the occurrence of shocks and its potential impact are high (resulting in high risks) households often adopt more coping strategies than when probability and potential impact are mild (Maxwel et al 2000). However, the use of these coping strategies has different implications on livelihood stability in the short and long term.

When rainfall and price variability is experience or is expected, households in The Gambia often adopt other cropping systems to hedge the impact (Ceesay M 2004). These include adopting high yielding or early maturing crop varieties, changing from cash crop to food crop production etc. These strategies are implemented before a hazard occurs and in the literature considered to be adaptation strategies.

Borrowing

Another option that is often adopted to reduce impact once a shock occurs includes borrowing. On average 70% of respondents interviewed highlighted that they take loans from middlemen and moneylenders whilst 30% secure loans from family members and friends in the village. Whilst networks, exchange of land, credit, labour etc are a strong pillar of rural Gambian society (Jamiovich 2012, Yilma et al 2014), during the lean period, most other households are affected by food insecurity. This is because price volatility is also a covariate risk which is incurred by all (Gilbert C 2012) in a given locality. Thus during the lean period, rural networks of exchange slightly become less effective, at least for food loans within a cluster of villages. However, this reduces the larger the area of analysis. Depending on the location of the village relative to lowland food surplus producing areas, poor harvest upland is often mitigated by borrowing from households in the lowland areas close to the fresh water source of the River Gambia (von Braun et al 1989, Carney and Watts 2001).

Distress Sale of Livestock

Livestock is often kept as savings (buffer stock) which can be used during periods of need especially in rural communities with little or no financial market penetration (Fafchamps M et al 1996). Extreme events such as drought can lead to distress sale of livestock (Kaitibie, Moyo and Perry 2008) during which time livestock is sold at low prices or in exchange for some quantity of cereals. Our data show that there is evidence of distress selling of livestock, as most sales occurred between July to September also corresponding to the hungry season (FAO 2011).

Hiring out own labour

The lean period in The Gambia also coincides with the farming season. In the absence of food during this period, most households will offer their own labour to work in other farmers farms in exchange for food, credit or money to buy food. This tends to disengage farmers from their own production leading to vicious cycles of indebtedness, low production and poverty (Bazin F 2004). Evidently, households in treated communities engage less in hiring out their labour in exchange for food or payments for food during the critical lean period than households in control villages.

Food Related Coping Strategies

Other coping strategies employed in rural areas against threats to household security include the use of less preferred foods, borrowing food from friends and kinsmen, reduce number and frequency of meals, restricting consumption by adults or temporary migration (Deressa T - 2010, Yilma et al 2014). From our data, households tend to use less preferred food, reducing meal sizes and borrowing than other coping strategies. Using less preferred food, reducing meal sizes or frequency of meals have a more direct an immediate impact on food and nutrition security in the very short run (Ivanic et al. 2011, Hoddinott et al 2008).

Since some of the variables are categorical varaibles, we conduct both ttest and the Wilcoxon rank-sum test to test for significance in the differences in our outcome indicators between treated and control villages. Often the Wilcoxon rank-sum (Mann-Whitney) test is used in place of the ttest in testing for differences in means or proportions for categorical and binary varaibles. It is widely used in experimental and quasi experiments (Sawilowsky S 2005). We present both the results to assess how robust the tests are for categorical and continuous outcome indicators.

Estimating Treatment Effect on the Treated

Cross sectional analysis

Given the successful matching, a cross-sectional econometric regression analysis using Ordinary Least Square Estimation (Olken B 2012) can then be implemented, controlling for village - and household level characteristics to estimate the actual impact of cereal banking on treated households. In other words, we attempt to quantitatively estimate the influence of cereal banking on the outcome of interest on the treated. This is similar to estimating the Average Treatment Effect on the Treated (ATET) or the Intention to Treat (ITT) (Arcand et al 2009, Duflo, Glennerster and Kremer 2007).

Our regression model at village level are estimated by

$$\mathbf{Y(i)} = \boldsymbol{\alpha}\mathbf{(w)} + \boldsymbol{\pi}\mathbf{V(i)} + \boldsymbol{\beta}\mathbf{T(i)} + \boldsymbol{\varepsilon}\mathbf{(i)} \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{1})$$

$$\mathbf{Y(i)} = \boldsymbol{\alpha}\mathbf{(w)} + \boldsymbol{\pi}\mathbf{V(i)} + \boldsymbol{\beta}\mathbf{T(i)} + \boldsymbol{\Phi}\mathbf{CDDP(i)} + \boldsymbol{\varepsilon}\mathbf{(i)} \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{2})$$

Village outcome variable $\mathbf{Y}$ for village i = Vector of village level characteristics (V), Cereal Bank dummy (T = 1 if treated, 0 otherwise) and εi is the error term. In equation 2, CDDP dummy also taking values 1 if the village was funded by CDDP and 0 if otherwise.

At household level our model is estimated by

$$\mathbf{Y(hi)} = \boldsymbol{\alpha}\mathbf{(h)} + \boldsymbol{\pi}\mathbf{V(i)} + \boldsymbol{\beta}\mathbf{T(i)} + \boldsymbol{\Upsilon}\mathbf{H(hi)} + \boldsymbol{\varepsilon}\mathbf{(hi)} \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{3})$$

$$\mathbf{Y(hi)} = \boldsymbol{\alpha}\mathbf{(h)} + \boldsymbol{\pi}\mathbf{V(i)} + \boldsymbol{\beta}\mathbf{T(i)} + \boldsymbol{\Phi}\mathbf{CDDP(i)} + \boldsymbol{\Upsilon}\mathbf{H(hi)} + \boldsymbol{\varepsilon}\mathbf{(hi)} \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{4})$$

Yi is a random variable measuring the outcome of interests for household (h) in village (i.) V and H represent a vector of village and household characteristics respectively, Ti indicates the treatment status of village (i). Ti = 1 if the village or household (i) participates or has a cereal banking scheme and Ti = 0 if the household or the village does not. The CDDP in equation (4) captures the CDDP dummy. εi is a random unobserved "error" term which is assumed to be independently and identically distributed.

α = baseline outcome
π = estimating the influence of village characteristics
β = is our impact variable at village level accounting for the mean differences in outcome between treated and control groups.
Υ = impact of cereal banking on households in communities with and without cereal banking. A positive value for $\boldsymbol{\Upsilon}$ indicates a positive impact of cereal bank on the outcome of interest at household level.

In addition, we estimate our treatment effect using district and village fixed effects as a means to control for time invariant district and village level characteristics that may affect the choice of cereal banking in a village (Olken B 2012). For our case, fixed effects were important to capture among others effects such as that of leadership quality, elite capture, biophysical attributes etc in the choice and impact of cereal banking. We expect that such estimation will enhance the precision of our estimates.

Food availability

Food self-sufficiency is an important driver to food security especially in rural communities in developing countries (Deb Uttam et al 2009). This is even more so in the face of recurrent global food crisis which makes reliance on own food production for consumption more appropriate. The regression results show the treatment effect of cereal banking on food self-sufficiency measured by the number of months households depend on their own farm and off farm production or income to meet food needs of the households.

VARIABLES	(1) Self-Sufficiency Treatment Dummy	(2) Self-Sufficiency CDDP Dummy	(3) Self-Sufficiency District FE	(4) Self-Sufficiency Pure Cont plus FE	(5) Self-Sufficiency Part Cont plus FE
Treatment	0.182**	0.0883	0.160**	0.168*	0.141
	(0.0704)	(0.0786)	(0.0800)	(0.0961)	(0.0853)
Hired Labour	-0.0303	-0.0384	-0.0750	0.00871	0.0592
	(0.0711)	(0.0707)	(0.0742)	(0.101)	(0.0948)
Food Expenses	-0.00597*	-0.00486	0.00158	0.00337	0.00159
	(0.00336)	(0.00337)	(0.00359)	(0.00495)	(0.00424)
Education expenses	-0.00771	-0.00675	-0.00173	0.00190	-0.00477
	(0.00506)	(0.00504)	(0.00520)	(0.00715)	(0.00608)
PP. of Self-produced	0.00739***	0.00672***	0.00541**	0.00542*	0.00255
	(0.00218)	(0.00218)	(0.00224)	(0.00279)	(0.00281)
Age of HH head	0.00435*	0.00417*	0.00320	0.00243	0.00178
	(0.00235)	(0.00233)	(0.00229)	(0.00302)	(0.00285)
No. of HH members	0.0184	0.0225	0.0224	0.00408	0.0294*
	(0.0144)	(0.0144)	(0.0140)	(0.0179)	(0.0174)
No. of Farmer	-0.0239**	-0.0241**	-0.0218*	-0.00712	-0.0115
	(0.0119)	(0.0118)	(0.0125)	(0.0163)	(0.0161)
Farming Implement	0.0596**	0.0525**	0.0860***	0.0588*	0.0644**
	(0.0244)	(0.0244)	(0.0259)	(0.0325)	(0.0299)
CDDP Village		0.218***	0.0401		
		(0.0838)	(0.0862)		
District Dummy 4			0.710***	0.710***	0.791**
			(0.196)	(0.267)	(0.372)
District Dummy 9			0.841***	0.965***	0.869**
			(0.228)	(0.272)	(0.377)
Observations	459	459	459	294	327
R-squared	0.281	0.295	0.389	0.450	0.390

The treatment effect of cereal banking on food self-sufficiency is positive and significant implying that cereal banking enhances food self-sufficiency by an average of 11.6%. When the CDDP dummy is introduced in model (2), the results also show a positive and significant impact of CDDP on food self-sufficiency. However, this renders the impact of cereal banking insignificant. We also observe negative influence of coping strategies, food and education expenditure on food self-sufficiency whilst revenue sources being from own production positively influences self-sufficiency.

The key policy implications are that cereal banking and improving access to farming implements are important for enhancing the capacity of smallholders to be food self-sufficient. However, unlike as though, the numbers of household members who are farmers

tend to reduce the ability of households to be food self-sufficient. This may imply that other income sources are more productive than farming or that diversified income sources for households have a better influence on food production.

We also estimate the ATET using village level fixed effects. Similar to Olken B 2012, this was incorporate to reduce bias that may result from unobservable but time invariant village characteristics confounding the results of our estimation. More importantly, the result show a positive and significant impact of irrigation enable double cropping on food self-sufficiency. District 4 and 9 are rice growing areas that have access to Tidal Irrigation Infrastructure (Ceesay M 2004, Carney et al 1992). The estimation with fixed effects produces similar results to that without fixed effects. However, the higher R^2 depicts higher precision for the model with fixed effects. However, with or with fixed effects, the average treatment effect on the treated is positive.

VARIABLES	(1) Fertilizer use Treatment Dummy	(2) Quantity fertilizer CDDP Dummy	(3) Fertilizer Use District Fix. Eff.	(4) Fertilizer Pure Cont plus FE	(5) Quantity fertilizer Part Cont plus FE
Treatment	0.354**	0.282	0.307*	0.461**	0.128
	(0.163)	(0.180)	(0.174)	(0.225)	(0.229)
Land_Borrowed	0.123**	0.123*	0.132**	0.179*	0.151*
	(0.0625)	(0.0625)	(0.0668)	(0.0924)	(0.0855)
Double_cropping	0.380	0.400	0.0422	0.302	-0.886*
	(0.283)	(0.284)	(0.314)	(0.420)	(0.517)
Feeding_Ownproduction	-0.175	-0.191*	-0.0760	-0.0201	-0.144
	(0.107)	(0.108)	(0.113)	(0.134)	(0.145)
Food_Expenses	-0.00125	-0.000510	-0.00707	-0.00260	-0.00679
	(0.00749)	(0.00753)	(0.00836)	(0.0108)	(0.0108)
No_Coping_Strategies	0.0568	0.0634	0.0719	-0.0257	0.199*
	(0.0699)	(0.0702)	(0.0767)	(0.106)	(0.108)
NNotliterate	-0.0829***	-0.0856***	-0.0862***	-0.0746**	-0.122***
	(0.0280)	(0.0281)	(0.0294)	(0.0376)	(0.0379)
Farmer	-0.305	-0.308	-0.187	-0.310	-0.358
	(0.207)	(0.207)	(0.222)	(0.279)	(0.288)
WealthIndex	4.612***	4.646***	4.443***	1.785	8.456***
	(0.904)	(0.904)	(0.916)	(1.095)	(1.432)
District Dummy 9			-0.558	-0.786	-0.980
			(0.485)	(0.533)	(0.908)
cddp_vill		0.180			
		(0.187)			
Observations	452	452	452	289	322
R-squared	0.329	0.330	0.355	0.360	0.449

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

Our results show positive and significant impact of cereal banking on fertilizer application, improving fertilizer application by at least 12.8%.

Contrary to earlier literature, the proportion of land borrowed by households significantly improves fertilizer application. For example, it is argue that land ownership enhances investment in long term productivity enhancement inputs which may improve yields, food production and self-sufficiency (Feinerman and Peerlings 2002, Deininger and Jin 2006, Hagos H 2012). This may be explained by the fact that most borrowed lands are marginal lands in upland areas that require fertilizer application (ActionAid 2012). Similarly, double cropping which is carried out in lowland areas during the dry season requires fertilizer

application to maintain soil fertility (Jaimovich and Jatta 2014 forthcoming). The proportion of food expenses, household head being farmer and illiterate negatively impacts on fertilizer application. This may be due to the investment cost and information required for fertilizer application. The CDDP dummy shows a positive impact on fertilizer application. The use of fixed effects enhances our precession as it increases our R^2 and standard errors.

The important policy implication is that beside affordability, education of farmers though extension services significantly improves investments and technology adoption.

Food Stability

Variables	(1)	(2)	(3)	(4)	(5)
Food_Quantity	∇in Food Qty Treatment Dummy	∇ in Food Qty CDDP Dummy	∇ in Food Qty District Fixed Eff	∇ in Food Qty Part Cont plus FE	∇ in Food Qty Pure Cont plus FE
Treatment	-1.160***	-1.320***	-1.142***	-0.542*	-1.388***
	(0.201)	(0.220)	(0.215)	(0.279)	(0.255)
Feeding_Ownproduction	-0.272**	-0.309**	-0.201	-0.0761	-0.106
	(0.127)	(0.130)	(0.139)	(0.171)	(0.164)
Hired_Labour	0.845***	0.824***	1.401***	0.940***	1.435***
	(0.183)	(0.184)	(0.213)	(0.273)	(0.266)
Fertilizer_applied	-0.296	-0.296	-0.678***	-1.168***	-0.370
	(0.239)	(0.239)	(0.258)	(0.330)	(0.309)
age	-0.0211***	-0.0213***	-0.0173**	-0.0232***	-0.0210**
	(0.00656)	(0.00656)	(0.00672)	(0.00872)	(0.00828)
N	0.0329	0.0345	0.000726	-0.0141	0.00112
	(0.0347)	(0.0347)	(0.0357)	(0.0429)	(0.0403)
NFrom30to65	-0.0766	-0.0791	-0.0162	0.0226	-0.00246
	(0.0835)	(0.0838)	(0.0856)	(0.111)	(0.0991)
Notliterate	0.870***	0.929***	0.257	0.478	0.270
	(0.210)	(0.213)	(0.238)	(0.302)	(0.303)
WealthIndex	0.741	0.893	0.492	0.698	0.438
	(1.024)	(1.032)	(1.072)	(1.329)	(1.572)
District Dummy 4			-1.491**	-1.491*	-1.172
			(0.631)	(0.850)	(1.025)
District Dummy 9			-1.866***	-1.611**	-1.837*
			(0.599)	(0.657)	(0.973)
Cddp_vill		-0.421*			
		(0.224)			
Observations	452	452	452	289	322
R2	0.0748	0.0773	0.1135	0.1352	0.1283

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

Using an Ordered Logit, we estimate the effect of cereal banking on the stability of the quantity of food used for household consumption from harvest to lean period. Changes in food quantity is self-reported categorical variable in which 1 indicates more stability whilst 5 indicates less stability. Our results show a negative treatment effect of cereal banking on food quantity instability. This implies that cereal banking significantly reduces household food instability. This is also true for access to double cropping and food self-sufficiency showing the positive influence of irrigation which is possible for district 4 and 9. On the other hand, households that practice hiring out own labour and large household sizes tend to increase food instability. This is also true of age of household head and the proportion of household members within active working age of 30-65 years.

The result clearly point to the fact that households that are poor are likely to adopt less efficient coping strategies such as hiring out their own labour are more vulnerable and suffer from seasonal food insecurity.

	(1) MUAC Score Treatment Dummy	(2) MUAC Score CDDP Dummy	(3) MUAC Score District FE	(4) MUAC Score Pure Cont plus FE	(5) MUAC Score Part Cont plus FE
Treatment	0.668	0.488	0.710	1.032	0.491
	(0.215)**	(0.237)*	(0.219)**	(0.315)**	(0.217)*
% of land borrowed	-0.178	-0.181	-0.149	-0.108	-0.211
	(0.081)*	(0.081)*	(0.085)	(0.116)	(0.087)*
Fertilizer (inorganic)	0.325	0.352	0.184	0.292	0.625
	(0.270)	(0.269)	(0.271)	(0.335)	(0.284)*
Children skipping meals	-0.704	-0.797	-0.653	-0.967	-0.833
	(0.259)**	(0.264)**	(0.266)*	(0.351)**	(0.330)*
Marital status	0.055	0.060	0.146	0.186	0.071
	(0.155)	(0.154)	(0.151)	(0.188)	(0.155)
No. of Coping Strategies	-0.253	-0.253	-0.178	-0.240	-0.080
	(0.090)**	(0.090)**	(0.097)	(0.135)	(0.109)
Age categories of children	0.561	0.547	0.534	0.495	0.465
	(0.066)**	(0.067)**	(0.068)**	(0.091)**	(0.071)**
Gender of Child	-1.040	-1.041	-1.100	-1.745	-1.311
	(0.300)	(0.302)	(0.275)	(0.085)	(0.075)
HH head Not literate	-0.748	-0.726	-0.688	-1.086	0.029
	(0.207)**	(0.207)**	(0.255)**	(0.321)**	(0.293)
CDDP_Vill		0.451			
		(0.252)			
District Dummy 4			1.427	1.868	0.913
			(0.609)*	(0.826)*	(1.068)
District Dummy 9			0.357	0.169	1.685
			(0.574)	(0.646)	(1.057)
Observations	366	366	366	239	261
R-squared	0.47	0.48	0.55	0.59	0.60
Standard errors in parentheses	* significant at 5%; ** significant at 1%				

The treatment effect on the level of nutrition measured by the Midupper Arm Circumference score is positive and significant whilst land borrowing has a negative effect on nutrition of children. The number and frequency by which households employ food related coping strategies has a negative impact on the level of nutrition. Polygamy and illiteracy of household head negative impacts on nutrition level,

In agreement with recent literature and empirical findings, nutritional level of children as measured by an unadjusted MUAC cut-off mark of 11.5cm indicate that the malnutrition reduces with age of children. This supports the argument for an MUAC-Age comparison. Unlike our age-MUAC interaction, we do not observe any significant difference between male and female children in in their MUAC scores although females tend to have a lesser MUAC scores than male children as shown by the regression results.

Like other studies, we observe that the literacy of household head significantly improves the nutritional status children.

Conclusion

According to the (FAO 2013), the majority of the World's 842 million hungry are rural smallholders or landless people in developing countries without access to productive resources, especially Sub Saharan Africa. The Gambia, like most West Africa has experienced very little progress in reducing food insecurity and child malnutrition in the past 20 years (Lopriore and Ellen 2003, ECA 2012, IFPRI 2012) and is off track in meeting MDG1 (GoG 2009). This is due to a composite of factors such as recurrent climate shocks compounded by low level of human development and import dependence. Food markets have been proved to be inherently volatile (Kalkuhl M et al 2013) and a total dependence on these markets exposes economies to shocks and uncertainties in their food and nutrition security. Having responsive safety nets is thus critical to the attainment and stability of food and nutrition security of the teeming poor population in food deficit importing countries.

We attempted to evaluate the impact of cereal banking by comparing food and nutrition security outcomes between households that practice the schemes and similar counterfactual households without the schemes. Our results vividly supports our hypotheses that cereal banking is important for enhancing food and nutrition security at community, households and individual levels and in all the four dimensions; food availability, accessibility and nutrition and stability. The strongest effects are found in indicators of food availability, stability and nutrition. The least effects are on wealth proxies.

In the rural areas of the Gambia, as in many other rural areas of developing countries, food self-sufficiency is an important food and nutrition security driver. In terms of food intake, the mere fact that food is supplied to households at critical period of the lean period reduces the food gap, smooth consumption and stabilizes food intake. This has a bearing on avoiding malnutrition, hunger. This also helps households to avoid the long term consequences of short term food insecurity situations even for under-five-year old children.

The evidence of lower prices and lesser price variability in communities that operate cereal banking schemes also support our hypothesis that cereal banking affect food accessibility by reducing inter-seasonal food price variability by an average of 25%.

Our regression results showing the average treatment effect on the treated (ATET) implies that participation in cereal banking reduces changes in food availability from harvest to lean periods and thus enhances smooth consumption for participating households. The treatment effect of cereal banking on food self-sufficiency is positive and significant implying that cereal banking enhances food self-sufficiency by an average of 11.6%. Households who participate in cereal banking reported stability in the quantity of food they consume during the lean period, and this can be attributed 40% to the impact of cereal banking. This is partly explained by the fact that cereal banking provides physical food credit facilities which are meant to ensure that the quantity of food available remain stable throughout the year (Sarris et al 2006). The treatment effect on the yields of participating households is quiet significant. Yields on average increases by 12 bags of cereals and reduces the number of days households had offered to hire out their own labour for food by 14 days or 11.7%. Participation in cereal banking enable household invest in their farming operations more in terms of their time,

equipment and inputs. Our results show positive and significant impact of cereal banking on fertilizer application, improving fertilizer application by at least 12.8%. The investments enhance yields and on average build the capacity to feed from own production.

Contrary to what we hypothesised, there is a positive but insignificant impact of cereal banking on wealth score. Our wealth score combines the score for household ownership of domestic assets, farming implements, access to electricity, toilet facilities and the nature of housing materials used. The positive coefficient on the treatment indicates a positive treatment effect, implying that participation in cereal banking activities enhances wealth.

Conversely, it is also observed that the treatment effect on the number of coping strategies is significant different from zero implying that participation in cereal banking reduces the number of coping strategies a household employs.

Participation in cereal banking enhances the nutritional level of children in participating households by 1.5 MUAC scores. The DIM show significant differences of more than 16 percentage points between the rates of malnutrition of children in treated households and children from control villages. Like other studies, we observe that the literacy of household head significantly improves the nutritional status children.

Beside the treatment effect of cereal banking, we observe that education of rural household heads is important for enhancing the nutrition of children as well as adoption of technology such as fertilizer application. Similarly, provision of farming implements has a significant impact on food self-sufficiency or rural households

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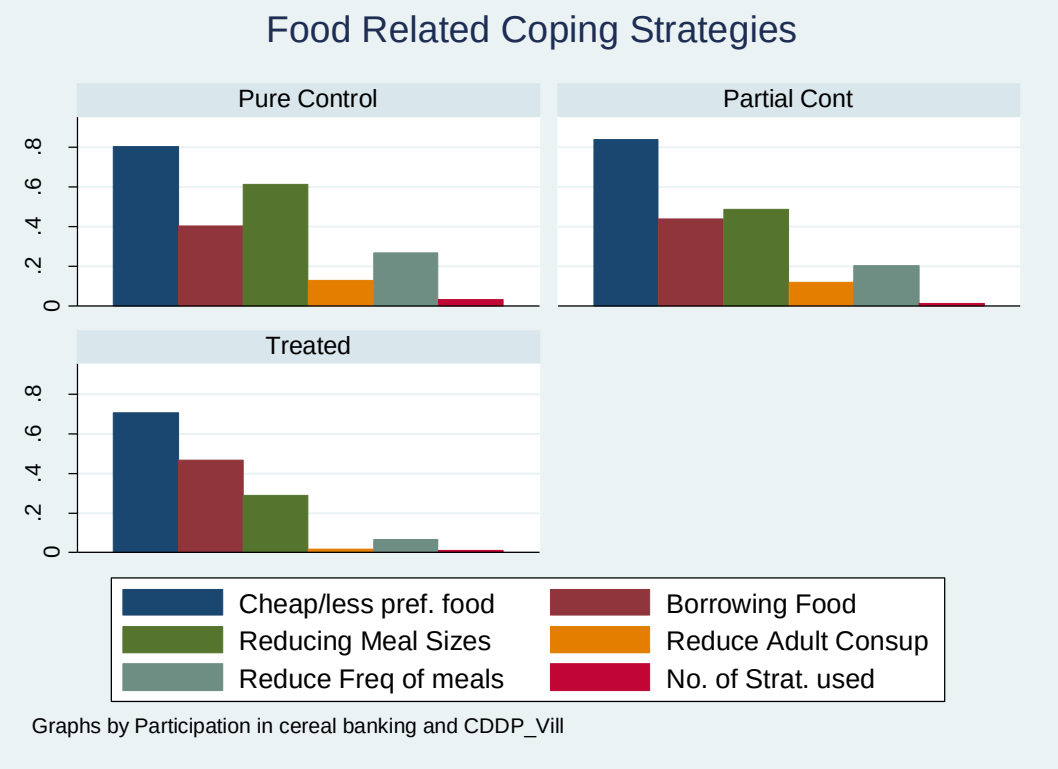
Annexes



	(1) No. of Coping Strategies Treatment Dummy	(2) No. of Coping Strategies CDDP Dummy	(3) No. of Coping Strategies District Fixed Effects	(4) No. of Coping Strategies Pure Cont plus FE	(5) No. of Coping Strategies Part Cont plus FE
Treatment	-0.516	-0.502	-0.529	-0.780	-0.387
	(0.115)**	(0.127)**	(0.110)**	(0.129)**	(0.125)**
% of land borrowed	0.075	0.075	0.101	0.011	0.112
	(0.044)	(0.044)	(0.043)*	(0.055)	(0.048)*
Fertilizer (inorganic)	-0.371	-0.372	-0.134	-0.139	-0.091
	(0.143)**	(0.143)**	(0.137)	(0.157)	(0.154)
Self labour hired	0.373	0.376	0.010	0.241	-0.206
	(0.112)**	(0.112)**	(0.116)	(0.135)	(0.138)
Notliterate	0.268	0.265	0.305	0.121	0.337
	(0.112)*	(0.113)*	(0.124)*	(0.144)	(0.150)*
Livestock Val	-0.004	-0.004	-0.015	-0.012	-0.018
	(0.007)	(0.007)	(0.007)*	(0.007)	(0.009)*
∇ Food quantity	-0.121	-0.119	-0.033	-0.002	0.013
	(0.042)**	(0.043)**	(0.041)	(0.046)	(0.048)
CDDP_Vill		-0.036			
		(0.131)			
District Dummy 4			-1.427	-2.097	-1.151
			(0.296)**	(0.371)**	(0.492)*

District Dummy 9			-1.716	-1.355	-1.928
			(0.313)**	(0.319)**	(0.516)**
Observations	452	452	452	289	322
R-squared	0.37	0.37	0.52	0.59	0.54

Standard errors in parentheses * significant at 5%; ** significant at 1%