# Agriculture to Nutrition (ATONU): Evaluation of Integrated Agriculture and Nutrition-Sensitive Interventions for the African Chicken Genetic Gains (ACGG) Programme in Tanzania

**ATONU ENDLINE EVALUATION REPORT**

**2019**

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**List of Acronyms**

| | |
|---|---|
| ACGG | African Chicken Genetic Gains |
| ATONU | Agriculture to Nutrition |
| BCC | Behaviour Change Communication |
| BMI | Body Mass Index |
| BMIAZ | Body Mass Index for Age Z- scores |
| CI | Confidence Interval |
| CSV | Comma-separated values |
| CDDS | Children Dietary Diversity Score |
| DDS | Dietary Diversity Score |
| DED | District Executive Director |
| DLFDO | District Livestock and Fisheries Development Officer |
| DID | Difference in Difference Analysis |
| ENA | Emergency Nutrition Assessment |
| GEE | Generalized Estimating Equation |
| FANRPAN | Food, Agriculture Natural Resources and Policy Network |
| FAO | Food and Agriculture Organization |
| FFQ | Food Frequency Questionnaire |
| GDP | Gross Domestic Product |
| HAZ | Height for Age Z-scores |
| HDDS | Household Dietary Diversity Score |
| HIV/AIDS | Human Immuno-deficiency Virus-Acquired Immune Deficiency Syndrome |
| HFIAS | Household Food Insecurity Access Scale |
| iAGRI | Innovative Agricultural Research Initiative |
| ICC | Inter-cluster Correlation Coefficient |
| ILRI | International Livestock Research Institute |
| KAP | Knowledge, Attitude and Practices |
| MDD-W | Minimum Dietary Diversity for Women |
| MoHCDGEC | Ministry of Health, Community Development, Gender, Elderly and Children |
| MUCHALI | *Mfumo wa Uchambuzi wa Uhakika wa Chakula na Lishe* |
| NBS | National Bureau of Statistics |
| NGO | Non-Governmental Organization |
| NSI | Nutrition-sensitive Intervention |
| ODK | Open Data Kit |
| SBCC | Social Behavioural Change Communication |
| SE | Standard Error |
| SMART | Self-Monitoring, Analysis, and Reporting Technology |
| TDHS | Tanzania Demographic and Health Surveys |
| TALIRI | Tanzania Livestock Research Institute |
| TNBC | Theatre for Nutrition Behaviour Change |
| TDHS-MIS | Tanzania Demographic and Health Survey and Malaria Indicator Survey |
| UNICEF | United Nations Children's Fund |
| WASH | Water, Sanitation and Hygiene |
| WAZ | Weight for Age Z-scores |
| WB | World Bank |
| WDDS | Women Dietary Diversity Score |
| WHZ | Weight for Height Z-scores |
| WLZ | Weight for Length Z-Scores |
| WHO | World Health Organization |
| UNICEF | United Nations Children Education Fund |
| FFQ | Food Frequency Questionnaire |
| SAS | Statistical Analysis System |

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**Executive Summary**

**Background:** In recent years, agricultural investment in sub-Saharan Africa has increased, leading to increased food production. However, despite increased food production, malnutrition rates are still high. This is because agricultural programmes have traditionally focused on increasing the availability of food rather than promoting consumption and improving nutrition status. The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPRAN) and partners implemented the Agriculture to Nutrition (ATONU): Improving Nutrition Outcomes Through Optimized Agricultural Investments Project. The project delivered tailor-made nutrition-sensitive interventions, which targeted women of child-bearing age and children in the first 1,000 days of life (i.e., from conception to two years). ATONU focused on improving the nutrition of the smallholder farm families to grow and buy the right type and amount of food they needed to be healthy, in an effort to break the intergenerational cycle of undernutrition among poor households in Sub-Saharan Africa. ATONU's approach was to work with existing agriculture development projects to integrate nutrition-sensitive interventions (NSIs), implement the interventions, evaluate their impact and provide evidence of what agriculture can do to deliver positive nutrition outcomes. ATONU implemented NSIs in the African Chicken Genetic Gains (ACGG) project, which was being implemented by the International Livestock Research Institute (ILRI) in the Ethiopia and Tanzania.

This study hypothesized that both ACGG and ATONU can improve women's and children's diets via the following three pathways: food production (chicken and vegetables) for own consumption, increased income expenditure on additional nutrient dense foods, and women's empowerment, all working in concert. The overall aim of the endline assessment was to determine the impact of the ATONU interventions on a range of nutrition indicators for target members of participating households. Interventions implemented were on nutrition education and hygiene, increase expenditure on nutritious food and women empowerment, which were implemented through social and behaviour change communication. Another intervention was on promotion of increased vegetable production for improving dietary diversity. These interventions were evaluated in a cluster randomised study design whereby villages were allocated/assigned to three treatment arms namely, ACGG + ATONU, ACGG only and Control. ACGG + ATONU treatment arm included villages that obtained improved chickens from the ACGG project and a package of nutrition-sensitive interventions to promote behaviour change and home vegetable gardening/production. The ACGG treatment arm comprised villages that obtained improved chickens from the ACGG project but did not receive the package of nutrition-sensitive interventions, and the Control treatment arm comprised villages that did not receive improved chickens from the ACGG project and had no package of nutrition-sensitive interventions.

**Methods:** Data were collected from three agro-ecological zones, namely Central semi-arid, Eastern sub-humid and Southern Highlands at baseline and endline. The baseline data were collected in November 2016 and endline data were collected from 30$^{th}$ April to 3$^{rd}$ June 2018. A total of 1762 households participated at the baseline survey and 1604 (91.1%) at the endline survey. The loss to follow-up was 158 (9%). Data were collected on an ODK system using mobile devices linked to the server hosted by the University of Dodoma in Tanzania.

Face-to-face interviews with adult women responsible for food preparation (preferably husband and wife together) were carried out at the respondents' residences. A structured questionnaire was used to collect information on demographic characteristics, land and asset ownership, crop/livestock production, marketing of crops/livestock, hygiene and sanitation practices, vegetable production and preparation and food consumption pattern. Questionnaires were checked before and after the day of the survey to ensure completeness and accuracy. After the interviews, mother/caregiver, father/partner and children were referred to a makeshift centre for anthropometric measurements. The weight of children was measured to the nearest 0.1 kg or 100 g using SECA electronic bathroom scale (SECA GMBH & Co. kg, Hammer Steindamm 3-25, 22089 Hamburg, Germany). The height of women and that of children were measured using a length board (Shorr Productions, Perspectives Entreprises & Portage, Missouri USA). Food consumption was assessed using a food frequency questionnaire (FFQ) and 24 hour dietary recall methods to obtain information on children, women and household dietary diversity scores (C/W/HDDS). Data collected through the structured questionnaire were analysed using SAS version 9.4. Child anthropometric data were analysed using WHO Anthro by computing Z-scores and generated nutritional indices as well as categories and later exported to SAS version 9.4 for further analysis. The analysis also involved comparisons of the treatment arms (baseline/endline and across treatment arms). The difference in difference analysis was performed using a Linear Mixed model to assess the effect of the intervention on changes to dietary diversity scores.

**Primary outcomes**

**Dietary diversity for children, women and households:** Dietary diversity is an important predictor of household nutrient adequacy. Limited household dietary diversity may lead to inadequate consumption of

micronutrients. A significant improvement in mean household dietary diversity score was reported at endline compared to baseline. Change in household dietary diversity score (HDDS) was significantly higher in ACGG and ACGG+ATONU treatment arms (β=0.3274, p=0.0278) and ACGG+ATONU (β=0.3434, p=0.0193) compared to the Control treatment arm. The change in HDDS was significantly associated with zones (p=0.0239) and ownership of improved chickens (p=0.0002). Similarly, women's dietary diversity score at endline was higher in ACGG + ATONU and ACGG treatment arms compared to the Control treatment arm. Women in the higher wealth index quintile and high nutrition knowledge had the highest mean dietary diversity score. Dietary diversity for children increased at endline where the highest improvement was observed in ACGG+ATONU treatment arm. The proportion of children who consumed eggs, flesh foods and dairy products increased at endline. Change in children's dietary diversity at endline was significantly higher in ACGG+ATONU treatment arm compared to Control treatment arm (β=0.3595, p=0.0249) but not significant between ACGG treatment arm and Control treatment arm (β=0.2855, p=0.0796) and between ACGG+ATONU and ACGG treatment arms (β=0.07406, p=0.6529).

**Secondary outcomes**

**Nutritional status of adults and children:** The prevalence of obesity was high among adults, especially among females than males. However, the prevalence was higher at baseline than at endline. In addition, males showed significant difference in prevalence of nutritional status among treatment arms at endline (p=0.0436). The prevalence of underweight was higher among males in ACGG+ATONU treatment arm compared to Control and ACGG treatment arms. However, the difference was not statistically significant (p=0.9324). In the ACGG+ATONU treatment arm, the prevalence of overweight among women was 30%. This was slightly higher than in other treatment arms ACGG (27%) and Control (26.6%) but not statistically significant (p=0.063). At endline, the prevalence of overweight among women was higher in the ACGG treatment arm compared to Control and ACGG + ATONU treatment arms (p=0.1414).

At endline, the Z scores for children below two years of age for male and female children improved for all indicators and in all treatment arms. Changes in WLZ, LAZ and WLZ were higher among female children than for male children. For children of age between 2 and 3 years there was improvement in the mean WAZ, HAZ and WHZ scores. Mean HAZ scores for male children improved in all treatment arms and were all positive compared to that of female children. The nutritional status of children aged 3 to 4 years improved at endline compared to baseline. Mean HAZ scores were negative for all treatment arms in male and female children. However, the trends in nutritional status among children showed positive changes at endline compared to baseline. Mean WAZ was negative for male children at baseline and notable improvement was observed in ACGG treatment arm (-0.02 in baseline to 0.27 at endline). There was a negative change for ACGG+ATONU (0.1 at baseline vs. -0.15 at endline). A similar trend occurred among female children, whereby those in the ACGG treatment arm improved from -0.31 at baseline to -0.03 at endline, with no change for the ACGG+ATONU treatment arm.

**Intermediate outcomes**

**Hygiene and sanitation:** At endline, almost 70% of the households in the treatment arms had access to water services. About 99% of all households owned and used latrines. However, at endline, ownership of improved latrines increased by 7% in both ACGG and ACGG + ATONU treatment arms, but decreased in the Control treatment arm by almost 8%. Overall, hand-washing practices improved at endline in ACGG+ATONU but there was a slight decrease in ACGG and Control treatment arms. At endline, respondents in ACGG+ATONU treatment arm showed significant improvement in hand washing practice compared to those in ACGG (OR=1.87, p=0.0069). However, no significant difference was observed for respondents in ACGG and Control treatment arms (OR=0.97, p=0.8904). Training on hygiene knowledge helped to improve hand-washing practice at endline among respondents in ACGG+ATONU compared to Control treatment arm.

**Main source of income and expenditure:** The main source of household income in all treatment arms was from sale of harvested crops and the highest spending was on food. Sale of harvested crops increased from 66% at baseline to 78% at endline across all treatment arms. At endline sale of harvested crops was not significantly different among treatment arms ($\chi^2$ = 0.2556, p= 0.88). At endline, sale of animals also increased compared to baseline in all treatment arms (10% to >77%). Specifically, sale of chicken increased from 27% at baseline to 59% at endline. A significant difference in sale of chicken across treatment arms was observed at endline ($\chi$2= 39.75, p <0.0001). In addition, ceremonies ($\chi^2$ =0.62, p=0.73) and entertainment ($\chi^2$ =0.74, p=0.69) had a relatively higher expenditure at endline compared to baseline in all treatment arms. This could be due to the time of the year whereby most traditional ceremonies happen after harvesting or towards the end of the year ($\chi^2$=2.52, p=0.87).

**Crop and vegetable production and consumption:** Maize was the main food crop produced and accessed in all study areas. Vegetable availability through own production increased in all treatment arms and the most common produced vegetables were pumpkin leaves, amaranth, Chinese cabbage, sweet potato leaves and okra. Consumption of all types of vegetables improved at endline in all treatment arms. At endline, the major crops grown by households across treatment arms were maize (88%), beans (47%) and sunflower (47%). The trend showed that there was an increase of 12% in beans and 5% in sunflower production compared to baseline values, respectively. Maize production remained at the same level (88%) at both survey points. However, due to agro-ecological differences, there were major variations in terms of the dominant crops that were grown in the various zones. Maize production was dominant in the Southern Highlands zone (99%) compared to the Central (87%) and Eastern (69%) zones. Paddy production was dominant in Eastern zone (69%) compared to Central zone (9%) and Southern Highlands (2%). The Southern Highlands zone was also famous for production of beans (83%), and the Central zone was also famous for the production of sunflower (69%).

**Chicken production and consumption:** The average number of chickens kept by households was 22 and 17 during the baseline and endline, respectively. Although the overall average number of chickens decreased at the endline, more households in ACGG+ATONU treatment arms kept chicken. On average, 20 chickens were consumed per year and more chickens were slaughtered for household consumption at endline compared to the baseline in ACGG and ACGG+ATONU treatment arms. However, in the Control treatment arm the number of chickens slaughtered for household consumption decreased. Similarly, the number of chickens sold in the ACGG and ACGG+ATONU arms increased at endline compared to that observed at baseline. The number of eggs produced was lower in the Control (10 vs 7) but it increased in ACGG (9 vs 13) and the ACGG+ATONU (9 vs18) treatment arms at endline compared to baseline. The number of eggs sold was 5 vs 1 in the control treatment arm, 5 vs 5 and 3 vs 11 in ACGG+ATONU at baseline and endline, respectively. At endline there was no significant difference in egg production between treatment arms ($F=0.85$, $p=0.43$). In addition, the number of eggs sold was not significantly different among treatment arms ($F=0.76$, $p=0.47$) at endline.

**Decisions on expenditure from own and household income**: Decision-making on household income and expenditure improved, particularly on the capacity of women to make decisions on household budgets related to their own income expenditure. Overall, the proportion of empowered women was higher at endline (78.3%) compared to baseline (71%). At baseline, no significant difference in the proportion of empowered women was observed across treatment arms ($\chi^2 =0.0197$, $p=0.9902$). The magnitude of the difference in empowerment of women in the Control treatment arm improved by 2.9% and in ACGG and ACGG+ATONU treatment arms improved by 8.5% and 10.5%, respectively. The magnitude of the difference in women empowerment observed in ACGG+ATONU treatment arm was 7.6% higher than that observed in the Control treatment arm and was 2% higher than in ACGG treatment arm. For ACGG+ATONU, the D-I-D Odds ratio was 1.56, and was significant ($p=0.0473$). This means that, the proportion of empowered women at baseline and at endline was significantly higher in ACGG+ATONU compared to Control treatment arms. This suggests that, the training on budgeting and decision-making helped to improve women empowerment at endline. The intervention on social behaviour change communication influenced women participation in decision making at household level. Women who participated in SBCC training were twice more likely to participate in decision making of own and household income.

**General nutrition knowledge:** Although nutrition education was one of the interventions implemented, nutrition knowledge of the respondents at endline in all treatment arms did not improve significantly. This could be due to limited exposure time to nutrition knowledge. The mean general nutrition knowledge score at baseline was 2.4 (SE: 0.06) and at endline it was 2.7 (SE: 0.11). This did not vary significantly with treatment arms ($p=0.3911$). It was 2.3 for the Control, 2.5 for ACGG and 2.4 for ACGG+ATONU treatment arms. Nevertheless, the mean general nutrition knowledge score at endline showed significant variation across treatment arms ($p<0.0001$) and it was 2.1, 3.0 and, 3.1 for Control, ACGG and ACGG+ATONU treatment arms, respectively. The rate of change in nutrition knowledge at endline in the ACGG treatment arm was significantly higher than that in the Control treatment arm ($\beta=0.4475$, $p=0.0407$). However, the change in nutrition knowledge at baseline and endline was not significant in ACGG+ATONU treatment arm compared to the Control ($\beta=0.3850$, $p=0.0747$) treatment arms. Likewise, there was no significant difference in the ACGG+ATONU treatment arm compared to ACGG treatment arm ($\beta=-0.06247$, $p=0.7737$). The average nutrition knowledge was significantly higher among respondents from Eastern zone compared to those from Southern Highlands zone ($\beta =0.3681$, $p=0.0030$). However, no significant difference was observed between Central and Southern Highlands zone ($\beta=0.1257$, $p=0.2212$).

**Conclusion and recommendations**

Increased production of improved and local chicken led to an increase in the number of eggs that were available to the household for consumption as well as for sale. Dietary diversity of children improved and was statistically significant in the ACGG+ATONU treatment arms than in the other treatment arms. Increased consumption of cereals, oils and fats, eggs, fruits and vegetables mainly contributed to an increase in dietary diversity among

children. This implies that the intervention on nutrition education had an impact on dietary diversity of households.

Improvement in vegetable production and consumption could be attributed to the introduction and establishment of home gardens, with the assumption that households were able to produce more vegetables through ownership of home gardens, hence more consumption. Vegetable production had a positive effect on food access and improved dietary diversity.

**Recommendation**

All agricultural interventions in Tanzania and indeed other countries, apart from fulfilling specific objectives, should be directed to have an ultimate outcome/goal of improving the nutritional wellbeing of the final beneficiaries. Development of agricultural interventions needs to incorporate nutrition considerations in the planning and implementation of activities to ensure that the interventions are nutrition-sensitive and lead to improved agricultural productivity and nutrition.

# 1. INTRODUCTION

## 1.1 Background

In recent years, agricultural investment in sub-Saharan Africa has increased, leading to an increase in food production. However, despite this increase in food production, malnutrition rates are still high. Agricultural programmes have traditionally focused on increasing the availability of food rather than promoting consumption and improving nutrition status. Africa has the highest malnutrition rates in the world, with 17 countries having stunting rates above 40% and 36 countries above 30% (UNICEF, WHO & WB 2014). Sub-Saharan Africa carries a high burden of under-nutrition, with 33% of childhood deaths linked to under-nutrition. It is, therefore, vital that agricultural programmes start to take nutrition into consideration if they are to provide long-term nutrition security. The barriers to good nutrition, amongst others, are a lack of knowledge about which food crops are nutrient-rich, low productivity/yield, high food waste, poor storage and farmers' inaccessibility to markets, all of which can prevent food reaching the people who need it most. Women's lack of empowerment partly contributes to the problem. It is generally agreed that when women are able to decide what to grow, what to consume and how household budgets are spent, nutrition at household level improves.

The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPRAN) and partners have been implementing the *Agriculture to Nutrition (ATONU): Improving Nutrition Outcomes Through Optimized Agricultural Investments* Project. The project sought to break the intergenerational cycle of under-nutrition and answer the question of what agriculture can do to deliver positive nutrition outcomes through tailored nutrition-sensitive interventions targeting women of childbearing age and children in the first 1,000 days of life, that is, from conception to two years. ATONU has developed frameworks to select and provide technical support to agriculture projects for integrating nutrition-sensitive interventions, identifying, selecting and implementing nutrition-sensitive interventions (NSIs) and evaluating their impact. The project's approach was to work with existing agriculture development projects to select and implement tailor-made interventions, evaluate their impact and provide evidence of what agriculture can do to deliver positive nutrition outcomes.

ATONU selected the African Chicken Genetic Gains (ACGG) project, which was implemented by the International Livestock Research Institute (ILRI) in several African countries, including Tanzania. The ACGG Project's aim was to improve the production and productivity of chickens kept by smallholder households by introducing and testing the performance of improved and tropically adapted genotypes.

Although ACGG was implemented in five zones, ATONU interventions were implemented in three zones of Tanzania, namely Eastern, Central and Southern Highlands. The following interventions were selected and overlaid onto the ACGG project and delivered as a package to participating households:

i. Social behaviour change communication (SBCC) on nutrition education and hygiene to increase consumption of eggs and chicken meat;
ii. SBCC to increase expenditure on nutritious food through income generated from sale of eggs and chicken;
iii. SBCC for women empowerment to influence changes in women's time use and participation in decision making within the household; and
iv. Promotion of home gardens to increase vegetable production for improving dietary diversity.

This study hypothesized that both ACGG and ATONU can improve women and children's diets via the following three pathways: food production for own consumption, increased income expenditure on additional nutrient dense foods, and women's empowerment, all working in concert. Specifically, ACGG could increase production of chicken meat and eggs, which would increase access to these products for household consumption. These products could also be marketed, providing a source of income that could be used in part for improving diets. ACGG's efforts to target women could also lead to greater engagement and participation by women in household decision-making on chicken production and marketing, which could, in turn, empower them and improve their status within the household. The SBCC on nutrition education and hygiene could encourage household consumption of chicken products and other nutrient-dense foods, especially by women and children. SBCC on household budgeting could encourage use of income from chicken production, specifically for the purchase of other foods that could not be produced by the household but provide nutrients that would be missing in the household diet. Interventions addressing gender dynamics within the household could further empower women in chicken production and other aspects of household life. Household members' adoption of appropriate Water, Sanitation and Hygiene (WASH) behaviors could decrease harmful exposure to poultry droppings, thereby decreasing morbidity among children and improving food and nutrient utilization. Given that chicken products provide a good source of animal protein and essential amino acids and micronutrients, it was expected that infants and young children would have better growth, women would be less likely to be underweight, and both women and children would have a reduced risk of anaemia.

## 1.2 Delivery of Nutrition-Sensitive Interventions

In each village, the ATONU interventions were administered to 40 ACGG participating households, reaching out to approximately 800 smallholder households. However, only 30 households were included in the impact evaluation surveys. Field Assistants (FAs) who had been trained and equipped to support farmers to adopt certain behaviours to improve dietary

diversity and support hygienic practices delivered the interventions. Tanzania Livestock Research Institute (TALIRI) employed the Field Assistants and assigned each to one participating village.

SBCC sessions were delivered through group sessions and discussions, individual household visits and theatre for nutrition behaviour change (TNBC). The schedule of SBCC engagements is presented in Table 1.

**Table 1: Schedule of SBCC engagements in a month**

| Week | Delivery of NSI |
|---|---|
| 1st Week | Group sessions – 4 groups (15 -20 participants) in a village and all receiving the same message |
| 2nd Week | Household visits (an average of 56 HH in all zones per month) and follow-ups |
| 3rd Week | Group sessions |
| 4th Week | Household visits for data collection |

**SBCC for nutrition and hygiene education**
Nutrition education and hygiene promoted best practices and mitigation of negative practices that would affect the achievement of good nutrition. The ATONU beneficiary households were engaged in weekly sessions covering lessons on basic nutrition, dietary diversity, child and maternal nutrition, food safety, hygiene and sanitation. The sessions lasted between 45 and 60 minutes, especially if cookery sessions were included. The key nutrition messages were premised on the understanding that the participants were farmers; hence agriculture production and productivity informed the approach to delivery of content.

**SBCC for influencing expenditure of income**
This intervention was aimed at influencing expenditure of income from both agriculture and non-agriculture activities for purchase of nutritious food at household level. The budgeting and financial planning training session was arranged for households and was offered as a two-day special sessions. The sessions covered the basics of joint husband and wife budgeting, financial planning and meal planning, and deciding on savings. In addition to the training sessions, weekly SBCC sessions covered aspects of income expenditure.

**SBCC for women empowerment**
This intervention was designed to increase women's capacity to participate in decision-making and improve time use. The interventions involved creating awareness among men of the nutrition needs of family members and workload, especially women and children. The women empowerment sessions were delivered along with nutrition and hygiene education.

**Vegetable production**
Vegetable production was a way of increasing households' access to micronutrient rich foods and improved dietary diversity. The promotion of vegetables was also a way of supporting the households' ability to manage chicken faecal matter. The farmers learned through demonstration gardens, which were located at public places. Members of participating households were trained on how to harvest vegetables to minimise nutrient loss, how to prepare vegetables and how to process vegetables for storage. The consumption part was delivered during the community sessions as part of the cookery demonstrations. Emphasis was placed on utilisation of vegetables in infant diets.

**Implementation timeline**
The ATONU interventions were implemented for about 16 months from January 2017 to April 2018, following the baseline survey in November 2016. Both the baseline and implementation of interventions were meant to take place after distribution of ACGG chickens. However, some beneficiary households did not receive chickens until after ATONU interventions had started, while some (45%) did not receive any chickens as previously planned.

### 1.3 Objectives of the Impact Evaluation Study
This report describes the results of the impact evaluation of the ATONU project conducted by Sokoine University of Agriculture (SUA). The study comprised two surveys conducted at the baseline and endline. The baseline survey was conducted in November 2016, and the endline survey was conducted in May-June 2018 following the cessation of interventions.

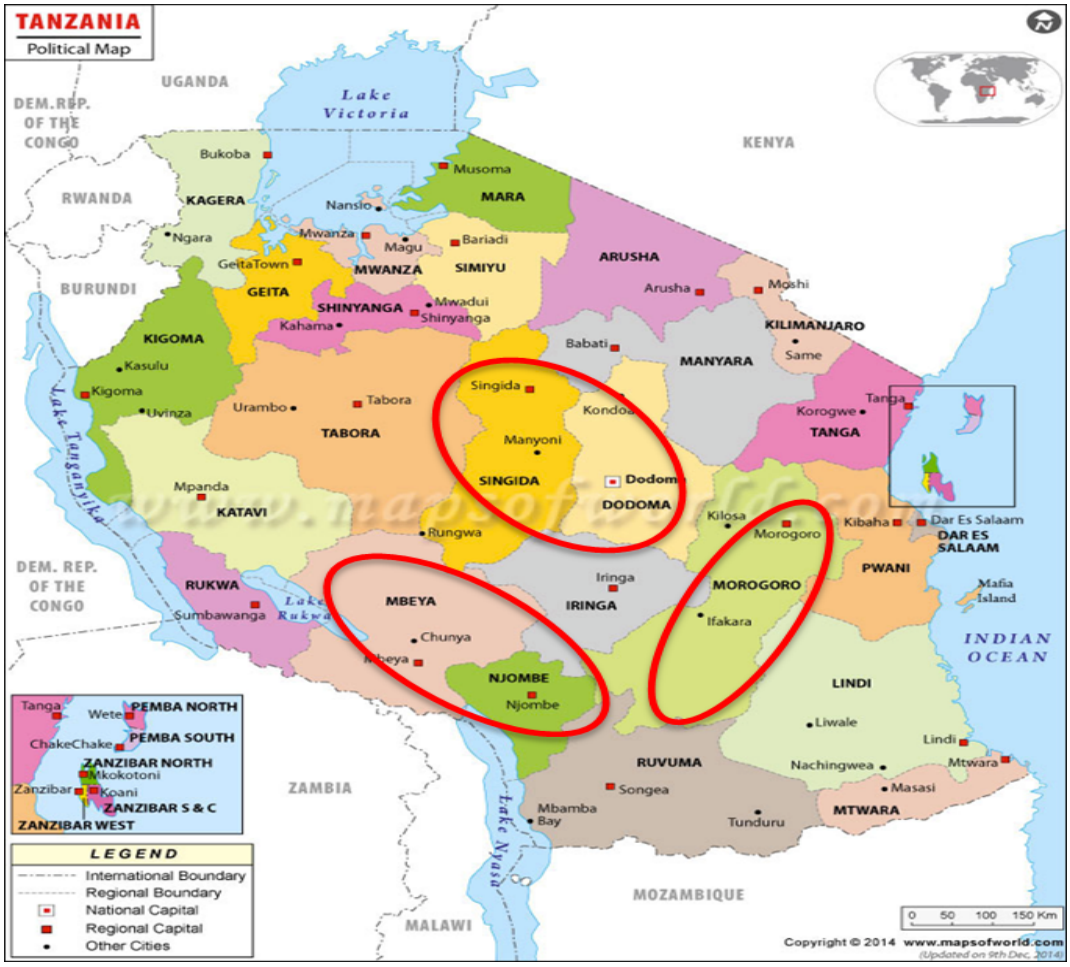
## 2. METHODOLOGY

### 2.1 Selection of Study Area

In Tanzania, three agro-ecological zones were selected, namely Central, Eastern and Southern Highlands zones (Table 2 and Map 1). During the baseline survey the government of Tanzania divided Mbeya region into two regions, namely Mbeya and Songwe.

**Table 2: Study sites**

| Agro-ecological Zone | Southern Highlands | Central Semi-arid | Eastern Sub-humid |
|---|---|---|---|
| Districts | Ileje<br>Mbeya Rural<br>Njombe Rural<br>Wanging'ombe | Bahi<br>Chamwino<br>Iramba<br>Manyoni | Kilombero<br>Morogoro Municipality<br>Mvomero |
| Number of villages | 24 | 24 | 12 |
| Number of households | 720 | 720 | 360 |




**Map 1: Tanzania map showing areas of baseline and endline surveys**

**Description of the study zones**

*Central Ecological Zone*

***Dodoma Region***

Dodoma Region is located in the central part of the country and is primarily semi-arid, covering an area of 41,311 square kilometres. It is divided into seven districts. Dodoma has the highest proportion of households with very low food security (38%), while Kongwa, Bahi and Chamwino districts are the three least food-secure districts in the Region. Low rainfall is common and results in crop failure, with food harvested in each year lasting 6-9 months. Food insecurity is acute from December to February. Dodoma is one of the regions with a high population of livestock and had a total of 4.4 million (cattle, goat, sheep, chicken and pigs) in 2007.

***Singida Region***

Singida is one of the poorest regions in Tanzania. The region is part of the semi-arid Central zone, which experiences low rainfall and often erratic short rainfall, with a range of 500-800 mm per annum. There are two main seasons, the rainy season during the months of December to March and the long dry season from April to November. The region is divided into six districts.

*Eastern Ecological Zone*

***Morogoro Region***

Morogoro Region is divided into six districts. Its economy is dominated by agriculture and related activities. The major activities include: (i) small scale farming (food and cash crop production and subsistence farming); (ii) cattle keeping (mainly indigenous livestock); and (iii) plantations and estates (sisal, sugar). There is, however, growth of a small capital intensive urban sector whose main activities include: (i) manufacturing; (ii) provision of services, offices, hotels and petty trading; (iii) traditional fishing along the Kilombero and Wami rivers and Mindu dam. Maize and paddy are the major staple food crops. Other food crops in the region include sorghum, sweet potatoes, beans, cassava, millet, groundnuts, tomatoes, fruits and vegetables.

*Southern Highlands Ecological Zone*

***Mbeya Region***

Mbeya Region is located in the South Western Corner of the Southern Highlands of Tanzania and is divided into seven districts. In the highlands (1,500 to 2,400 metres altitude), the cultivated food crops include maize, groundnuts, beans, wheat, potatoes and bananas. In the Midland zone (800 to 1500 meters) the main crops grown are maize, sorghum, finger millet, cotton, cowpeas, groundnuts, cassava, beans and some paddy. Cattle and goats are also common. Several crops thrive well in the Lowlands zone (400 to 800 meters), for example, tobacco, maize, sorghum, finger millet, cassava, groundnuts, cocoa, cashew nuts, palm oil, paddy and bananas. Cattle, goats and sheep are reared as well.

## 2.2 Calculation of Sample Size

The total sample size for the ATONU-NSI impact assessment study was 1,800 households, with 1,200 receiving treatments and 600 belonging to the Control arm. The sample had 20 villages per treatment arm; each village had a total of 30 participating households, making a total of 1,800 households. The selection of these arms was made in collaboration with the ACGG staff based in the zones where chickens had been supplied to farmers. The aim was to determine the minimum number of clusters (villages) to detect a specified difference between the mean treatment (intervention households) arms and the Control arm (non-intervention households). The sample size was computed using the following equation:

$$n = \frac{(\sigma_T^2 + \sigma_C^2)[z_{\alpha/2} + z_{\beta}]^2}{\Delta^2}$$

Where :-

N = Number of individuals

$\sigma_T^2$ and $\sigma_C^2$ (1.63 and 1.61) are the variation of individual food diversity scores in the treatment arms and Control treatment arm, respectively.

$z_{\alpha/2}$ and $z_{\beta}$ (1.96 and 0.842) are the z values usually at 5% and 80% levels representing the level of significance and the power of the test respectively

$\Delta^2$ is the detectable difference 2.99 and 2.56

Given a sample of size n under individual randomization, the number of clusters needed was given by:-

$$K = \frac{(\sigma_T{}^2 + \sigma_C^2)[z_{\alpha/2} + z_\beta]^2[1 + (m-1)\rho]}{m\Delta^2}$$

Where :-

K= is the number of clusters

$\rho$ = is the inter-cluster correlation coefficient (ICC) equal to 0.1

m = is the average cluster size (number of households in a village) which was 40 villages

$$K = \frac{(1.63^2 + 1.61^2)[1.96 + 0.842]^2[1 + (40-1)0.1]}{40(2.99 - 2.56)^2}$$

K=28 ≈ 30 clusters

### 2.3 Study Design and Sampling

The study adopted a cluster randomized control design. The study evaluated the effectiveness of the interventions implemented by ACGG and ATONU through the difference-in difference approach (i) Pre- and post-interventions differences between the baseline and endline, and (ii) the differences between interventions versus control villages.

The sampling frame was the ACGG participating regions in the selected zones. Three zones were selected purposively from the five zones that were implementing ACGG interventions. All regions representing each zone were included in the sampling process. The districts in each region were listed and assigned a number. Computer software ENA for SMART was used to select the districts randomly. Similarly, all villages in the selected districts were assigned numbers and the same software was used to select the villages randomly. Therefore, a total of ten districts and sixty (60) villages were randomly selected from all the zones. Forty villages were randomly allocated to the treatment arms i.e. ACGG and ACGG+ATONU and 20 villages were allocated to the Control treatment arm. Thirty households were randomly selected from each village based on inclusion criteria and these were the households that were interviewed at both baseline and endline surveys. The control villages were selected based on the inclusion criteria for ACGG but had not been selected for ACGG chicken intervention.

The inclusion and exclusion criteria for the ACCG/ATONU cluster were:

i) Households were required to be participating in the ACGG program
ii) Have at least one woman of reproductive age (18-49 years at enrolment) and
iii) Provide informed consent

The inclusion criteria for the Control cluster were that:
In addition to criteria ii) and iii) above, a household should have produced chickens for at least two years, be currently keeping not more than 50 chickens, and have interest to expand production in the future.

The Central and Southern Highlands had four districts each, while the Eastern zone had two districts, with the villages allocated to the three treatment arms across the three zones as shown in Table 3.

**Table 3: Sample description and distribution by treatment arms and ecological zones**

| Agro-ecological Zones | Districts | ACGG | | ACGG + ATONU Interventions | | Control | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Villages | HH | Villages | HH | Villages | HH | Villages | HH |
| Central | 4 | 8 | 240 | 8 | 240 | 8 | 240 | 24 | 720 |
| Southern Highlands | 4 | 8 | 240 | 8 | 240 | 8 | 240 | 24 | 720 |
| Eastern | 2 | 4 | 120 | 4 | 120 | 4 | 120 | 12 | 360 |
| Total | 6 | 20 | 600 | 20 | 600 | 20 | 600 | 60 | 1800 |

### 2.4 Data Collection

**Ethical Considerations**

The research protocol was explained to the responsible authorities and the research team obtained appropriate authorization from the region, district, ward and village leaders through clearance requested by the Vice Chancellor of Sokoine University

of Agriculture. The National Institute of Medical Research (NIMR) issued the ethical certificate (NIMR/HQ/R.8a/Vol. IX/2554). In addition, participants were asked to indicate their consent to be interviewed by completing and signing a consent form after being informed about the objectives and activities of the endline survey. Participation in the survey was voluntary. Caregivers and or children who were identified by the researchers as malnourished and those who were reported to be ill during the survey were advised to report to the health facilities, where they would normally receive standard treatment and/or rehabilitation.

**Research permission and reconnaissance visits at endline**

The endline survey for the three zones implementing ACGG and ATONU interventions was planned for May and June 2018. Before the actual survey, three supervisors visited the three zones to refresh the district officials about the endline survey. The endline reconnaissance visit was done in three zones, namely; Eastern Sub-humid, Central and Southern Highlands zones, by the respective supervisors Peter Mamiro, Akwilina Mwanri and Teddy Jumbe, respectively. As usual, the procedure to obtain permission to carry out the endline survey involved the Vice Chancellor of Sokoine University of Agriculture, who submitted a request on behalf of researchers to the respective Regional and District Authorities to conduct research in their zones. At the district level, the District Executive Director (DED) authorised researchers by an official letter that instructed the District Livestock Development Officer (DLFDO) to issue a letter to the village authority to support researchers to conduct the survey and assigned one officer to accompany researchers to the villages. The letter from the district was intended to inform the Village Executive Officer about the survey and tentative dates for the activity. The three supervisors travelled to respective zones from 2$^{nd}$ to 8$^{th}$ April 2018 and visited all selected districts to deliver the University permit and to introduce the survey to the respective Districts/Town/Municipal Directors. Discussions were held with the Directors, District Livestock, and Fisheries Development Officers (DLFDOs) about the survey and on all logistics that would be involved. In addition, a list of selected households that would participate in the endline survey was shared with the DLFDOs to inform/notify them prior to the survey dates. DLFDOs identified a responsible person who would be available to accompany the field teams to the respective villages during the endline survey. Permission was granted to conduct the survey in all zones visited and the reconnaissance teams were well received. In addition, the supervisors shared a summary of the results of the baseline survey with the district authorities. In all zones, the visit was successful and all District Executive Directors were cooperative and were excited because they were interested in the feedback reports on the nutrition situation provided to some of the villages during the theatre performance. The District Executive Directors in the respective districts in the zones received the results of the baseline survey and they looked forward to the outcome of the project, especially on how to use the results to promote nutrition-sensitive interventions in their respective districts. They promised to work on the challenges identified during the baseline survey and implementation of the project. However, they requested ATONU to present the endline results and facilitate discussions at district level to identify solutions to nutrition challenges or resistant points that had been identified during implementation or would be identified during the endline survey. They also expected guidance as to how the information could be utilised to improve nutrition at district level.

**Training of Enumerators**

**Selection**

Enumerators were selected from a pool of personnel with experience in quantitative surveys; preferably the ones who had participated in the baseline survey. When they were not available, a replacement was identified from the reserve list of the baseline survey and if this was not possible, a new person was identified. The qualification of the enumerators was a Bachelor of Science Degree (13); Master of Science Degree (12) and Doctor of Philosophy degree (2). The selected enumerators were officially invited to participate in the training and field survey.

**Training**

The training was conducted for five days at iAGRI premises at the Sokoine University of Agriculture main campus. It involved 27 participants, including enumerators, data management specialists, nutrition measurement specialists and supervisors.

Enumerators were trained on the data collection tool, how to conduct interviews and anthropometric measurement techniques for three days. The survey team navigated through all the questions in the questionnaire. Questions that were not clear were modified accordingly. This ensured consistency and accuracy during data collection. The technicians, although experienced, were also trained on procedures and use of equipment for measurements of weight, height/length and mid-upper arm circumference as well as on how the data were going to be incorporated in the data collection tool. Experienced and qualified supervisors from Sokoine University of Agriculture conducted the training. The approach used during the training included:

i) Familiarisation with the tools for data collection
ii) Going through each question in the digital questionnaire in order to have the same understanding
iii) Opportunity to practice the tool in pairs as well as to practice taking anthropometric measurements
iv) Pretesting the questionnaire in the outskirts of SUA campus and later, modifying the tool accordingly in readiness for data collection
v) Clarity on logistics to allow teams to leave for the field trips.

All teams travelled to the respective zones on the 29th April 2018.

**ATONU endline field survey**
The ATONU endline survey in Tanzania was carried out from 30th April 2018 to 03 June 2018. Sixty villages were visited during the survey. Twelve (12) were in the Eastern zone, 24 in the Central zone and 24 in the Southern Highlands zone. According to sample size calculation (30 households per village) and based on the baseline sample, the target of the survey was to interview 1800 households but only 1762 households could be reached.

A total of 1604 (91.1%) households participated in the endline survey and were interviewed out of the target of 1762 households. The loss to follow-up was 158 (9%). The reasons for dropout were migration 58 (3.0%), travel 54 (3.0%), refusal 20 (1.5%) and no-show 26 (1.5%) (Table 4).

**Table 4: ATONU endline field survey summary sheet**

| zone | Expected | Participated | Not participated | Migrated | Travelled | No show | Refused |
|---|---|---|---|---|---|---|---|
| **Eastern** | **370** | 324 | 46 | 19 | 24 | 1 | 2 |
| **Central** | **704** | 637 | 67 | 33 | 26 | 3 | 5 |
| **Southern Highlands** | **688** | 643 | 45 | 6 | 4 | 22 | 13 |
| **Total** | **1762** | 1604 | 158 | 58 | 54 | 26 | 20 |
| **Percentage** | | 91.0 | 9.0 | 3.3 | 3.0 | 1.5 | 1.5 |

**Interviews with selected respondents**
Face to face interviews were conducted at the participant's residence and involved women and partners whenever possible. All household members were later referred to a central place where measurements of weight, height and mid-upper-arm circumference were taken. The enumerators collected information on tablets and the supervisors checked the information for completeness and correctness before uploading the data to a server.

**Anthropometric Measurements**
Anthropometric measurements offer a historical perspective on physical development, capturing accumulated changes in body size caused by dietary intake, physical activity, infection and other factors. To determine these characteristics, all respondents were directed through a referral system to go to a makeshift centre for measurements. Anthropometric measurements were carried out at a central agreed location. After obtaining a referral form, the household, parents/guardian and children present at the time of the interview had their weight and height measured. Weight measurements were done using an electronic SECA 874 flat scale designed for mobile use. The scale had a double display to facilitate the accurate recording of weight and could be turned on with a toe tap. For the weight measurement of very young children, the mother or caretaker was weighed first, the tare facility was used to set the scale to zero, the mother or caretaker was provided with the child, and the weight of the child was recorded to the nearest 0.1 kg. An automatic two-in-one adjustment button allowed the weight of the mother stored to be deducted, which left the baby's weight displayed on the scale.

Height was measured with a Shorr measuring board. Children younger than 24 months of age or shorter than 85 cm were measured lying down on the board (recumbent length). Standing height was measured for older or taller children and adults. The measurement was recorded while the subject was standing without shoes, on a horizontal flat plate attached to the base of the height-metre with heels together; and stretched upwards to a full extent and the head in the Frankfurt plane. The subject was closely observed to ensure that the heels remained on the ground and that the head was in an upright position during the measurement. The measurement was recorded to the nearest 0.1 cm and at the end of the day all records were uploaded to a server.

### 2.5 ATONU Survey Tool Programming and Installation on Mobile Devices and Training
The programming for the ATONU survey tool was done using the XML language Open Data Kit (ODK) technology. The technology was adopted because it does not require internet connection during data collection and allows a supervisor to check and approve the survey answers before submission to the server. To ensure that all information needed for the project impact assessment was properly captured in the programme, some adjustments had to be made on the phrasing of the questions and the flow of questions. After completion of survey programming, the survey tool was loaded onto Android tablets for usage. The ODK Survey mobile App was installed on the tablets for the survey to load and later uploaded onto the

ODK aggregate server. The ODK Survey mobile application had to be downloaded onto the tablets from the server for the survey to load. This was followed by training of the survey team at Sokoine University of Agriculture. The training, apart from imparting knowledge on the understanding of the questions, provided an opportunity for enumerators to understand how to use the mobile devices during data collection.

**Server hosting, management and piloting**
The Dodoma Health and Demographic Surveillance server hosted the survey data to ensure security and ease of access. The server was then configured and after installation of the ODK aggregate and associated software, the server was ready to accept data uploading. However, to be sure of the data collection tool, the ATONU team conducted a pilot in a selected village in Morogoro. Errors encountered during the survey were corrected before the actual data collection.

***Data collection***
Data collection was conducted during the day and in the evening supervisors had to crosscheck the data before submitting to the server. If any technical problem came up during the data collection or data submission, enumerators and/or supervisors would call and request for support from the server administrator who would then step in to solve the problem.

***Data extraction***
As data began aggregating on the server, the data manager kept on checking for errors, omissions and logical mismatch across the submitted data. There was daily communication with supervisors to provide feedback on the quality of data collected on the previous day. After completion of the data collection, the data were extracted in Comma-separated values (CSV) format, cleaned, documented and made ready for analysis.

### 2.6 Data Analysis
Data processing involved labeling, checking for values and re-assigning of values for the open-ended questions, checking for noises, and re-writing the incorrectly entered/spelling checks for nominal responses. The process also involved merging and appending the baseline and endline information.

The data analysis involved computation of the outcome variables of interest (wealth index, dietary diversity scores of the households, mothers and children and nutritional indicators). The analysis was in two parts, i.e. descriptive and inferential analysis. The descriptive analysis had graphical (Bar charts), numerical (mean, standard deviations/errors and median) and tabular (tables and cross tabulation) presentations. The analysis also involved comparisons of treatment arms (baseline/endline and across treatment arms) for dietary diversity scores and nutritional indicators. The inferential analysis involved the difference in difference analysis (D-I-D) in which linear mixed models were applied. The models accounted for the study design structure (cluster randomization of villages) and the repeated measures of the outcome variables, while arms and zones were treated as fixed effects.

***Inferential Analysis: Difference-in-Differences (DID) Analysis***

Difference-in-difference (D-I-D) analysis is used in the study of longitudinal cohort data with pre- and post-exposure repeated measures. It allows the comparison of changes over time in the outcome between exposed and Control treatment arms, while accounting for controlling the possible confounding variables. The D-I-D design measures the change in the outcome between two time points (the pre- and post-periods) for an exposed treatment arm and a Control treatment arm, then subtract one from the other to see the difference in the differences between the treatment arms. In this study, difference-in-difference analysis was performed using a linear mixed model to assess the effect of the intervention on change of dietary diversity score. The model accounted for the study design structure (cluster randomization of villages) and the repeated measures of the outcome variables. In this analysis, zone and treatment arm were treated as fixed effects, while village effect was treated as random and included in statistical models as a random intercept. The general fixed effect DID linear mixed model can be presented using the following equation:

$$Y_{it} = \beta_0 + \beta_1 * Time + \beta_2 * Treatment + \beta_3 * Time * Treatment + \varepsilon_{it}$$

$$\Rightarrow \mu_t = E(Y_{it}) = \beta_0 + \beta_1 * Time + \beta_2 * Treatment + \beta_3 * Time * Treatment$$

Where $\boldsymbol{Y_{ij}}$ is the outcome value for subject *i* at time *t*, **Time** is a dummy variable for period, equal to 1 when the outcome measurement was made in the post period (endline) and 0 for baseline measurements. **Treatment** is a dummy variable for subject treatment arm membership. The composite variable **Time* Treatment** is the interaction between time and treatment, and $\varepsilon_{it}$is the error term for the outcome measures of subject *i* at time *t*.

In the model above, the parameter $\beta_0$ represents the intercept, the mean outcome variable in the Control treatment arm at the baseline measurement. $\beta_1$ is the change in mean outcome variable in the Control treatment arm between baseline and endline.

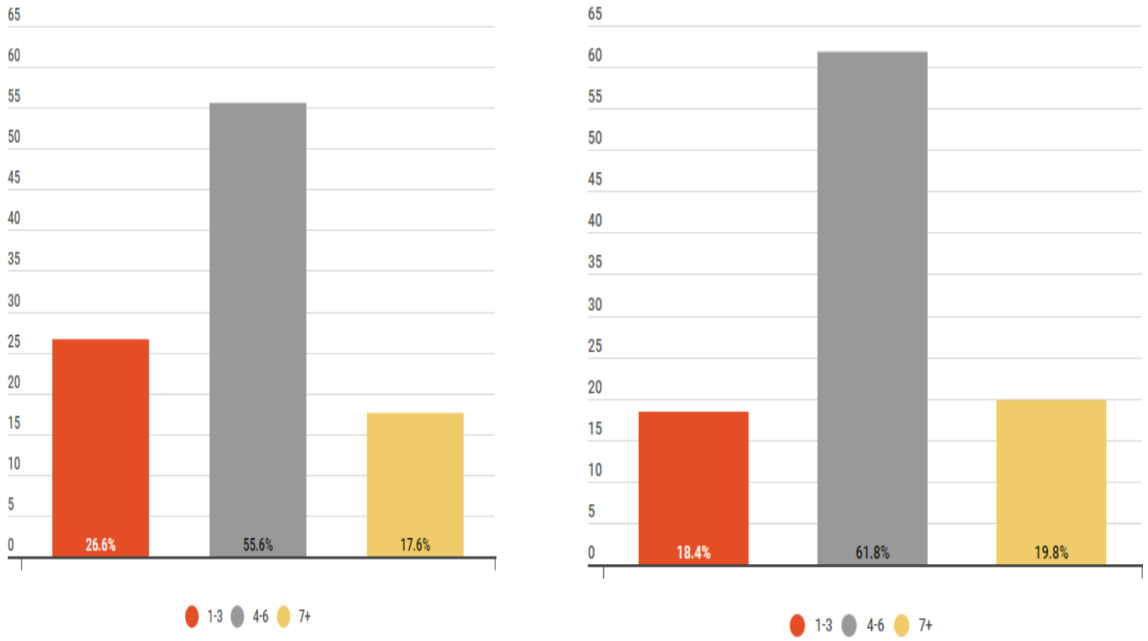
The parameter $\beta_2$ indicates the difference in mean outcome variable between the treatment and Control treatment arm at baseline, whereas the coefficient $\beta_3$ (Interaction) measures the difference in slopes between the two treatment arms (ACGG versus Control or ACGG+ATONU versus Control). The coefficient of the interaction term provides the estimate and inference of the difference-in-differences between the two treatment arms. In the model results, if this coefficient estimate is statistically significant it indicates that the slopes in the two treatment arms are not parallel, and so the intervention has affected the outcome in the treatment arm differently than the underlying background trend, as taken by the Control treatment arm.

## 3. RESULTS

### 3.1 Household Demographics and Characteristics

**Household size**

Median household size for all surveyed areas was 4 individuals at baseline and endline as well as by treatment arms. At baseline, 56% of the households had household size ranging between 4 and 6 individuals followed by household size of 1 to 3 (27%). At endline, 62% of the households had household size of 4 to 6 individuals and 20% had household size of at least seven individuals. The proportion of households with 4 to 6 individuals increased from 56% to 62% (Figure 1) between baseline and endline.




**Baseline** **Endline**

**Figure 1: The distribution of household size at baseline and endline**

About 57% of the households in the Control, 52.3% in ACGG and 57.4% in ACGG+ ATONU treatment arms had household size of 4 to 6 individuals. The distribution of the households size across treatment arms at baseline was not significantly different (p=0.1698). In addition, at endline the proportion of households with size ranging between 4 and 6 individuals was 65% in the Control treatment arm, 60% in ACGG and 60% in ACGG+ ATONU treatment arms. In all treatment arms, the proportion of households with size 4 to 6 individuals increased between baseline and endline. In the Control treatment arm, the proportion increased by 7.9% (57.4% to 65.3%), in ACGG treatment arm the proportion increased by 8% (52.3% to 60.3%) and in ACGG+ATONU treatment arm it increased by 2.5% (57.4% to 59.9%) (Table 5).

**Table 5: Household size by treatment arms at baseline and endline**

| | Baseline | | | | Endline | | | |
|---|---|---|---|---|---|---|---|---|
| **Persons** | **Control N=484** | **ACGG N=509** | **ACGG+ ATONU N=470** | **$X^2$ (P)** | **Control N=542** | **ACGG N=501** | **ACGG+ ATONU N=561** | **$X^2$ (P)** |
| | % | % | % | 6.91 (0.1698) | % | % | % | 8.7 (0.2425) |
| 1 to 3 | 27.7 | 26.9 | 25.3 | | 19 | 17.8 | 18.4 | |
| 4 to 6 | 57.4 | 52.3 | 57.4 | | 65.3 | 60.3 | 59.9 | |
| ≥ 7 | 14.9 | 20.8 | 17.3 | | 15.7 | 22.0 | 21.7 | |

**Education Attainment**

The level of education of adults determines the ability of respondents to acquire nutritional knowledge, skills and practices. At endline, 59.5% of the adults had attained primary level education (i.e. class seven) and 4% had no formal education. At endline, the ACGG + ATONU treatment arm (61%) had a slightly higher proportion of adults who had attained primary

education compared to 58% in ACGG and 59.8% in Control treatment arms (Table 6). At baseline, 63% of the members had attained primary education compared to 59.5% at endline; however, more members (14%) had either attained or were in secondary education at endline compared to baseline (9%) (Figure 2). No significant difference in education level across treatment arms was observed at baseline (p=0.0539), however significant difference was observed at endline (p <0.0001).

**Table 6: Educational attainment by treatment arms**

| | BASELINE | | | | ENDLINE | | | |
|---|---|---|---|---|---|---|---|---|
| | **CONTROL N=1838** | **ACGG N=1815** | **ACGG+ATONU N=1877** | **$\chi^2$ (p)** | **CONTROL N= 2656** | **ACGG N=2631** | **ACGG+ATONU N=2872** | **$\chi^2$ (p)** |
| | **%** | **%** | **%** | | **%** | **%** | **%** | |
| No Formal education | 4.1 | 4.4 | 3.7 | 26.0077 (0.0539) | 4.7 | 4.4 | 3.0 | 85.06 (<0.0001) |
| Adult education | 0.2 | 0.3 | 0.4 | | 0.3 | 0.6 | 0.3 | |
| Primary education | 61.8 | 64.9 | 61.5 | | 59.8 | 57.7 | 60.9 | |
| Secondary education | 7.8 | 9.3 | 11.1 | | 9.7 | 16.7 | 15.4 | |
| A-level | 0.4 | 0.5 | 0.6 | | 0.3 | 0.3 | 0.5 | |
| Certificate/diploma | 1.1 | 1.0 | 1.3 | | 0.9 | 2.7 | 1.7 | |
| University | 0.7 | 1.0 | 0.9 | | 0.3 | 1.2 | 0.9 | |
| Pre-School | 9.1 | 7.8 | 7.6 | | 11.3 | 8.0 | 8.7 | |
| NA | 14.7 | | | | 12.7 | 8.4 | 8.7 | |

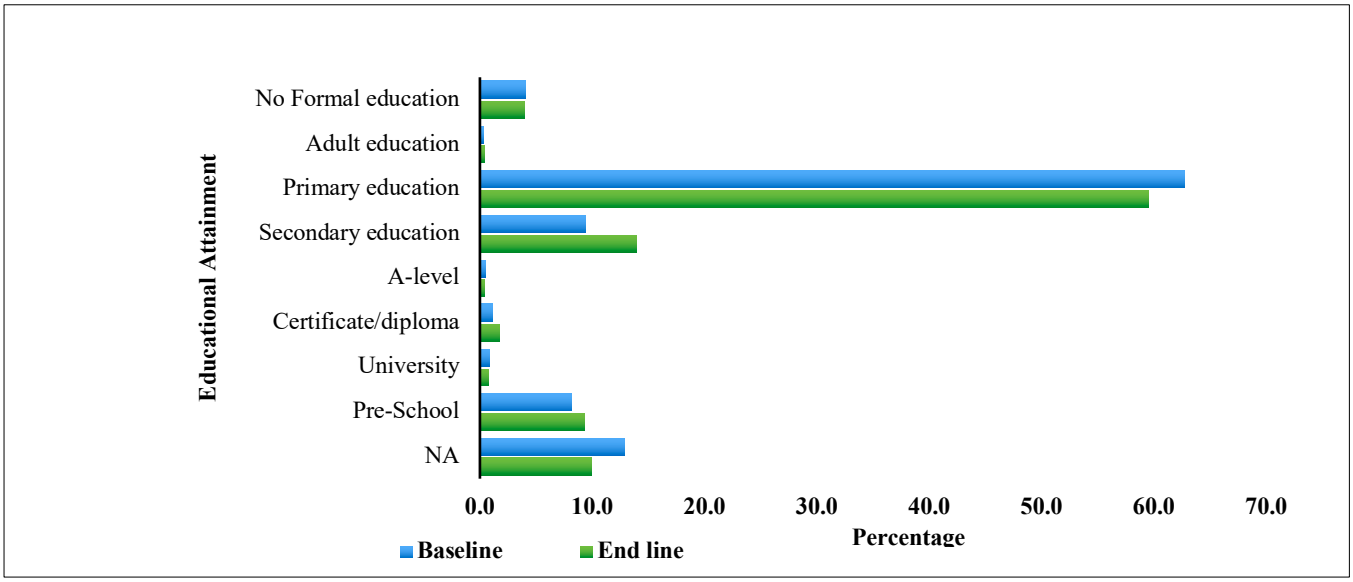



**Figure 2: Educational attainment at baseline and endline**

**Education level of the head of the households**

Most heads of households had attained primary education at baseline (78.7%) and endline (76.6%) (Figure 3). About 6% had no formal education and very few had attained tertiary education.

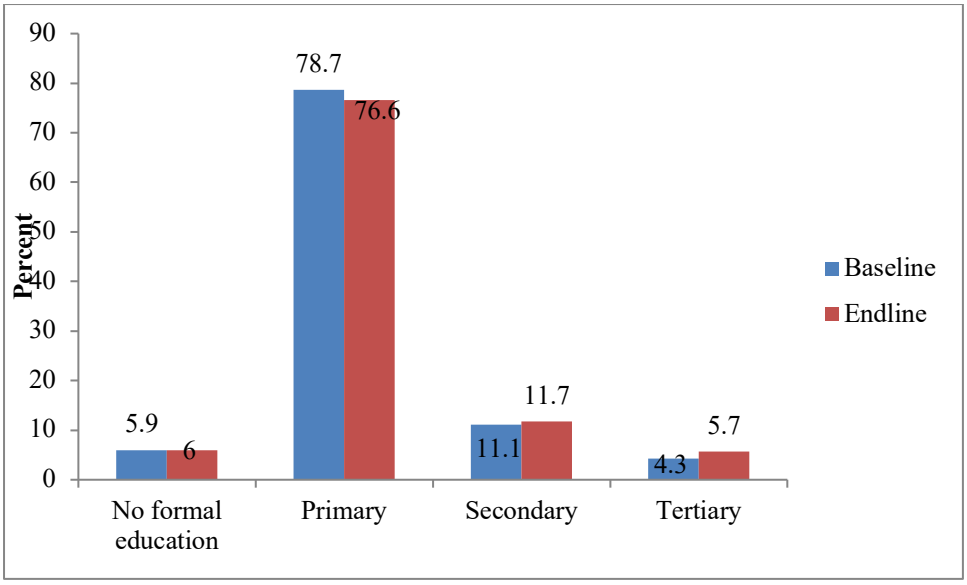



**Figure 3: Education level of the head of household at baseline and endline**

The education level of heads of households by treatment arms is presented in Table 7. At baseline, about 78% of the head of households in the CONTROL treatment arm had attained primary education, 80.6% and 77.3% of the respondents in ACGG and ACGG+ATONU treatment arms, respectively. At endline, 78.9%, 72.1% and 78.2% of the heads of households in the Control ACGG+ATONU and ACGG treatment arms attained primary education. At baseline, the education level of the head of household was not significantly different across treatment arms (p=0.2926) but was significantly different at endline (p<0.0020).

**Table 7: Education level of head of household according to treatment arms**

| | **BASELINE** | | | | **ENDLINE** | | | |
|---|---|---|---|---|---|---|---|---|
| | **CONTROL N=441** | **ACGG N=423** | **ACGG+ATONU N=454** | $\chi^2$ **(p)** | **CONTROL N= 532** | **ACGG N=484** | **ACGG+ATONU N=542** | $\chi^2$ **(p)** |
| | **%** | **%** | **%** | | **%** | **%** | **%** | |
| No Formal education | 7.1 | 6.1 | 4.6 | 7.32 (0.2926) | 8.5 | 6.0 | 3.7 | 20.81 (0.0020) |
| Primary education | 78.2 | 80.6 | 77.3 | | 78.9 | 72.1 | 78.2 | |
| Secondary education | 11.8 | 8.3 | 13.0 | | 10.7 | 11.8 | 12.5 | |
| Tertiary education | 3.0 | 5.0 | 5.1 | | 1.9 | 10.1 | 5.5 | |

**Occupation**

Information about occupation status of households is presented in Figure 4. At endline, 65.3% of the participating households were engaged in farming as their most important occupation compared to 45% of the participating households at baseline.

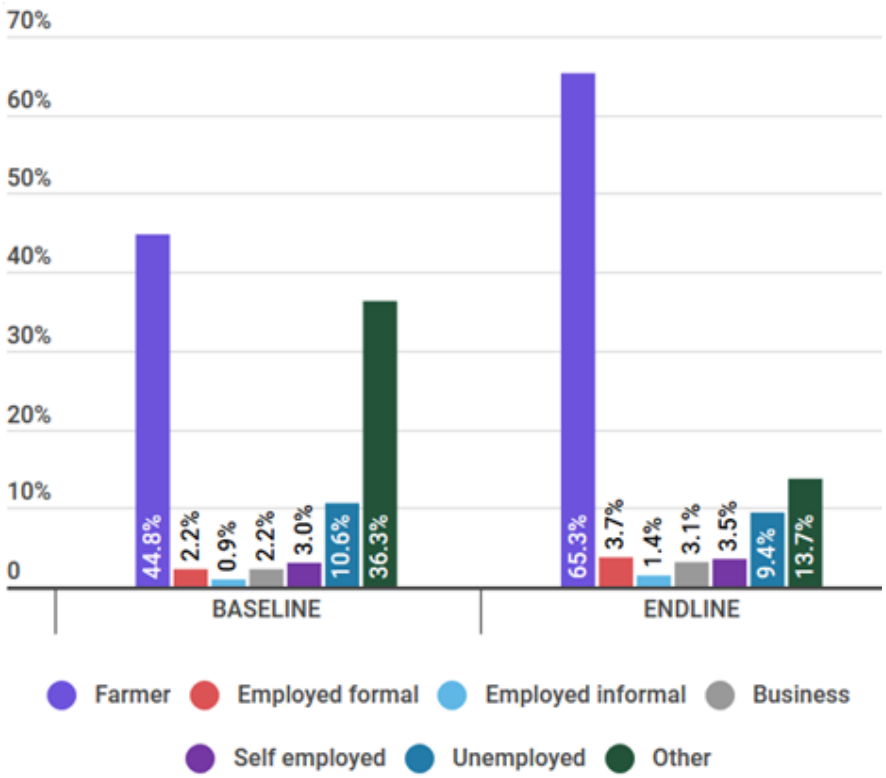



**Figure 4: Occupation of respondents at baseline and endline**

The occupation of respondents by treatment arms is presented in Table 8. At baseline, about 46% of the respondents in the Control treatment arm were farmers, 45% and 43% of the respondents in ACGG and ACGG+ATONU treatment arms, respectively, were engaged in farming. At endline, more than 75% of the respondents in the Control treatment arm were engaged in farming compared to 64% and 57% of the respondents in ACGG+ATONU and ACGG treatment arms. At baseline, the distribution of occupation status was not significantly different across treatment arms (p=0.5217) but it was significantly different at endline (p<0.0001).

**Table 8: Occupation status of household members in surveyed areas by treatment arms**

| | | | Baseline | | | Endline | | |
|---|---|---|---|---|---|---|---|---|
| | **CONTROL** | **ACGG** | **ACGG+ATONU** | **$\chi^2$ (p)** | **CONTROL** | **ACGG** | **ACGG+ATONU** | **$\chi^2$ (p)** |
| N | 1737 | 1746 | 1809 | | 1403 | 1537 | 1679 | |
| | % | % | % | | % | % | % | |
| Farmer | 46.3 | 45.2 | 43.1 | | 75.7 | 57.1 | 64.1 | |
| Employed - formal | 1.5 | 2.6 | 2.3 | 11.08 (0.5217) | 1.5 | 5.4 | 3.9 | 57.45 (p<0.0001) |
| Employed - informal | 0.6 | 0.9 | 1.1 | | 1.3 | 1.6 | 1.3 | |
| Business | 2.2 | 1.8 | 2.8 | | 2.0 | 3.8 | 3.2 | |
| Self-employed | 2.9 | 2.7 | 3.3 | | 2.2 | 4.4 | 3.8 | |
| Unemployed | 9.6 | 9.3 | 12.8 | | 7.8 | 11.8 | 8.5 | |
| Other | 36.8 | 37.5 | 34.7 | | 9.6 | 15.9 | 15.2 | |

The occupation of the head of households is presented in Figure 5. At baseline and endline about 80.7% and 62.9% were farmers. In addition, the occupation of the head of households by treatment arms is presented in Table 9. About 83.4, 81.6 and 77.3 at baseline and 75%, 52.7% and 60.5% at endline of the heads of households in CONTROL, ACGG and ACGG+ATONU treatment arms, respectively (Table 9).

**Occupation of the head of household**

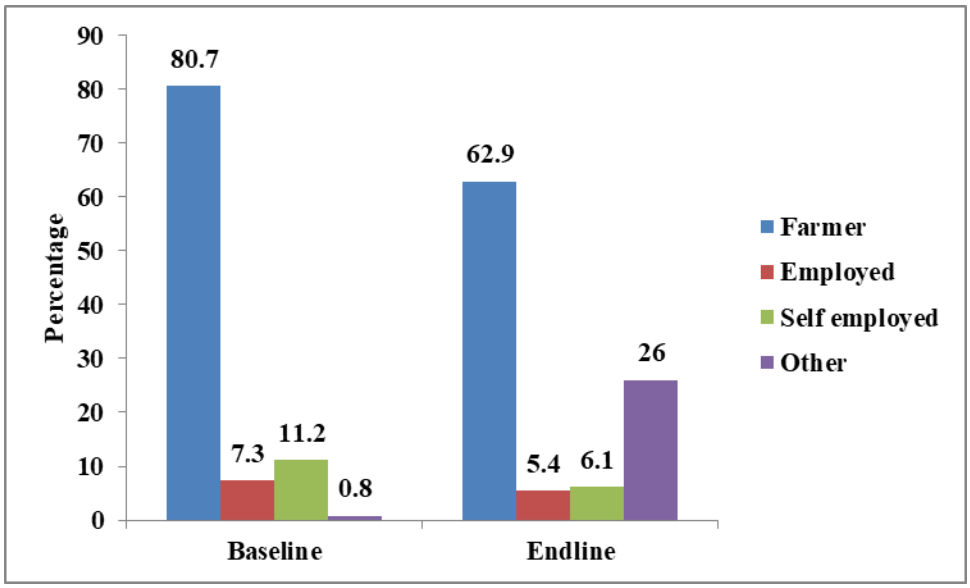



**Figure 5: Occupation of the head of household at baseline (n=1318) and endline (n=1436)**

**Table 9: Occupation status of the head of households in surveyed areas by treatment arms**

| | Baseline | | | | Endline | | | |
|---|---|---|---|---|---|---|---|---|
| **Occupation** | **CONTROL** | **ACGG** | **ACGG+ATONU** | **$\chi^2$ (p)** | **CONTROL** | **ACGG** | **ACGG+ATONU** | **$\chi^2$ (p)** |
| N | 441 | 423 | 454 | | 480 | 450 | 506 | |
| | % | % | % | 8.97(0.1719) | % | % | % | 30.11(<0.0001) |
| Farmer | 83.4 | 81.6 | 77.3 | | 75.0 | 52.7 | 60.5 | |
| Employed | 5.0 | 8.3 | 8.6 | | 2.5 | 8.4 | 5.3 | |
| Self-employed | 11.1 | 9.0 | 13.2 | | 4.4 | 7.8 | 6.1 | |
| Other | 0.5 | 1.2 | 0.9 | | 18.1 | 31.1 | 28.1 | |

### 3.2 Household Wealth Index

Wealth Index is a composite proxy measure of a household's cumulative living standard. The index is calculated based on a household's ownership of selected assets, such as television and bicycle; materials used for housing construction; and types of water access and sanitation facilities. In this study, the household wealth was computed through the household assets from the ATONU survey for both baseline and endline data (i.e. car/van/truck, motorbike/scooter, bicycle, television, radio, cell phone, telephone, sewing machine, generator, table, stove, fridge/freezer, tractor, tractors drawn farm implements, oxen, ox, wheelbarrows, hand tools: hoe, rake, spade, axe, digging fork, grain mill). All these assets were combined into a single variable of the wealth index using the factor analysis under the principal component method. The index was then divided into five categories of equal size (quintiles). Wealth status of surveyed households is presented in Table 10. The proportion of households in the lowest quintile wealth index decreased from 21% to 13.2% in the ACGG treatment arm and 18% to 11.6%,

in the ACGG+ATONU treatment arm at the baseline and endline, respectively. However, for the Control treatment arm the proportion of households in the lowest quintile wealth index increased from 21% to 34.9%. At baseline, the distribution of family wealth index was not significant across treatment arms (p=0.2539) but was significant at endline (p <0.0001).

**Table 10: Wealth Index of surveyed population at baseline and endline**

| | **Baseline** | | | | **Endline** | | | |
|---|---|---|---|---|---|---|---|---|
| **Wealth Index Quintiles** | **CONTROL** | **ACGG** | **ACGG+ATONU** | $\chi^2$ **(p)** | **CONTROL** | **ACGG** | **ACGG+ATONU** | $\chi^2$ **(p)** |
| **N** | **272** | **267** | **311** | | **542** | **501** | **561** | |
| | % | % | % | | % | % | % | |
| Lowest | 21 | 21 | 18.3 | 10.1612 (0.2539) | 34.9 | 13.2 | 11.6 | 157.5830 (<.0001) |
| Second | 22.8 | 17.9 | 19.3 | | 24.9 | 17.2 | 17.8 | |
| Middle | 18.3 | 20.2 | 21.2 | | 18.5 | 17.8 | 23.6 | |
| Fourth | 19.1 | 16.9 | 23.5 | | 12.7 | 23.8 | 23.5 | |
| Highest | 18.8 | 24 | 17.7 | | 9 | 28 | 23.5 | |
| | | | | | | | | |
| **Wealth Index Quintiles** | **Central zone** | **Eastern zone** | **Southern Highlands zone** | **X²** (p) | **Central zone** | **Eastern zone** | **Southern Highlands zone** | **X²** (p) |
| N | **333** | **637** | **180** | | **324** | **337** | **643** | |
| % | % | % | % | | % | % | % | |
| Lowest | 21.6 | 18.1 | 20 | 2.3841(0.9669) | 21.3 | 18.4 | 21.2 | 12.1582 (0.1443) |
| Second | 19.6 | 19.6 | 19.4 | | 16.4 | 20.7 | 22.2 | |
| Middle | 18.6 | 17.9 | 22.2 | | 18.1 | 20.2 | 23 | |

In the Central zone 3.5% of the households moved along the quintiles; as a result, the lowest wealth index quintile dropped from 21.6% of the households at baseline to 18.1% at endline. Similarly, the proportion of households in the highest wealth index quintile increased by 4.5% (Table 10). An increase of 1.3% in the Lowest Wealth Index Quintile and an increase of 2.6% in the highest wealth index quintiles occurred in the Eastern zone. In the Southern Highlands zone, the proportion of households in the lowest wealth index quintile increased by 3.2% and the proportion of households in the highest wealth index decreased by 5.7% (Table 10).

**Improved chickens ownership**

The distribution of the households with improved chicken across treatments arms at baseline and endline are presented in Figure 6. Overall, the proportion of household with improved chickens was higher at baseline (37%) as compared to endline (25.2%). At baseline, no significant difference in proportion of household with improved chickens across treatment arms was observed ($\chi^2$=4.5932, p=0.1006), where by 41.6% of the households in ACGG and 37.2% in ACGG+ATONU were having improved chickens. Likewise, 33.8% of the households in control had improved chickens. However, significant difference in household with improved chickens was noted at endline ($\chi^2$=190.7564, p<.0001).

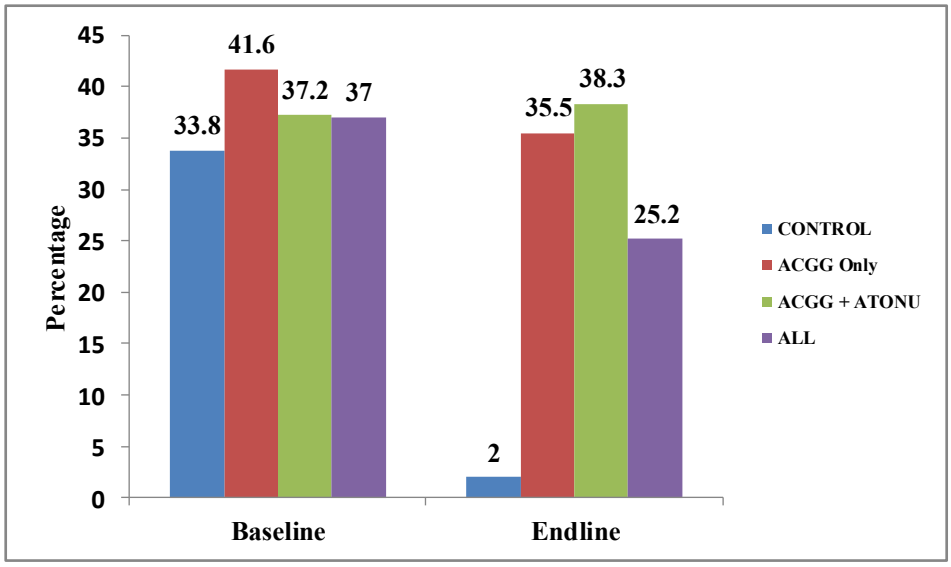



**Figure 6: Proportion of the household with improved chicken by treatment arms at baseline and endline**

### 3.3 Physical characteristics of the housing

Information on materials used for construction of walls, roofs and floors in the surveyed areas is presented in Table 11. At endline, over 70% of the houses in all treatment arms had walls constructed using earth bricks and cement mortar. Houses with walls constructed using cement blocks were 21%, 16% and 14% in the ACGG, ACGG+ ATONU and Control treatment arms, respectively. At baseline, only 11% of the houses were constructed using concrete/cement blocks. Close to 90% of the houses were covered using corrugated iron sheets. Above 60% of the houses in ACGG and ACGG + ATONU treatment arms had concrete floors and only 42% in the Control treatment arm.

### Access to utilities and services

At endline, more than 95% of the households had access to a cellphone network. The proportion was not different from baseline. Availability and accessibility to electricity increased from an average of 19% at baseline to 44.5% at endline. Accessibility to water services was 70% in all treatment arms. The level of accessibility to water was similar to the national average of 65% (NBS, 2017). At endline, more than 66% of the households in all treatment arms had access to clinic, hospital or health facilities and services.

### Fuel for lighting

Various types of fuel for lighting are used in the surveyed areas. The most important source of fuel for lighting at endline was solar (44%) and electricity (33%) in ACGG and ACGG+ATONU treatment arms and the Control treatment arm (13%). Other sources included battery powered, 28.8% for Control, 14% for ACGG only and 17% in ACGG + ATONU treatment arms.

### Types of fuel for cooking

Firewood and charcoal were the most important sources of energy for cooking and heating in the surveyed areas. Firewood was the most important fuel for cooking at both baseline (85%) and endline (76%). However, the proportion of households using firewood for cooking decreased slightly at endline for the ACGG (by 9%) and ACGG + ATONU (by 14%) treatment arms, but slightly increased (1.3%) in the Control treatment arm (Table 11).

**Table 11: Housing characteristics and energy sources**

| | Control | | ACGG | | ACGG + ATONU | | Overall |
|---|---|---|---|---|---|---|---|
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | |
| **N** | **458** | **498** | **453** | **482** | **481** | **538** | **2988** |
| | % | % | % | % | % | % | % |
| **Materials used to construct the walls of the main house** | | | | | | | |
| Bricks and Mortal / Cement | 84.9 | 76.5 | 84.8 | 72.7 | 84.2 | 78.6 | 80.1 |
| Concrete Blocks and Mortar/Cement | 10.3 | 14.9 | 11.2 | 20.7 | 11.4 | 16.5 | 14.3 |
| Corrugated Iron | 0 | 0.4 | 0 | 0.2 | 0.4 | 0 | 0.2 |
| Wood | 0.2 | 0 | 0 | 0 | 0 | 0.3 | 0.1 |
| Stick and Mud | 4.6 | 8.2 | 4 | 6.4 | 4 | 4.6 | 5.3 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Materials used for the roof of the main house** | | | | | | | |
| Tiles/Slate/Concrete | 0.9 | 0 | 1.1 | 0.4 | 0.2 | 0 | 0.4 |
| Asbestos | 0.1 | 0.6 | 0 | 0.8 | 1.1 | 0.2 | 0.5 |
| Corrugated iron | 94.8 | 92.8 | 94 | 94.4 | 95 | 96.9 | 94.8 |
| Thatch grass | 4.2 | 6.6 | 4.9 | 4.4 | 3.7 | 2.9 | 4.3 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Main type of floor** | | | | | | | |
| Natural (earth/sand) | NA | 49.8 | NA | 21.4 | NA | 27.3 | 33.1 |
| Wood/Bamboo | NA | 0.7 | NA | 0.3 | NA | | 0.3 |
| Concrete | NA | 41.9 | NA | 63.7 | NA | 60.6 | 55.3 |
| Finished (tile/ceramic/mosaic) | NA | 7.6 | NA | 14.6 | NA | 12.1 | 11.3 |
| Total | | 100 | | 100 | | 100 | 100 |
| **Utilities and services available/accessible to the household** | | | | | | | |
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | |
| **N** | **457** | **542** | **453** | **501** | **480** | **561** | |
| | % | % | % | % | % | % | |
| Cell phone Network Access | 98.2 | 95.4 | 98.7 | 97.2 | 97.9 | 97.0 | |
| **N** | **526** | **452** | **481** | **542** | **501** | **562** | |
| Electricity (%) | 15.8 | 29.9 | 21.0 | 51.3 | 20.6 | 44.5 | |
| N | **444** | **500** | **500** | **500** | **500** | **571** | |
| Telephone line (%) | 0.9 | 0.4 | 0.4 | 1.4 | 0.4 | 0.7 | |
| N | **NA** | **542** | **NA** | **501** | **NA** | **561** | |
| Water (%) | NA | 69.9 | NA | 71.5 | NA | 69.7 | |
| **N** | **NA** | **542** | **NA** | **501** | **NA** | **561** | |
| Health facilities (clinic, hospital, health centre) (%) | NA | 66.1 | NA | 72.1 | NA | 72.4 | |
| **Fuel used for lighting** | | | | | | | |
| Firewood | 2.2 | 0.6 | 2.9 | 1.2 | 3.5 | 0.5 | |
| Battery powered light/lamp | 24.1 | 28.8 | 24.5 | 14.2 | 25.8 | 17.1 | |
| Paraffin | 13.3 | 13.3 | 13.2 | 4.4 | 13.3 | 4.5 | |
| Electricity | 66.5 | 13.7 | 64.9 | 35.7 | 64.2 | 30.7 | |
| Solar | 0 | 41.5 | 0 | 43.7 | 0 | 47.1 | |
| **Fuel used for cooking and heating** | | | | | | | |
| Firewood | 82.3 | 83.6 | 83.0 | 74.7 | 85.4 | 71.1 | |
| Charcoal | 36.4 | 15.5 | 36.6 | 22.0 | 31.5 | 25.0 | |
| Paraffin | 2 | 0.0 | 1.3 | 0.4 | 1.3 | 0.5 | |
| Electricity | 1.1 | 0.0 | 0.4 | 0.6 | 0.6 | 0.2 | |
| Hand gas | 2.8 | 0.4 | 12.9 | 1.4 | 1.7 | 2.3 | |
| Solar | 0 | 0.6 | 0 | 0.8 | 0 | 0.5 | |

**Water availability and access**

At endline, almost 70% of the households in the treatment arms had access to water services. However, 14% of the households accessed water from unimproved water sources in all treatment arms during the wet season at baseline as well as at endline (Figure 7). In addition, 25% of the households accessed water from unimproved water sources during the dry season at both endline and baseline survey periods. This implies that there was no improvement in the quality of water sources for the period of implementation of nutrition-sensitive interventions.

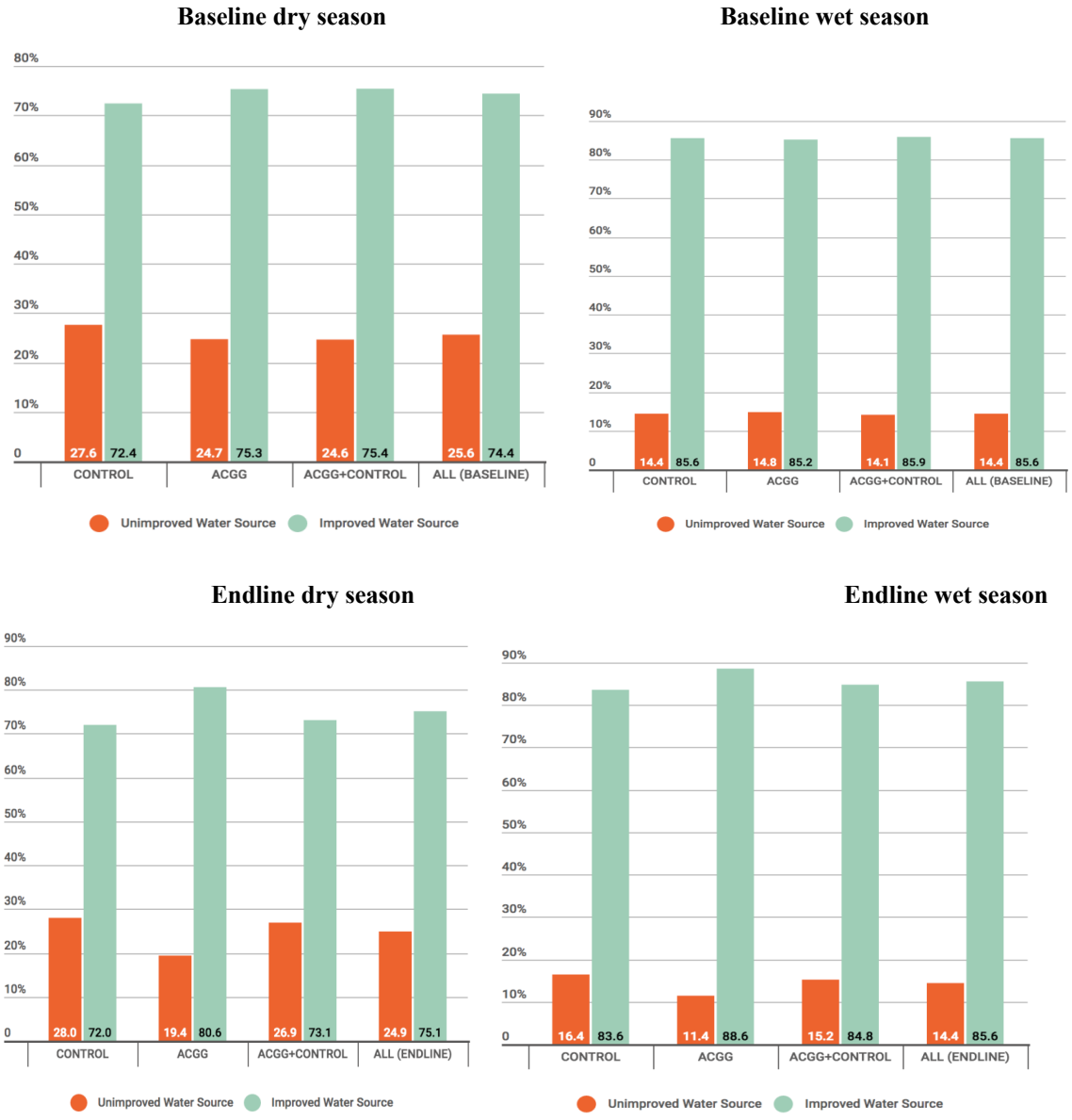



**Figure 7: Availability and access to water sources during dry and wet season at baseline and endline by treatment arms**

**Sanitation**

**Ownership of latrines**

Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feaces. Inadequate sanitation is a major cause of disease worldwide and improving sanitation is known to have a significant beneficial impact on health, both in households and across communities. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal (WHO, 2015). Sanitation practices play a big role in transmission and prevention of food-borne diseases such as diarrhea and are the main route of feacal and/or oral diseases. At baseline, 99% of all households owned and used latrines (Figure 8). However, at endline, the

proportion of households that owned latrines decreased by 4%, 3% and 1% in the Control, ACGG, ACGG + ATONU treatment arms, respectively. Similarly, the proportion of households across zones decreased by 5% and 1% at endline in the Central and Eastern zones, respectively but not in the Southern Highland zone (0.2%). The main reason for not having a toilet was damage and high cost of construction.

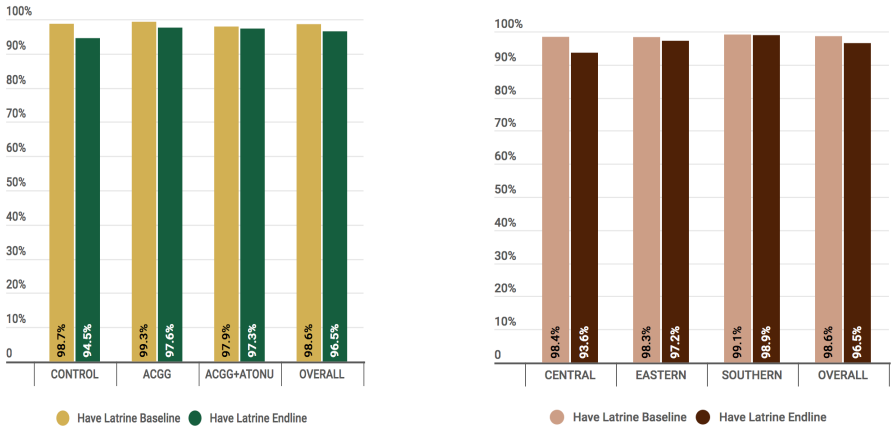



**Figure 8: Ownership of latrines at baseline and endline by treatment arms and zones**

**Ownership of improved latrines**

At endline, ownership of improved latrines increased by 7% in both ACGG and ACGG + ATONU treatment arms but not in the Control treatment arm, whereby ownership decreased by almost 8% (Figure 9). The proportion of households owning improved latrines increased by 10% and 1% at endline in the Eastern and Southern Highlands zones but decreased by 1% in the Central zone.

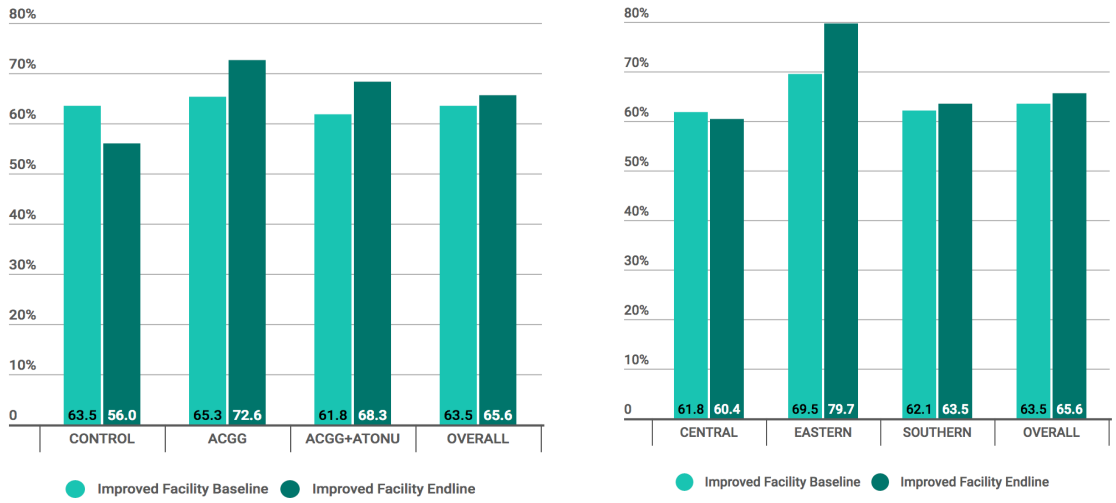



**Figure 9: Ownership of improved latrines by treatment arms and zones**

**Sanitary disposal of children's faeces during the day**

Sanitary and proper disposal of children's faeces during the day was 5%, 12% and 11% in the Control, ACGG and ACGG + ATONU treatment arms, respectively, at endline (Figure 10). Similarly, in the Eastern and Southern Highlands zones, sanitary disposal of faeces increased by 19% and 16%, respectively between baseline and endline but decreased by 3% in the Central zone.

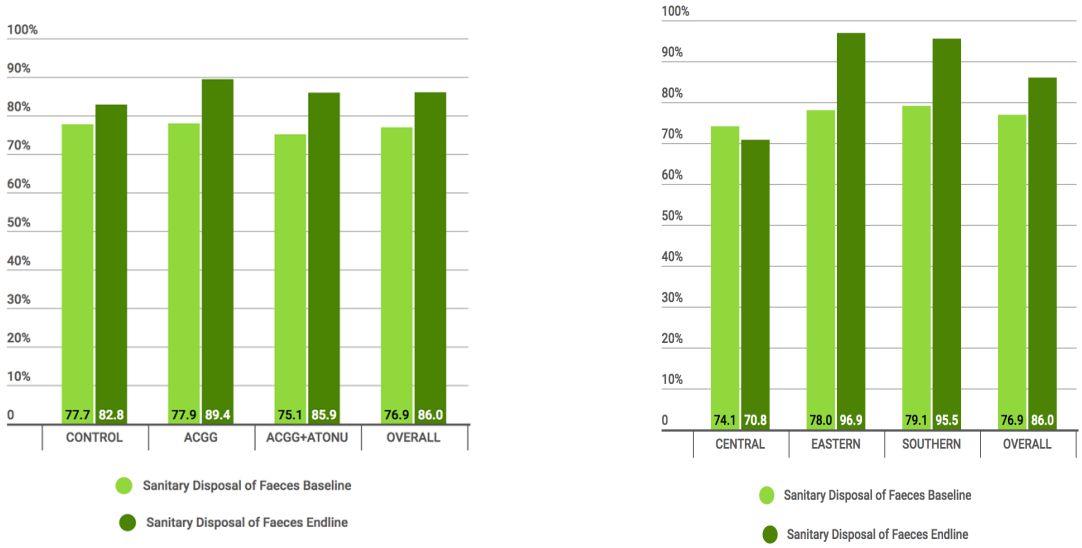



**Figure 10: Sanitary disposal of children's feaces during the day by treatment arms and zones**

**Sanitary disposal of children's faeces at night**

At endline, sanitary and proper disposal of children's faeces at night was 4%, 16% and 11% in the Control, ACGG and ACGG + ATONU treatment arms, respectively (Figure 11). Sanitary and proper disposal of children's faeces at night increased by 19% and 16% in the Eastern and Southern Highlands zones but there was no change in the Central zone (Figure 11).

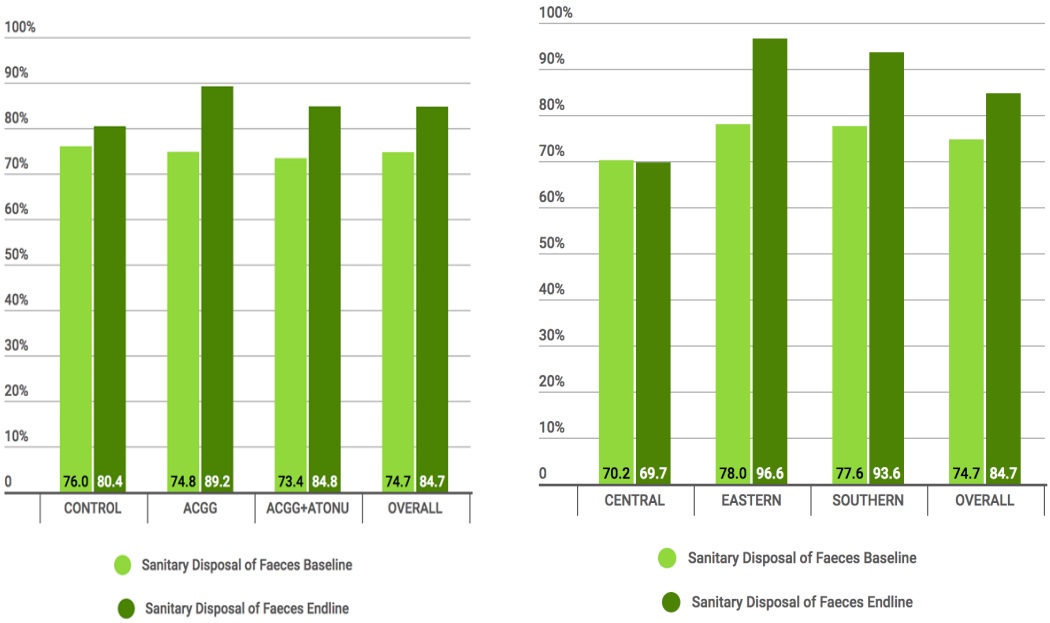



**Figure 11: Sanitary disposal of children's faeces at night by treatment arms and zones**

**Hygiene**

Overall, the proportion of respondents who washed hands with soap was the same at baseline and endline. However, there was an increase of 9% of the respondents who washed hands with soap in ACGG + ATONU treatment arm at endline (86%), but a slight decrease (1%) in ACGG and Control (5%) treatment arms (Figure 12).

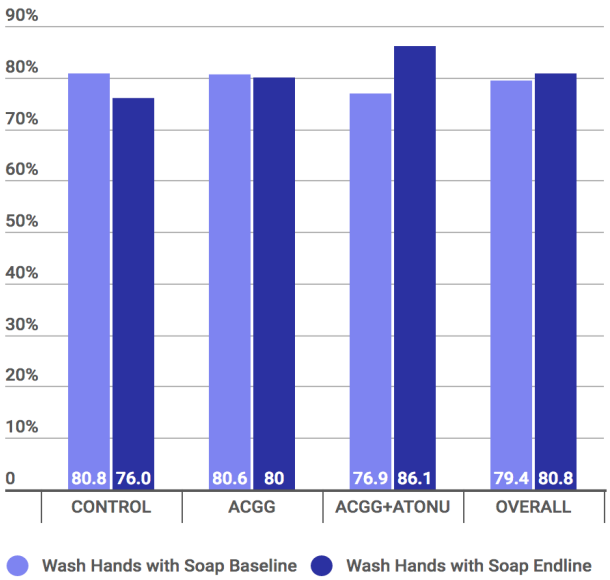
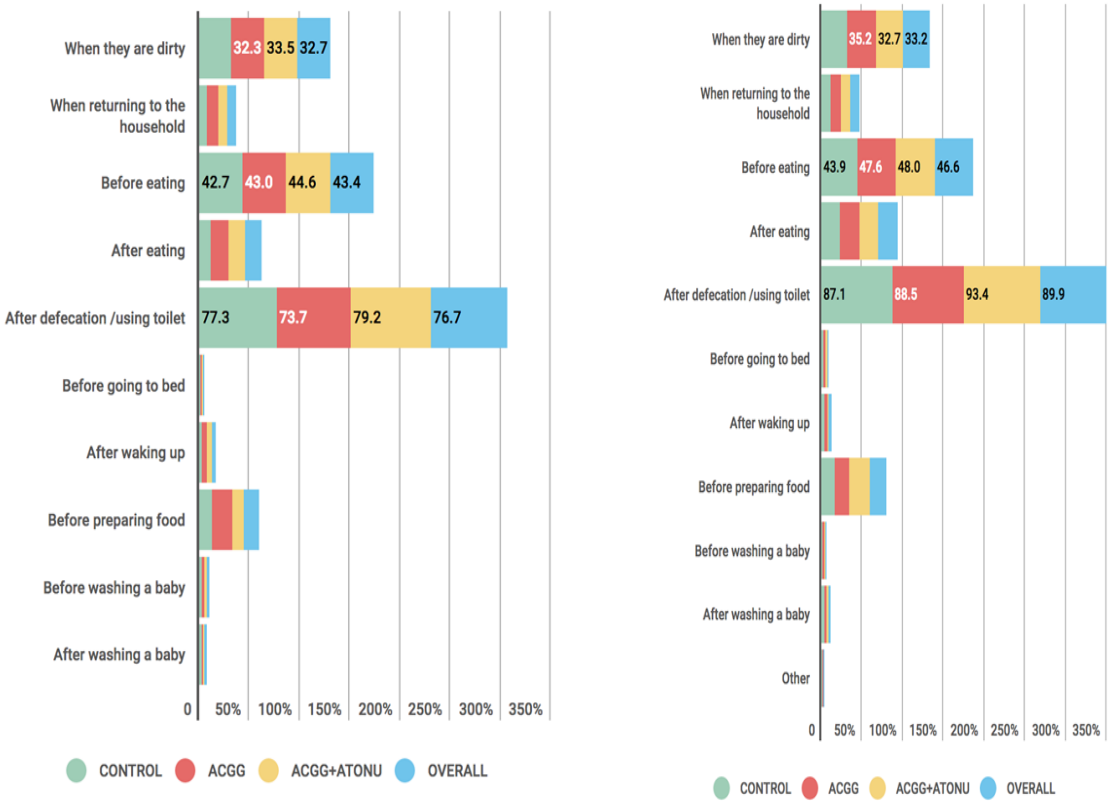



**Figure 12: Washing hands with soap**

In all treatment arms, the number of respondents washing hands with soap after defecation or using the toilet increased at endline. The magnitude of increase was 9.8% in the Control, 14.8% in ACGG and 15.2% in ACGG+ATONU treatment arms (Figure 13).




**Baseline** **Endline**

**Figure 13: Time to wash hands with soap in treatment arms at baseline and endline**

The proportion of respondents who washed hands in a designated area increased in all treatment arms at endline. The increase was 23.9% in ACGG + ATONU, 6.3% in ACGG and 2.7% in the Control treatment arms (Figure 14).

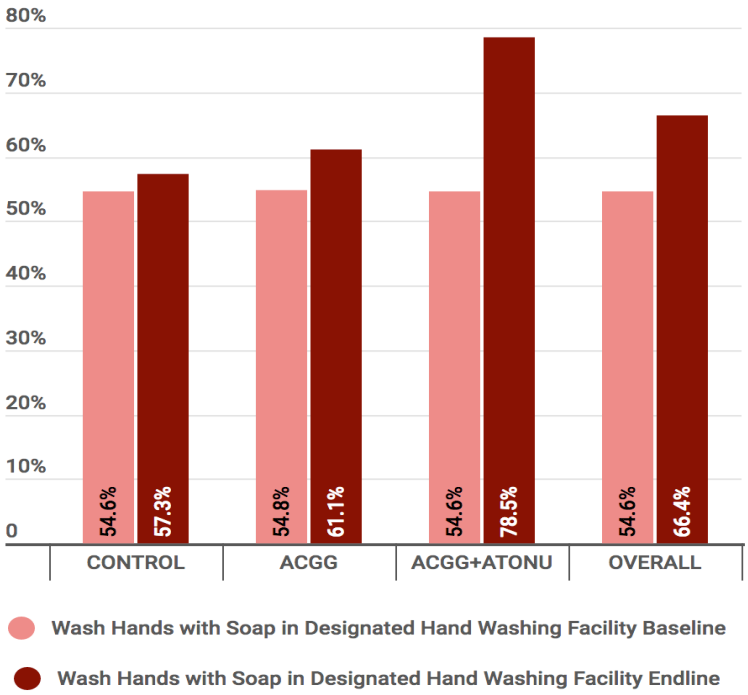
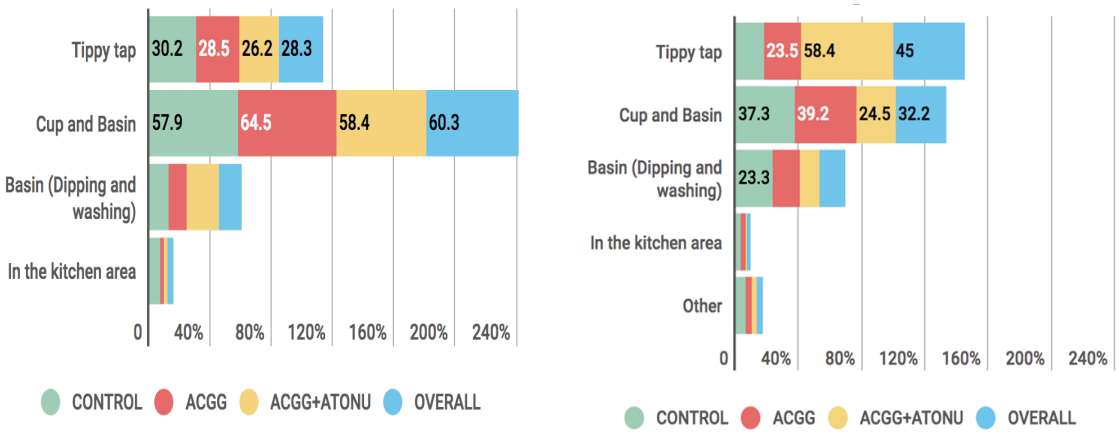



**Figure 14: Wash hands in a designated hand washing facility**

Hand washing facilities included tippy tap, cup and basin and a basin. At baseline, about 60% of the households used cup and basin facility to wash hands, 28% used tippy tap and 15% dip basin. At endline, the proportion of households who used a tippy tap increased by 32% in the ACGG+ATONU treatment arm but decreased by 12% in the Control and 3% in ACGG treatment arms. Conversely, the use of cup and basin facility decreased across the treatment arms by 21% in the Control, 23% in ACGG and 36% in ACGG+ATONU treatment arms (Figure 15). The tippy tap technology was introduced in most villages by other projects operating in these areas (Mwanzo Bora and UNICEF) but was heavily promoted by ATONU.

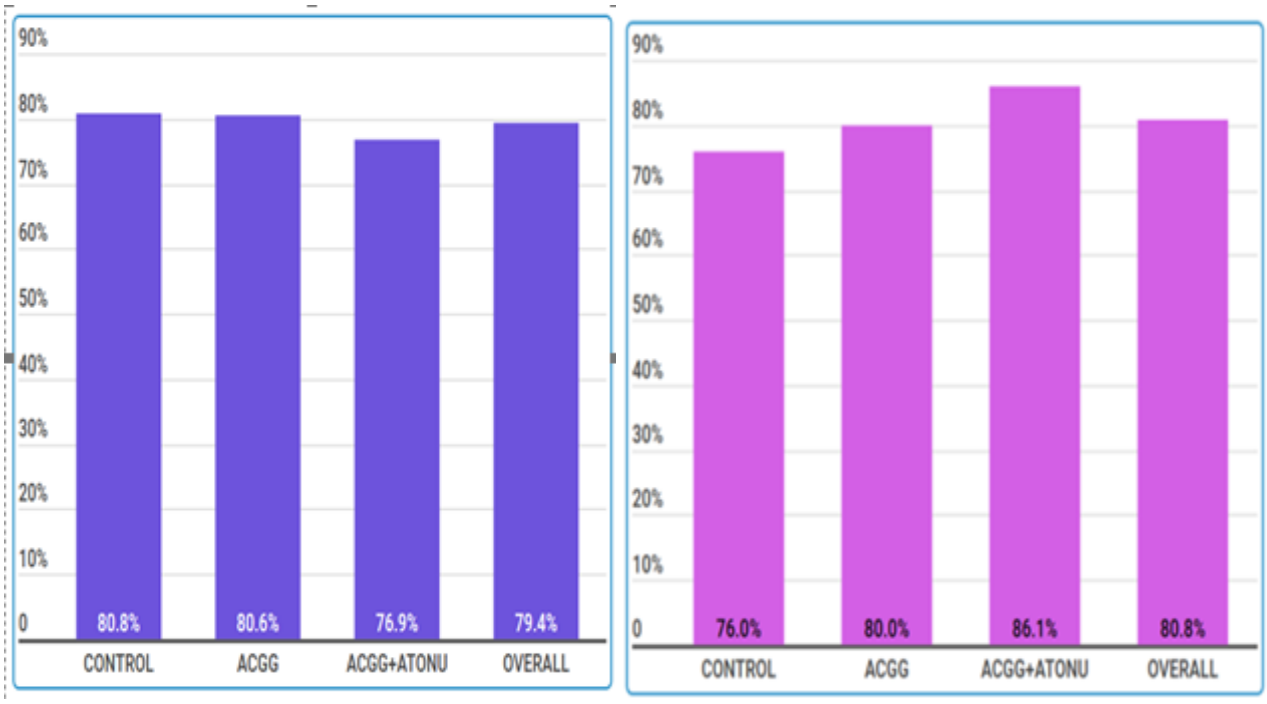



**Baseline** **Endline**

**Figure 15: Hand washing facility at baseline and endline by treatment arms**

**Analysis of WASH practices**

In this study, respondents were asked if they washed their hands with soap. Figure 16 displays the proportion of respondents who washed their hands with soap across treatments arms at baseline and endline. Overall, the proportion of respondents who washed hands with soap was slightly higher at endline (80.8 %) compared to baseline (79.4%). At baseline, the proportion of respondents who washed hands with soap was not significantly different across treatment arms ($\chi^2 = 2.6853$, $p = 0.2612$). Close to 89% of the subjects in the Control treatment arm, 80.6% in ACGG only and 76.9% in ACGG+ATONU treatment arms washed their hands with soap. At endline, the proportion of respondents who washed their hands with soap was lower in the Control (76%) and ACGG (80%) treatment arms, but higher in ACGG+ATONU (86.1%) treatment arm. The magnitude of the difference in the proportion of respondents who washed their hands with soap in the Control treatment arm decreased by 4.8% (80.8% to 76%), and in ACGG treatment arm by 0.6% (80.6% to 80%). However, in the ACGG+ATONU treatment arm the proportion increased by 9.2% (76.9% to 86.1%).




**Baseline** **Endline**

**Figure 16: Proportion of households who washed hands with soap by treatment arms at baseline and endline**

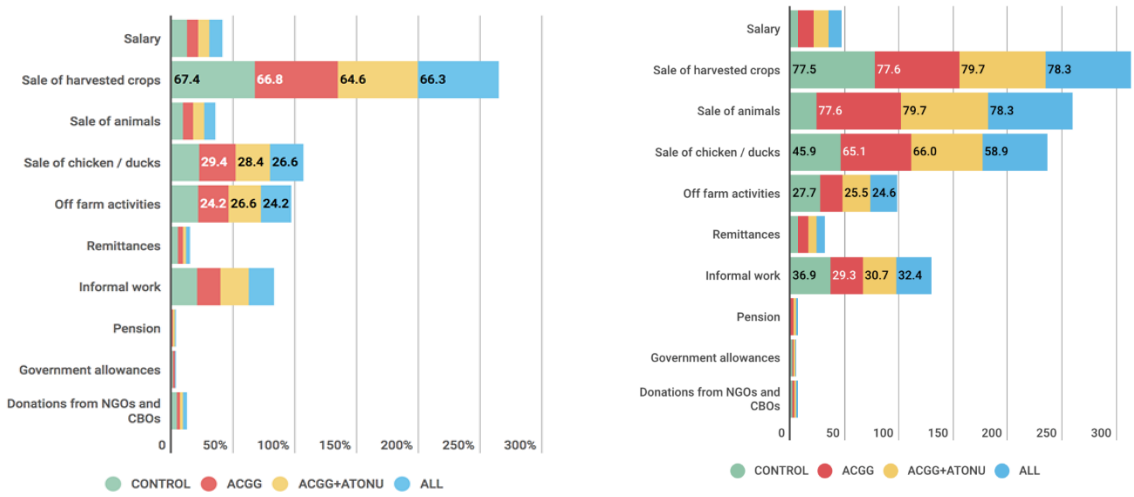
The results of the fitted adjusted repeated measures Generalized Estimating Equation (GEE) for the effect of intervention on wash practice are presented in Table 12. The analysis was adjusted for zone and education level of the head of household at endline. The magnitude of the D-I-D Odds ratio (OR) for ACGG +ATONU was 1.98, and it was significant at $\alpha=0.05$ ($p=0.0045$). Based on these results, it appears that the training on hygiene knowledge helped to improve hand washing practice at endline among respondents in ACGG+ATONU compared to Control treatment arm. Likewise, there was a significant improvement in hand washing practice when moving from baseline to endline for subjects in ACGG+ATONU compared to those in ACGG (OR=1.94, p=0.0055). However, no significant difference was observed for respondents in ACGG and Control treatment arms (OR=1.02, p=0.9277).

**Table 12: Empirical based parameter estimates (β) and Odds ratio (OR) of the adjusted GEE for difference in difference analysis of hand washing practice**

| Effect | Estimate (β) | Standard Error | P-Value |
|---|---|---|---|
| | | | |
| Intercept | 1.0350 | 0.2232 | <0.0001 |
| Time | | | |
| Endline | -0.1374 | 0.1716 | 0.4234 |
| Baseline | Reference | | |
| Treatment | | | |
| ACGG | -0.0463 | 0.1739 | 0.7903 |
| ACGG+ATONU | -0.2948 | 0.1666 | 0.0769 |
| Control | Reference | | |
| **Zone** | | | <0.0001 |
| Central | 0.5297 | 0.1102 | <0.0001 |
| Eastern | -0.0307 | 0.1243 | 0.8049 |
| Southern | Reference | | |
| Education level of the Head of HH | | | |
| No Formal education | Reference | | |
| Primary education | 0.2172 | 0.1966 | 0.2695 |
| Secondary education | 0.6164 | 0.2397 | 0.0101 |
| Tertiary education | 0.5463 | 0.2774 | 0.0489 |
| Time*Treatment | | | |
| Time*ACGG | 0.0218 | 0.2407 | 0.9277 |
| Time*ACGG+ATONU | 0.6836 | 0.2406 | 0.0045 |
| | | | |
| | **D-I-D adjusted Odds Ratio (AOR)** | | |
| Label | Estimate | Standard Error | P-Value |
| ACGG versus CONTROL | 1.02 | 0.2461 | 0.9277 |
| ACGG+ATONU Vs CONTROL | 1.98 | 0.4765 | 0.0045 |
| ACGG+ATONU Vs ACGG | 1.94 | 0.4624 | 0.0055 |

### 3.4 Household Income

The main source of household income in all treatment arms was from sale of harvested crops (Figure 17). Sale of harvested crops increased from 66% at baseline to 78% at endline across all treatment arms. At endline, sale of harvested crops was not significantly different among treatment arms ($\chi^2$ = 0.2556, p= 0.88). In ACGG + ATONU, ACGG and Control treatment arms, the sale of harvested crops was 79.7%, 77.6% and 77.5%, respectively. This is because the survey was carried out at the time when households were harvesting crops. At endline, sale of animals also increased compared to baseline in all treatment arms (10% to >77%). Specifically, sale of chicken increased from 27% at baseline to 59% at endline. A significant difference in sale of chicken across treatment arms was observed at endline ($\chi^2$= 39.75, p <0.0001). The sale of chicken was higher in the ACGG (65%) and ACCGG+ATONU (66%) treatment arms than in households in the Control treatment arm (46%). Income generated from informal work also increased at the endline compared to the baseline.




**Baseline** **Endline**

**Figure 17: Main sources of household income at baseline and endline by treatment arms**

### 3.5 Market Access

Information on availability of markets in the village at baseline and endline is presented in Figure 18. About 46% of the households at baseline and 49% at endline reported that they had access to the markets within their villages. Availability of markets increased slightly in ACGG and ACGG+ATONU treatment arms but remained the same in the Control treatment arm. In most areas, markets operated on a daily basis. However, monthly and bimonthly markets were also available and related to auction days taking place within or in neighbouring villages (Figure 19). At endline, there was a slight decrease in markets operating on a daily basis in the Control treatment arm, but a slight increase in ACGG (by 2%) and ACGG+ATONU (by 5%) treatment arms.

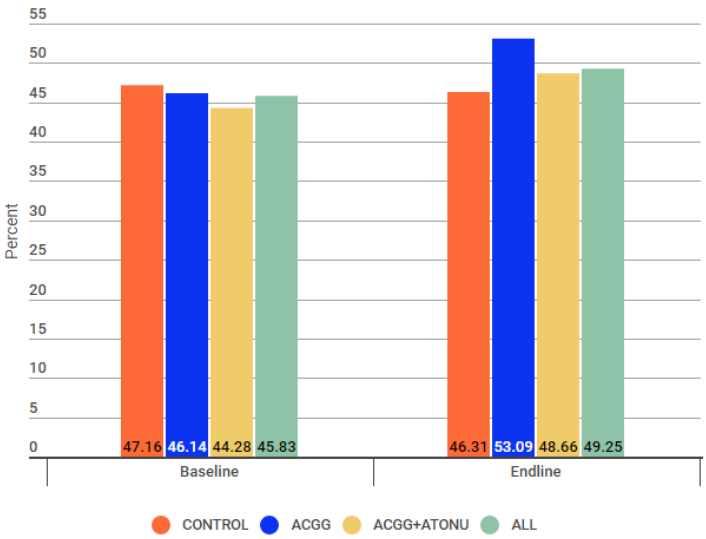



**Figure 18: The availability of village market by treatment arms at baseline and endline**

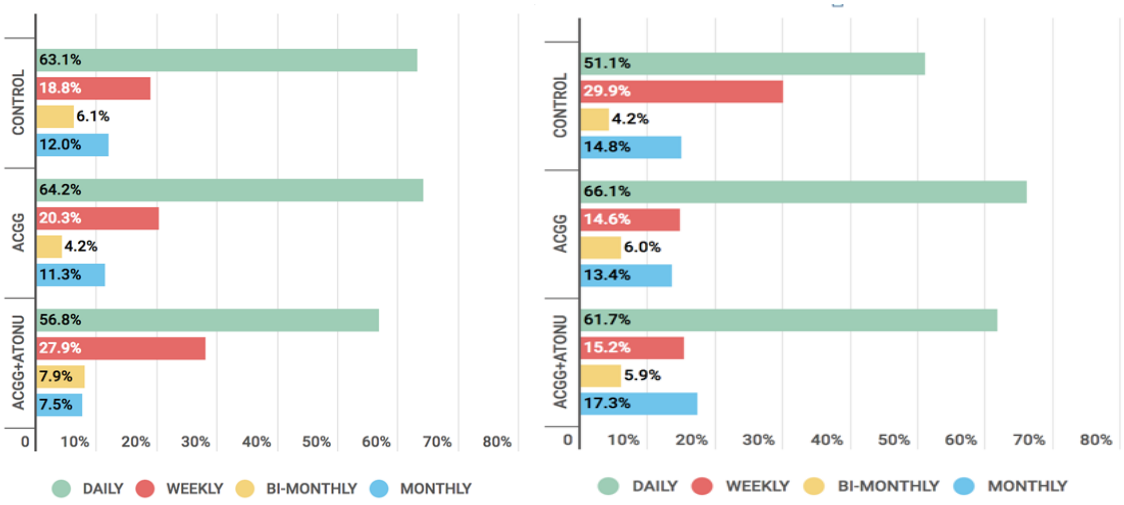



**Figure 19: Market operations at baseline and endline**

**Market food availability**

The frequency of availability of local foods in the village markets was reported as either always, often, seldom or never (Table 13). Over 90% of the respondents in all treatment arms at baseline and endline reported that local foods were always available in the village markets. At endline, 76% in Control, 81% in ACGG and 78% in ACGG+ATONU treatment arms reported that foods from other areas were always available in the village markets. Availability of foods from abroad was more common at baseline (71%) compared to endline (25%) in all treatment arms. Market availability of local cash crops was observed more at endline (70%) compared to that recorded at baseline (about 20%). This could mainly be due to variation in seasons when data collection was done. It is important to note that in other villages, some of the food crops are also cash crops; for example, in the Central zone, green grams (Mung bean) is a cash crop, whereas in the Southern Highlands and Eastern zones it is used as a food crop as well as cash crop. Therefore, interpretation of the data on availability of cash crops in the village market should be done with caution.

**Table 13: Availability of foods at the village by treatment arms at baseline and endline**

| Treatment arms | Control | | ACGG | | ACGG+ATONU | | Overall | |
|---|---|---|---|---|---|---|---|---|
| N | 216 | 542 | 209 | 501 | 213 | 561 | 638 | 1604 |
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| **Village availability of local foods** | | | | | | | | |
| Always | 90.74 | 89.85 | 89.95 | 92.6 | 91.1 | 93 | 91 | 92.0 |
| Often | 5.56 | 5.72 | 8.13 | 5.6 | 6.1 | 5 | 7 | 5.4 |
| Seldom | 2.31 | 2.58 | 0.48 | 1.2 | 1.4 | 1 | 1 | 1.4 |
| Never | 1.39 | 1.85 | 1.44 | 0.6 | 1.4 | 1 | 1 | 1.3 |
| Total | 100 | 100 | 100 | 100.0 | 100.0 | 100 | 100 | 100.0 |
| **Village availability of foods from other areas ((Data not collected at baseline)** | | | | | | | | |
| Always | | 76.2 | | 81.4 | | 78 | | 78.4 |
| Often | | 14.76 | | 12.2 | | 14 | | 13.8 |
| Seldom | | 6.27 | | 4.6 | | 5 | | 5.2 |
| Never | | 2.77 | | 1.8 | | 3 | | 2.6 |
| Total | | 100 | 0 | 100.0 | 0.0 | 100 | 0 | 100.0 |
| **Village availability of foods from abroad** | | | | | | | | |
| Always | 74.07 | 20.85 | 69.38 | 27.9 | 68.5 | 25 | 71 | 24.6 |
| Often | 18.98 | 7.01 | 19.62 | 7.2 | 22.1 | 6 | 20 | 6.6 |
| Seldom | 3.7 | 16.97 | 6.22 | 18.8 | 5.2 | 21 | 5 | 18.8 |
| Never | 3.24 | 55.17 | 4.78 | 46.1 | 4.2 | 48 | 4 | 50.0 |
| Total | 99.99 | 100 | 100 | 100.0 | 100.0 | 100 | 100 | 100.0 |
| **Village availability of local cash crops** | | | | | | | | |
| Always | 20.83 | 75.28 | 17.7 | 79.0 | 23.0 | 79 | 21 | 77.7 |
| Often | 10.19 | 15.13 | 17.7 | 11.8 | 13.6 | 15 | 14 | 14.1 |

| Treatment arms | Control | | ACGG | | ACGG+ATONU | | Overall | |
|---|---|---|---|---|---|---|---|---|
| Seldom | 19.44 | 46.15 | 13.4 | 34.6 | 17.4 | 19 | 17 | 4.9 |
| Never | 49.54 | 2.95 | 51.2 | 3.8 | 46.0 | 3 | 49 | 3.4 |
| Total | 100 | 139.51 | 100 | 129.2 | 100.0 | 117 | 100 | 100.0 |
| **Village availability of cash crop from other areas** | | | | | | | | |
| Always | | 61.25 | | 67.7 | | 69 | | 66.0 |
| Often | | 22.88 | | 18.8 | | 20 | | 20.6 |
| Seldom | | 10.15 | | 9.8 | | 7 | | 8.8 |
| Never | | 5.72 | | 3.8 | | 4 | | 4.6 |
| Total | | 100 | 0 | 100.0 | 0.0 | 100 | 0 | 100.0 |
| **Village availability of cash crop from abroad** | | | | | | | | |
| Always | 72.22 | 13.84 | 70.81 | 17.2 | 68.1 | 21 | 70 | 17.2 |
| Often | 9.26 | 6.27 | 14.35 | 10.0 | 13.2 | 5 | 12 | 7.0 |
| Seldom | 8.33 | 16.97 | 7.66 | 18.8 | 9.9 | 22 | 9 | 19.1 |
| Never | 10.19 | 62.92 | 7.18 | 54.1 | 8.9 | 53 | 9 | 56.6 |
| Total | 100 | 100 | 100 | 100.0 | 100.0 | 100 | 100 | 100.0 |
| **Village availability of local non-food products** | | | | | | | | |
| Always | 57.41 | 75.65 | 54.07 | 75.1 | 49.3 | 80 | 54 | 77.0 |
| Often | 21.3 | 14.21 | 22.49 | 12.4 | 23.0 | 12 | 22 | 12.9 |
| Seldom | 7.87 | 5.17 | 12.44 | 5.6 | 13.6 | 5 | 11 | 5.2 |
| Never | 13.43 | 4.98 | 11 | 7.0 | 14.1 | 3 | 13 | 4.9 |
| Total | 100.01 | 100.01 | 100 | 100.0 | 100.0 | 100 | 100 | 100.0 |
| **Village availability of non food products from other areas** | | | | | | | | |
| Always | | 65.5 | | 68.7 | | 70 | | 68.1 |
| Often | | 18.45 | | 16.0 | | 21 | | 18.5 |
| Seldom | | 9.96 | | 9.6 | | 6 | | 8.5 |
| Never | | 6.09 | | 5.8 | | 3 | | 5.0 |
| Total | | 100 | 0 | 100.0 | 0.0 | 100 | 0 | 100.0 |
| **Village availability of non food items from abroad** | | | | | | | | |
| Always | 72.69 | 34.87 | 67.94 | 38.7 | 67.6 | 41 | 69 | 38.1 |
| Often | 9.26 | 13.28 | 10.53 | 11.6 | 14.1 | 13 | 11 | 12.8 |
| Seldom | 4.63 | 16.24 | 10.53 | 18.6 | 6.1 | 17 | 7 | 17.2 |
| Never | 13.43 | 35.61 | 11 | 31.1 | 12.2 | 29 | 12 | 31.9 |
| Total | 100.01 | 100 | 100 | 100.0 | 100.0 | 100 | 100 | 100 |

Generally, more than half of the respondents reported that they had trouble in accessing village markets (Figure 20). However, more respondents reported to have faced difficulties at baseline compared to endline in treatment arms of ACGG (67% vs 52%) and ACGG+ATONU (69% vs 59%) but it was almost the same for the Control treatment arm (60% vs 59%). In some of the villages, there were no village markets; hence, villagers were accessing markets in the neighbouring villages, which were located far from the villages.

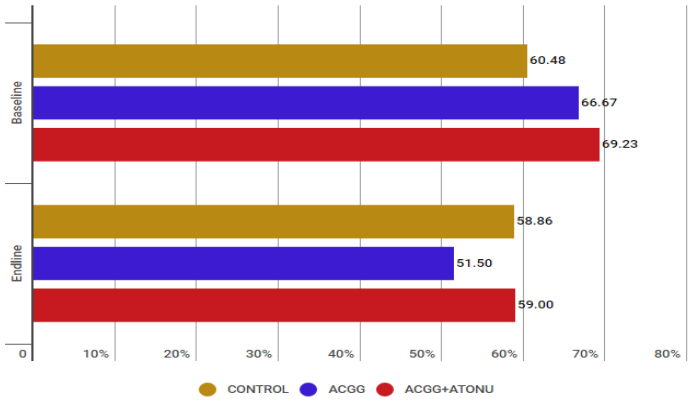
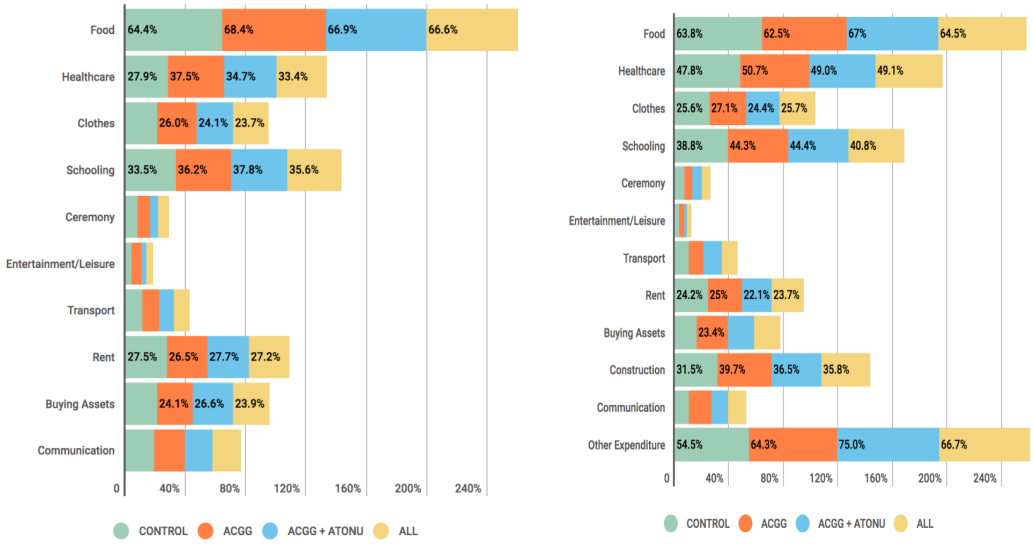



**Figure 20: Percentage of people facing problems in accessing village markets by treatment arms at baseline and endline**

### 3.6 Household Expenditure

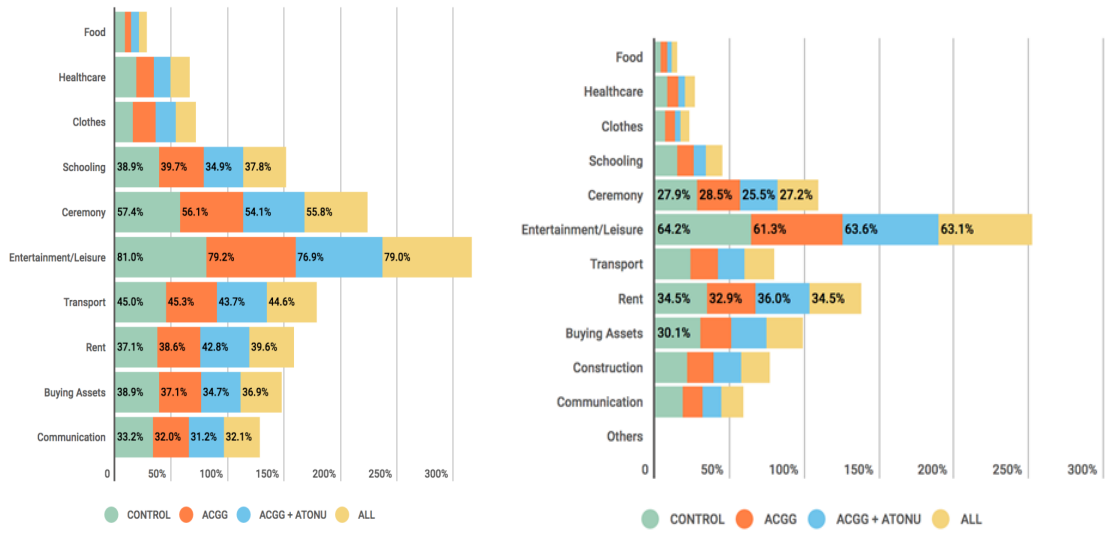
The highest expenditure was on food and it was almost similar in all treatments at baseline and endline (Figure 21). There was an increase in health care expenditure at the endline in all treatment arms compared to the baseline. The increase in health care expenditure could be associated with seasonal distribution of disease occurrence, especially among children. Generally, most diseases such as diarrhoea, respiratory tract infections and malaria occur during the rainy season, which was the case for the Eastern zone.




**Baseline** **Endline**

**Figure 21: Most important expenditure by treatment arms at baseline and endline**

Overall, the least expenditure at baseline and endline was on ceremonies and was reported by 56% and 27% of the respondents, respectively ($\chi^2$ =0.62, p=0.73). In addition, the least expenditure on entertainment was reported by 79% vs 63% at baseline and endline, respectively ($\chi^2$ =0.74, p=0.69) (Figure 22). However, there was relatively higher expenditure on ceremonies and entertainment at endline compared to baseline in all treatment arms ($\chi^2$=2.52, p=0.87). This could be due to the time of the year whereby most traditional ceremonies happen after harvesting or towards the end of the year.




**Baseline** **Endline**

**Figure 22: Least important expenditure by treatment arms at baseline and endline**

### 3.7 Food security (availability, access and sufficiency)

**Food accessibility and production**

Several foods were available through own production. Overall, maize (87%) was the main food crop which was accessed through own production in the study areas in both surveys. The other commonly produced food crops at baseline and endline included beans (37% vs 44%) and sunflower (32.5% vs 40%). Households that reported access to vegetables through own production increased slightly from 20% at baseline to 33.4% at endline. Vegetable availability through own production increased in all treatment arms with similar magnitude of increase in ACGG and ACGG+ATONU treatment arms. Overall, there was a slight increase in fruit production between baseline (3.5%) and endline (5.3%) (Table 14).

**Table 14: Types of food available through own production across arms during baseline and endline surveys**

| Crop name | CONTROL | | ACGG | | ACGG+ATONU | | OVERALL | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Bambara Nuts (44,137) | 4.2 | 10.4 | 2.6 | 10.3 | 3.3 | 6.3 | 3.4 | 9 |
| Beans (467, 668) | 35.3 | 45.6 | 35.6 | 41.6 | 36.4 | 43.7 | 35.8 | 43.7 |
| Millet (94,134) | 7.7 | 9.7 | 6.6 | 8.2 | 7.3 | 8.4 | 7.2 | 134 |
| Cassava (28,34) | 0.9 | 1.2 | 2.6 | 1.7 | 2.9 | 3.7 | 2.1 | 2.2 |
| Peas (107,175) | 6.7 | 12.5 | 10.4 | 8 | 7.5 | 13.4 | 8.2 | 11.4 |
| Groundnuts (256, 394) | 20 | 23.2 | 18.6 | 28.4 | 20.2 | 25.9 | 19.6 | 25.8 |
| Vegetables (264, 511) | 22.3 | 32 | 19.3 | 34.9 | 19.1 | 33.4 | 20.2 | 33.4 |
| Irish Potatoes (27, 56) | 1.6 | 3.1 | 2.1 | 3.6 | 2.4 | 4.3 | 2.1 | 3.7 |
| Maize (1136, 1340) | 87.7 | 85.3 | 85.6 | 88 | 87.6 | 89.4 | 87 | 87.6 |
| Rice (20, 238) | 20.4 | 12.5 | 20 | 13.9 | 14.9 | 20 | 18.4 | 15.6 |
| Pumpkin (35) | | 1.4 | | 2.5 | | 3 | | 2.3 |
| Sesame (26, 14) | 1.9 | 1.2 | 2.1 | 0.4 | 2 | 1.1 | 2 | 0.9 |
| Sorghum (80, 152) | 5.6 | 9.8 | 5.7 | 9 | 7.1 | 10.8 | 6.1 | 9.9 |
| Sweet Potatoes (24, 110) | 2.3 | 6.2 | 1.4 | 5.5 | 1.8 | 9.7 | 1.8 | 7.2 |
| Fruits (46, 81) | 2.6 | 4.2 | 4.2 | 5.7 | 3.8 | 6 | 3.5 | 5.3 |
| Sunflower (425, 615) | 31.8 | 42.3 | 36.1 | 38.9 | 29.9 | 39.4 | 32.5 | 40.2 |

***Multiple response questions (column percent) : Numbers in brackets represent n at baseline and endline***

**Food availability through purchase**

The common foods that were available through purchase at baseline were rice (70%), vegetables (41%) and beans (37%). The same foods were mostly accessed through purchase at endline (Table 15). In general, vegetable availability through purchase increased from 43% to 54% in Control treatment arm, 40% to 47% in ACGG and 40% to 51% in ACGG+ATONU treatment arms. There was also a slight increase in fruit accessibility in all treatment arms at endline compared to baseline.

**Table 15: Types of food available through purchase from the market across arms during baseline and endline**

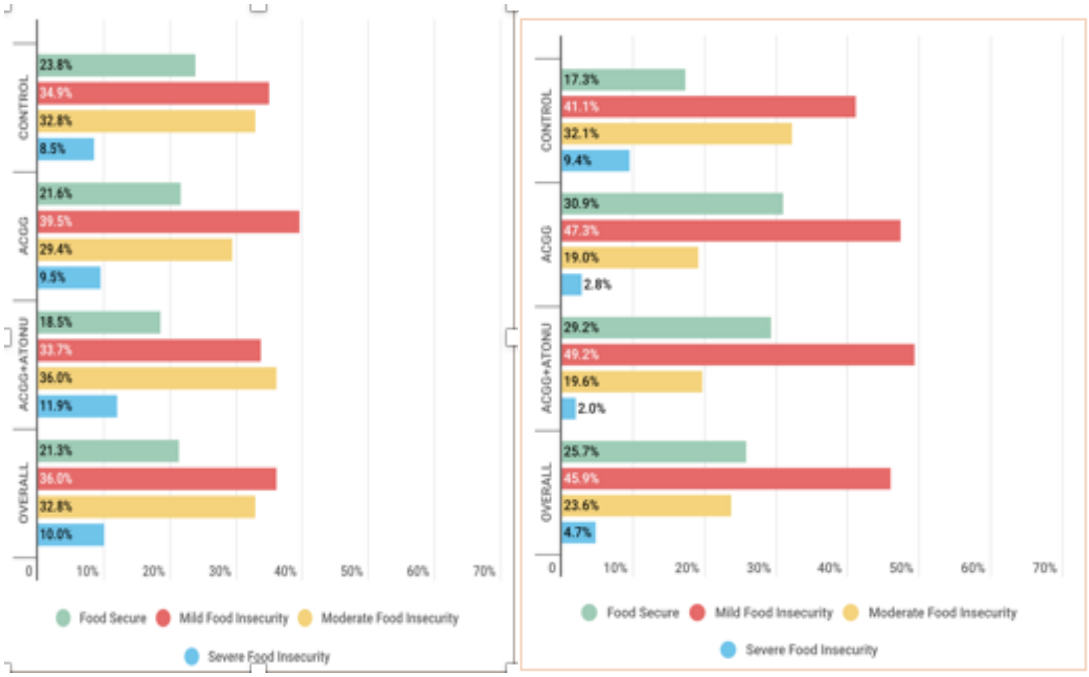
| Crop name | CONTROL | | ACGG | | ACGG+ATONU | | OVERALL | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Bambara Nuts (3, 14) | 0 | 0.9 | 0.5 | 0.6 | 0.2 | 1.1 | 0.2 | 0.9 |
| Beans (489, 606) | 35.7 | 36.4 | 40.3 | 43.4 | 34.1 | 36.9 | 36.7 | 38.7 |
| Millet (25,25) | 1.8 | 2.1 | 2.1 | 1.4 | 1.8 | 1.3 | 1.9 | 1.6 |
| Cassava (56, 82) | 3.6 | 5.1 | 4.6 | 2.9 | 4.4 | 7.5 | 4.2 | 5.2 |
| Peas (16, 38) | 1.1 | 2.8 | 1.6 | 1.4 | 0.9 | 2.9 | 1.2 | 2.4 |
| Groundnuts (46, 68) | 3.6 | 3.8 | 3.7 | 4.1 | 3.1 | 5.1 | 3.5 | 4.3 |
| Vegetables (544, 794) | 42.5 | 53.6 | 39.9 | 47.2 | 40.1 | 51.2 | 40.8 | 50.8 |
| Irish Potatoes (249, 360) | 8.7 | 22.9 | 19.8 | 21.7 | 17.6 | 24.3 | 18.7 | 23 |
| Maize (334, 348) | 24.3 | 25 | 24.9 | 21.9 | 26 | 19.9 | 25.1 | 22.3 |
| Rice (939, 1137) | 69.9 | 71.8 | 69.6 | 76.7 | 71.8 | 70 | 70.4 | 72.7 |
| Pumpkin (1, 5) | 0 | 0.4 | 0.2 | 0.2 | 0 | 0.4 | 0.1 | 0.3 |
| Sesame (3) | 4 | | 0 | | 0.2 | | 0.2 | |
| Sorghum (26, 20) | 0.2 | 1.5 | 1.8 | 1.4 | 1.8 | 0.9 | 2 | 1.3 |
| Sweet Potatoes (32, 192 110) | 0.1 | 10 | 2.1 | 13.7 | 2 | 13.2 | 2.4 | 12.3 |
| Fruits (131, 331) | 0.6 | 16.5 | 11.3 | 18.6 | 7.7 | 28 | 9.8 | 21.2 |
| Sunflower (32,66) | 0 | 3.4 | 1.8 | 5.5 | 3.3 | 3.8 | 2.4 | 4.2 |
| Fish (268, 609) | 22.5 | 36.4 | 18.4 | 41.5 | 19.4 | 39.1 | 20.1 | 38.9 |
| Wheat (136, 287) | 0.5 | 15.5 | 9.9 | 19.4 | 12.1 | 20.1 | 10.2 | 18.4 |
| Yams (10, 6) | 4 | 0.2 | 0.7 | 0.6 | 1.1 | 0.2 | 0.8 | 0.4 |

***Multiple response questions (column percent) : Numbers in brackets represent n at baseline and endline***

**Food security**

Food security was measured using the Household Food Insecurity Access Scale (HFIAS), which has a set of nine questions that measure the perception of food insecurity within the last 12 months from the time of interviews, with a possible maximum score of 27 indicating the highest level of food insecurity. Questions were asked about coping mechanisms: about reducing meal size, skipping meals, eating less preferred food, going to sleep hungry and not having enough food. The scale classifies households into the following categories: food secure (score 9), mildly food insecure (score 10-15), moderately food insecure (score 16-22) and severely food insecure (score 23-27).

Figure 23 presents information on household food security status measured by HFIAS. Overall, the proportion of food secure households improved from 21% at baseline to 26% at endline. Food secure households might have increased due to seasonal variations during data collection periods. Baseline data collection was done during the months of November and December, which is mostly the beginning of the rainy season in Central and in the Southern Highlands zones; the endline survey was conducted during the crop harvesting months of April/May in all the zones. Households that were severely food insecure decreased from about 10% to 5% between the two surveys. Food security levels differed across treatment arms, whereby the Control treatment arm had the lowest proportion of severe food insecure households (8.5%) compared to ACGG (9.5%) and ACGG+ATONU (12%) treatment arms at baseline but it had the highest (9.4%) at endline. The proportion of food secure households increased at endline in ACGG (22% at baseline to 29% at endline) and in ACGG+ATONU treatment arm (19% to 31%).

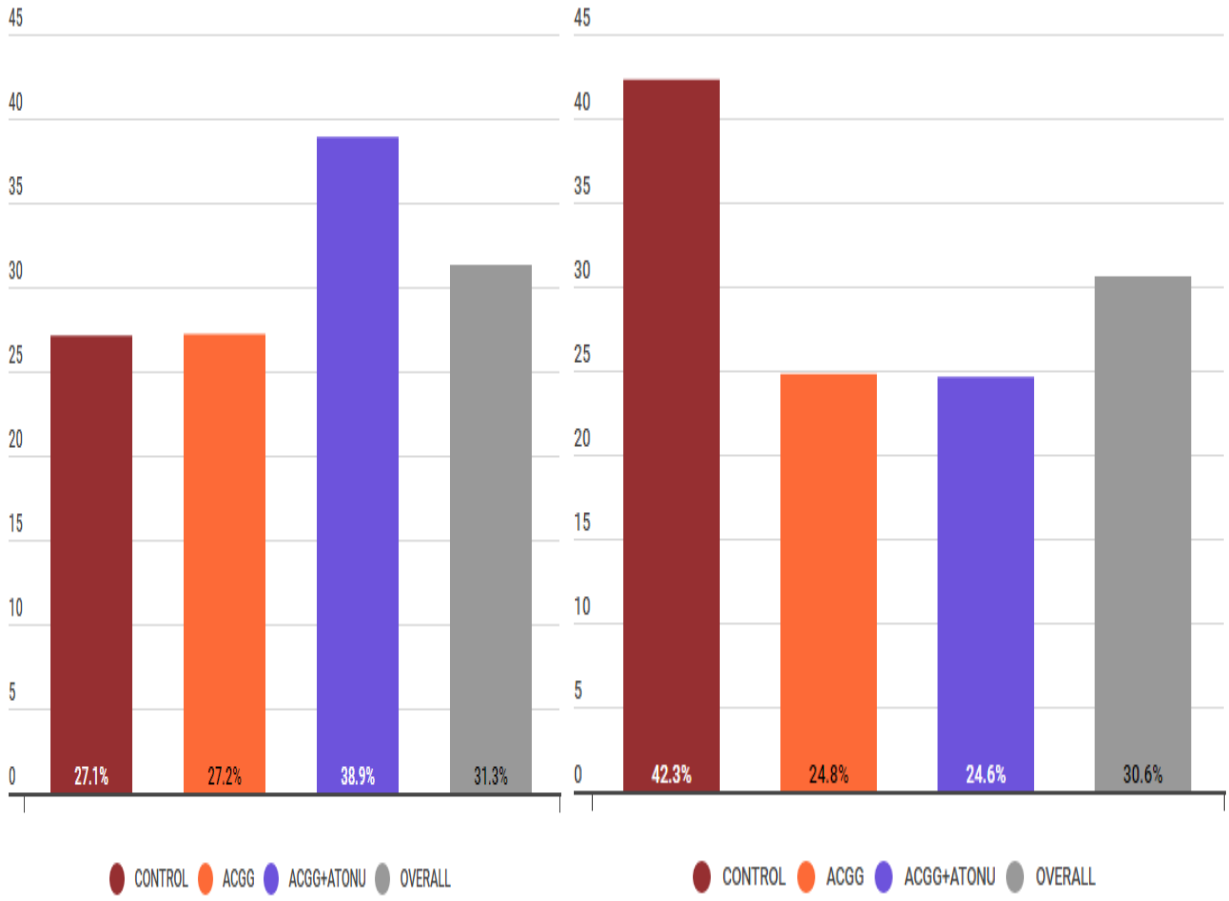



**Baseline** **Endline**

**Figure 23: Food security levels by treatment arms at baseline and endline**

**Food sufficiency analysis**

Food sufficiency is defined as the ability to meet consumption needs (particularly for staple food crops) from own production rather than from buying or importing**.** Using HFIAS, respondents were asked "Which of these statements best described the food eaten in the household in the last 12 months?" The responses were: 1=We always had enough to eat and the kinds of food we wanted, 2=We had enough to eat but not always the kinds of food we wanted, 3=Sometimes we didn't have enough to eat and 4=Often we didn't have enough food to eat. Households were then categorised as being food sufficient or food insufficient. The household was considered to experience food insufficiency if the responses of the question were "sometimes we didn't have enough to eat, or often we didn't have enough food to eat". Figure 24 shows the percentage of the households that experienced food insufficiency in the past 12 months by treatment arms at baseline and endline. Overall, the proportion of the households who experienced food insufficiency at endline (30.6%) is similar to that of baseline (31.1%). With respect to treatment arms, the magnitude of difference at baseline and at endline declined by 2.4% (27.2% to 24.8%) in ACGG treatment arm and 14.3% (38.9% to 24.6%) in ACGG+ATONU treatment arm. A difference-in-difference between ACGG+ATONU and ACGG treatment arms was 11.9%. The proportion of food insufficient households in ACGG+ATONU treatment arm decreased by 11.9% more than that in ACGG treatment arm. However, the proportion of households that experienced food insufficiency in the Control treatment arm increased by 15.2% (27.1% to 42.3%).




**Baseline** **Endline**

**Figure 24: Proportion of households experienced food shortage in the past 12 months by treatment arms**

The adjusted repeated measure GEE presented in Table 16, indicates that the change in proportion of households experienced food insufficiency was significantly different ($p<0.0001$) across the treatments arms. The magnitude of the D-I-D Odds ratio for ACGG treatment arm was 0.50, and it was significant ($p=0.0015$). Likewise, for ACGG+ATONU, the Odds ratio was 0.32 ($p<0.0001$). Based on these results, it appears that being in ACGG and ACGG+ATONU treatment arms contributed to reducing the risk of having food insufficiency at endline in contrast to what was observed in the Control treatment arm. Moreover, the prevalence of being food insufficient at endline for households in ACGG+ATONU treatment arm was significantly lower compared to households in ACGG treatment arm (OR=0.1355, $p=0.0333$). Food insufficiency was also associated with zones ($p<0.0001$) and keeping of improved chickens ($p=0.0022$). The proportion of households that experienced food insufficiency was significantly higher in the Central ($\beta$ =0.5221, $p<0.0001$) and Eastern zones ($\beta$ =0.7659, $p<0.0001$) than in the Southern Highlands zone.

**Table 16: Empirical based parameter estimates (β) and Odds ratio (OR) of the adjusted GEE for difference in difference analysis of household food insufficient**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | -1.0661 | 0.1462 | <0.0001 |
| Time | | | |
| Endline | 0.6203 | 0.1493 | <0.0001 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | 0.2279 | 0.1641 | 0.165 |
| ACGG+ATONU | 0.7488 | 0.1554 | <0.0001 |
| Control | Reference | | |
| **Time*Treatment** | | | **<0.0001** |

| | | | |
|---|---|---|---|
| Time*ACGG | -0.6873 | 0.216 | 0.0015 |
| Time*ACGG+ATONU | -1.1415 | 0.2076 | <0.0001 |
| **Zone** | | | |
| Central | 0.5221 | 0.094 | <0.0001 |
| Eastern | 0.7659 | 0.1096 | <0.0001 |
| Southern | Reference | | |
| **Ownership of improved chickens endline** | | | |
| Yes | -0.1504 | 0.1021 | 0.1409 |
| No | Reference | | |
| **Endline Family Wealth Index** | | | |
| Lowest | | | |
| Second | -0.0892 | 0.1226 | 0.4667 |
| Middle | -0.4289 | 0.1266 | 0.0007 |
| Fourth | -0.6536 | 0.1314 | <0.0001 |
| Highest | -1.0038 | 0.14 | <0.0001 |
| | | | |
| | **D-I-D adjusted Odds ratio (AOR)** | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs CONTROL | 0.50 | 0.1086 | 0.0015 |
| ACGG+ATONU Vs CONTROL | 0.32 | 0.0663 | <0.0001 |
| ACGG+ATONU Vs ACGG | 0.63 | 0.1355 | 0.0333 |

### 3.8 Crop Production and income

**Crop, vegetable and fruit production**

Agriculture plays a dominant role in the economy of the surveyed areas. About 90% of agricultural production in these areas is mainly from smallholder farming. There was high diversity of types of crops being grown in the surveyed areas. These included maize, rice, cassava, millet and sorghum, bambara-nuts, banana, beans, groundnuts, sesame, sunflower, potatoes, and peas. Others included assorted vegetables and fruits.

At endline, the major crops grown by households across treatment arms were maize (88%), beans (47%) and sunflower (47%) (Table 17). There was an increase of 12% in beans and 5% in sunflower compared to baseline, respectively. Maize production remained at the same level at 88% of households.

**Table 17: Crop production across treatment arms at baseline and endline surveys**

| **Crop name** | **CONTROL** | | **ACGG** | | **ACGG+ATONU** | | **OVERALL** | |
|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** |
| | % | % | % | % | % | % | % | % |
| Bambara Nuts (72, 157) | 7.2 | 11.5 | 5.7 | 11.5 | 3.5 | 7.3 | 5.4 | 10.1 |
| Banana (22,7) | 1.2 | 0 | 1.6 | 0.4 | 2.2 | 0.9 | 1.7 | 0.4 |
| Beans (441,731) | 30.3 | 46.7 | 34 | 45.6 | 35.6 | 48.1 | 33.3 | 46.8 |
| Cassava (31,40) | 1.6 | 0.9 | 3 | 2.7 | 2.4 | 4 | 2.3 | 2.6 |
| Groundnuts (300, 442) | 24.5 | 25 | 26.4 | 30.1 | 17.6 | 29.9 | 22.7 | 28.3 |
| Maize (169, 1376) | 87.3 | 85.5 | 87.8 | 89.7 | 89.9 | 89.4 | 88.4 | 88.1 |
| Millet (111, 163) | 8.3 | 10.5 | 9.2 | 9.1 | 7.7 | 11.6 | 8.4 | 10.4 |
| Rice (244, 272) | 20.1 | 14.5 | 19.1 | 15.5 | 16.3 | 22 | 18.4 | 17.4 |
| Sesame (59, 23 | 3.9 | 1.7 | 3.9 | 1 | 5.5 | 1.7 | 4.5 | 1.5 |
| Sorghum(100, 161) | 8.1 | 10 | 7.1 | 8.9 | 7.5 | 11.9 | 7.6 | 10.3 |
| Sunflower (561, 731) | 44.6 | 50.7 | 41.8 | 44.5 | 40.9 | 45.1 | 42.4 | 46.8 |
| Potatoes (37, 67) | 4.2 | 3.6 | 2.3 | 4.5 | 2 | 4.8 | 2.8 | 4.3 |
| Peas (215) | | 15.3 | | 10.5 | | 15.2 | | 13.8 |

***Multiple response questions (column percent): Numbers in brackets represent n at baseline and endline***

A similar trend was observed across the zones at baseline and endline (Table 18). However, due to agro-ecological differences, there were major variations in terms of the dominant crops that were grown in the various zones. Maize production was dominant in the Southern Highlands zone (99%) compared to the Central (87%) and Eastern (69%) zones. Paddy production was dominant in Eastern zone (69%) compared to Central zone (9%) and Southern Highlands (2%). The Southern Highlands zone was also famous for production of beans (83%), and the Central zone was also famous for the production of sunflower (69%) (Table 18).

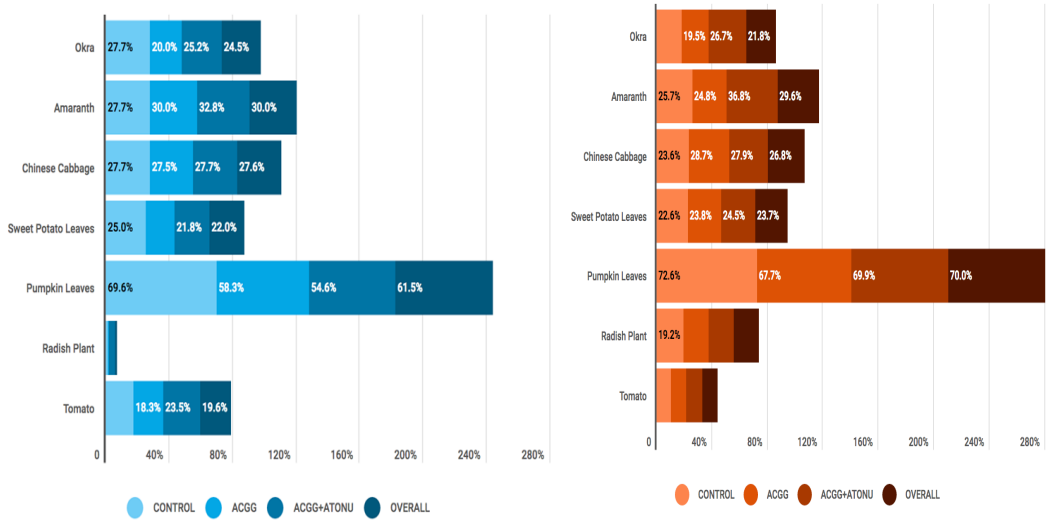
**Table 18: Crop production across zones at baseline and endline surveys**

| Crop name | Central | | Eastern | | Southern Highlands | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Bambara Nuts (72, 157) | 2 | 24.9 | 8.3 | 0 | 7.5 | 0.2 | 5.4 | 10.1 |
| Banana (22,7) | 1.9 | 0.5 | 1.1 | 1 | 1.8 | 0.2 | 1.7 | 0.4 |
| Beans (441,731) | 39.3 | 29.2 | 26.4 | 6.4 | 30.8 | 83.2 | 33.3 | 46.8 |
| Cassava (31,40) | 1.7 | 3.8 | 1.8 | 4.3 | 3.3 | 0.5 | 2.3 | 2.6 |
| Groundnuts (300, 442) | 18.7 | 54.3 | 32.2 | 0.3 | 21.8 | 15.9 | 22.7 | 28.3 |
| Maize (169, 1376) | 94.1 | 86.7 | 79.1 | 68.2 | 87.3 | 98.9 | 88.4 | 88.1 |
| Millet (111, 163) | 5 | 19.8 | 15.8 | 0.3 | 8 | 6 | 8.4 | 10.4 |
| Rice (244, 272) | 13.5 | 8.9 | 24.5 | 68.6 | 20.4 | 1.7 | 18.4 | 17.4 |
| Sesame (59, 23) | 3.3 | 3.7 | 7 | 0 | 4.3 | 0 | 4.5 | 1.5 |
| Sorghum(100, 161) | 8 | 25.6 | 12.8 | 0 | 4.3 | 0.2 | 7.6 | 10.3 |
| Sunflower (561, 731) | 52.4 | 68.7 | 35.2 | 3.3 | 35.7 | 45.8 | 42.4 | 46.8 |
| Potatoes (37, 67) | 3 | 0.2 | 1.1 | 0.7 | 3.5 | 10.1 | 2.8 | 4.3 |
| Peas (215) | | 16.6 | | 2.3 | | 16.4 | | 13.8 |

***Multiple response questions (column percent): Numbers in brackets represent n at baseline and endline***

**Vegetable production**

Vegetables available through production at both surveys were pumpkin leaves, amaranth, Chinese cabbage, sweet potato leaves and okra (Figure 25). There was a notable increase in production of pumpkin leaves at the endline (70%) compared to what was observed at baseline (62%). Production of other vegetables remained almost the same during the baseline and endline and not much variation was noted across treatment arms (Table 19). Tomatoes were among the least produced vegetables during both surveys, although they were among the commonly consumed.




**Baseline** **Endline**

**Figure 25: Vegetable production at baseline and endline**

**Table 19: Vegetable production across treatments arms at baseline and endline**

| Vegetable Name | CONTROL | | ACGG | | ACGG+ATONU | | OVERALL | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Okra (102, 310) | 24.9 | 22.6 | 17.2 | 24.2 | 17.7 | 34.8 | 20 | 27.7 |
| Amaranths(130, 449) | 26.6 | 30.2 | 24.5 | 32 | 25.1 | 55 | 25.4 | 40.1 |
| Chinese cabbage (166, 609) | 29.5 | 48.7 | 33.7 | 55.2 | 34.3 | 58.3 | 32.5 | 54.4 |
| Sweet potatoes (99, 348) | 23.1 | 29.3 | 16 | 31.5 | 18.9 | 32.1 | 19.4 | 31.1 |
| Pumpkin (256, 841) | 61.3 | 77.4 | 47.2 | 71.6 | 41.7 | 76.2 | 50.1 | 75.1 |
| Radish plant (21,340) | 2.9 | 31.7 | 3.7 | 30.6 | 5.7 | 29 | 4.1 | 30.4 |
| Tomato (103, 229) | 20.8 | 20.2 | 17.2 | 19.8 | 22.3 | 21.2 | 20.2 | 20.4 |

***Multiple response questions (column percent): Numbers in brackets represent n at baseline and endline***

At endline, pumpkins leaves were produced by 97%, 61%, and 60% in the Central, Eastern and Southern Highlands zones, respectively (Table 20); an increase of 50%, 7% and 10% from baseline, respectively in the same zones. Overall, vegetable production increased at endline compared to baseline in all zones, except for tomatoes; the level of production did not change at the two survey periods.

**Table 20: Vegetable production across zones at baseline and endline**

| Vegetable Name | Central | | Eastern | | Southern Highlands | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Okra (102, 310) | 24.9 | 22.6 | 17.2 | 24.2 | 17.7 | 34.8 | 20 | 27.7 |
| Amaranths(130, 449) | 26.6 | 30.2 | 24.5 | 32 | 25.1 | 55 | 25.4 | 40.1 |
| Chinese cabbage (166, 609) | 29.5 | 48.7 | 33.7 | 55.2 | 34.3 | 58.3 | 32.5 | 54.4 |
| Sweet potatoes (99, 348) | 23.1 | 29.3 | 16 | 31.5 | 18.9 | 32.1 | 19.4 | 31.1 |
| Pumpkin (256, 841) | 61.3 | 77.4 | 47.2 | 71.6 | 41.7 | 76.2 | 50.1 | 75.1 |
| Radish plant (21,340) | 2.9 | 31.7 | 3.7 | 30.6 | 5.7 | 29 | 4.1 | 30.4 |
| Tomato (103, 229) | 20.8 | 20.2 | 17.2 | 19.8 | 22.3 | 21.2 | 20.2 | 20.4 |

***Multiple response questions (column percent): Numbers in brackets represent n at baseline and endline***

**Fruit production**

The level of production of banana, mangoes, pawpaw and watermelon decreased from 13%, 44%, 26% and 20% at baseline to 4%, 29%, 22% and 16%, respectively at endline (Table 21). Similarly, cucumber production declined from 19% at baseline to 10% at endline. This was observed in all treatment arms. Production of avocado increased from 11% at baseline to 42% at endline.

**Table 21: Fruit production across treatments arms at baseline and endline**

| Fruit name | CONTROL | | ACGG | | ACGG+ATONU | | OVERALL | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Avocado (15,158) | 7 | 27.6 | 17.1 | 52.2 | 10 | 42.1 | 11.2 | 42 |
| Banana (17,15) | 23.3 | 6.1 | 4.9 | 2.9 | 10 | 3.6 | 12.7 | 4 |
| Mango (59,108) | 32.6 | 25.5 | 41.5 | 29 | 56 | 30.7 | 44 | 28.7 |
| Pawpaw (35,84) | 30.2 | 26.5 | 24.4 | 20.3 | 24 | 21.4 | 26.1 | 22.3 |
| Water melon (27, 61) | 27.9 | 24.5 | 22 | 11.6 | 12 | 15 | 20.1 | 16.2 |
| Orange (18,51) | 18.6 | 9.2 | 4.9 | 15.2 | 16 | 15 | 13.4 | 13.6 |
| Cucumber (25, 36) | 16.3 | 13.3 | 17.1 | 8.7 | 22 | 7.9 | 18.7 | 9.6 |

***Multiple response questions (column percent): Numbers in brackets represent n at baseline and endline***

Production of avocado increased from 13% at baseline to 77% at endline in the Southern Highlands zone. However, production of banana, mangoes, pawpaw watermelon declined from 16%, 45%, 25% and 27% at baseline to 4%, 26%, 11% and 5%, respectively at endline (Table 22). Cucumber production also decreased from 19% at baseline to less than 1% at endline. In the Central zone production of avocado, banana, mango and orange decreased from 11%, 11%, 42% and 16% at baseline to 2%, 1%, 22% and 9%, respectively at endline. However, production of pawpaw and watermelon increased from 22% to 43% and 16% to 39%, respectively at endline.

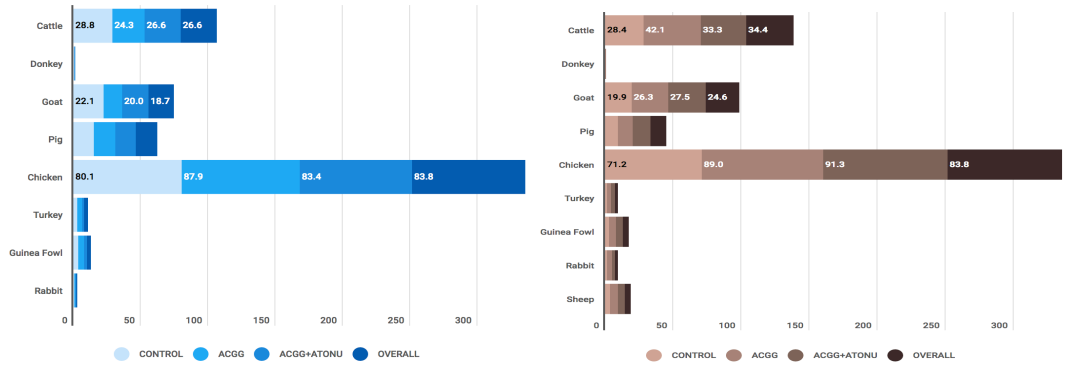
**Table 22: Fruit production across zones at baseline and endline**

| Fruit name | Central | | Eastern | | Southern Highlands | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Endline | Baseline | Endline | Baseline | Endline | Baseline | Endline |
| | % | % | % | % | % | % | % | % |
| Avocado (15,158) | 11.1 | 1.5 | 8 | 14.9 | 12.5 | 77.2 | 11.2 | 42 |
| Banana (17,15) | 11.1 | 0.7 | 8 | 12.8 | 15.6 | 4.1 | 12.7 | 4 |
| Mango (59,108) | 42.2 | 22.1 | 44 | 57.4 | 45.3 | 26.4 | 44 | 28.7 |
| Pawpaw (35,84) | 22.2 | 43.4 | 36 | 6.4 | 25 | 11.4 | 26.1 | 22.3 |
| Water melon (27, 61) | 15.6 | 37.5 | 12 | 2.1 | 26.6 | 4.7 | 20.1 | 16.2 |
| Orange (18,51) | 15.6 | 8.8 | 8 | 29.8 | 14.1 | 13 | 13.4 | 13.6 |
| Cucumber (25, 36) | 22.2 | 21.3 | 12 | 12.8 | 18.8 | 0.5 | 18.7 | 9.6 |

***Multiple response questions (column percent): Numbers in brackets represent n at baseline and endline***

### 3.9 Livestock Production and Income

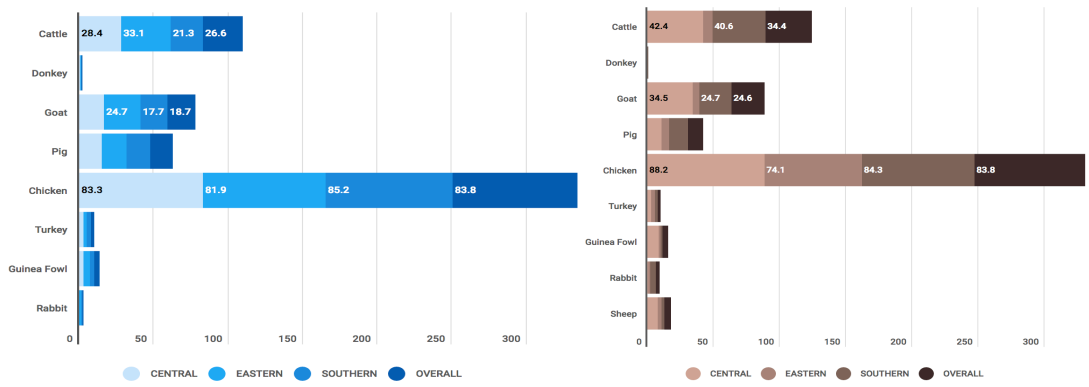
Chickens are an important livestock type in the surveyed areas. More than 80% of the households in all treatment arms owned chickens at the baseline and endline (Figure 26). At endline, more households in the ACGG+ATONU treatment arms (91%) kept chickens compared to 89% in the ACGG and 71% in the Control treatment arms. At baseline, the number of households who owned chickens was 88% in the ACGG and 83% in ACGG+ATONU treatment arms; this was an increase of 1% and 8%, respectively compared to the control (71%) treatment arm, which also showed a decline of 9% from 80% at baseline to 71% at endline (Figure 26).




**Baseline** **Endline**

**Figure 26: Households keeping livestock at baseline and endline by treatment arms**

At endline, chickens still ranked the highest among all types of animals kept in all zones; with the Central zone having a slightly higher proportion of households (88%) keeping chickens compared to 84% in the Southern Highlands zone and 74% in Eastern zone. Other animals kept by the households included cattle and goats (Figure 27). At endline, the Central zone had 42% of the households that kept cattle compared to 28% at baseline. In the Eastern zone, households that kept livestock decreased from 33% at baseline to 6% at endline; and in the Southern Highlands, 41% households kept cattle at endline compared to 21% at baseline. This was an increase of 14 to 20% over a period of 12 months for the Central and Southern Highlands zones but a drop of 27% for the Eastern zone.




**Baseline** **Endline**

**Figure 27: Households keeping livestock at baseline and endline by zones**

### 3.10 Chicken Consumption Per Year

Chicken meat consumption was higher at baseline than at endline (Table 23). At baseline, the mean number of chickens consumed per year ranged from 20 to 22 chickens in all treatment arms and zones. At endline, the mean number of chickens consumed was 18 (95% CI, 15.00 - 20.98) for ACGG+ATONU treatment arm, 20 (95% CI, 15.58 - 23.96) for ACGG and 13 (95% CI, 9.69 - 16.78) for Control treatment arm. The extent of reduction of the number of chickens consumed per year was 7, 3 and 4 in the Control, ACGG and ACGG+ATONU treatment arms, respectively. Similarly, the reduction was 6, 4 and 2 for the Central, Sothern Highlands and Eastern zones, respectively.

**Table 23: Household chicken consumption per annum at baseline and endline**

| | Baseline | | | | Endline | | | |
|---|---|---|---|---|---|---|---|---|
| **Treatment/Zone** | **N** | **Mean** | **SE** | **95 % CI** | **N** | **Mean** | **SE** | **95 % CI** |
| CONTROL | 458 | 20.04 | 1.31 | 17.43 - 22.65 | 386 | 13.23 | 1.77 | 9.69 - 16.78 |
| ACGG | 453 | 22.48 | 1.77 | 18.94 - 26.02 | 446 | 19.77 | 2.09 | 15.58 - 23.96 |
| ACGG+ATONU | 481 | 21.9 | 2.09 | 17.70 - 26.08 | 512 | 17.99 | 1.49 | 15.00 - 20.98 |
| Zone | | | | | | | | |
| Central | 564 | 20.04 | 1.55 | 16.94 - 23.13 | 562 | 14.44 | 0.68 | 13.09 - 15.79 |
| Eastern | 287 | 20.15 | 1.33 | 17.49 - 22.80 | 240 | 18.45 | 2.42 | 13.61 - 23.30 |
| Southern Highlands | 541 | 23.68 | 1.88 | 19.92 - 27.44 | 542 | 19.54 | 2.22 | 15.10 - 23.98 |

**DID analysis for chicken consumption**

To assess the effect of the treatment arms on change in household chicken consumption from baseline to endline, differences in difference analysis was performed using Linear mixed model. Results of the fitted model are presented in Table 24 (local chickens) and Table 25 (improved chickens). The analysis was adjusted for zone and endline household wealth index. For local chickens, the results revealed that consumption increased from baseline to endline. The magnitude of the D-I-D coefficient for ACGG+ATONU versus Control treatment arms was 1.1929, with p- value of 0.0473. This means that, the change in local chicken consumption from baseline to endline was significantly higher in ACGG+ATONU than in the Control treatment arm. However, no significant difference was observed for ACGG only compared to control treatment arm ($\beta$=1.1489, p= 0.0595) and ACGG+ATONU as compared to ACGG only ($\beta$=0.04400, p=0.9407).

**Table 24: Parameter estimates of the adjusted linear mixed model for difference in differences analysis of local chicken consumption**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 2.5215 | 0.3924 | <0.0001 |
| **Time** | | | |
| Endline | 0.5741 | 0.4379 | 0.19 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | -0.4452 | 0.4129 | 0.2811 |
| ACGG+ATONU | -0.5047 | 0.4065 | 0.2145 |
| Control | Reference | | |
| **Time*Treatment** | | | 0.0853 |
| Time*ACGG | 1.1489 | 0.6093 | 0.0595 |
| Time*ACGG+ATONU | 1.1929 | 0.6011 | 0.0473 |
| **Agro-ecological zone** | | | 0.0028 |
| Central | 0.5157 | 0.2741 | 0.06 |
| Eastern | 1.1553 | 0.3395 | 0.0007 |
| Southern Highlands | Reference | | |
| **Endline Wealth Index** | | | <0.0001 |
| Lowest | Reference | | |
| Second | 0.5326 | 0.3928 | 0.1753 |
| Middle | 0.7423 | 0.3972 | 0.0618 |
| Fourth | 1.2249 | 0.3997 | 0.0022 |
| Highest | 2.2261 | 0.4001 | <0.0001 |
| | **D-I-D coefficients** | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs. Control | 1.1489 | 0.6093 | 0.0595 |
| ACGG+ATONU Vs. Control | 1.1929 | 0.6011 | 0.0473 |
| ACGG+ATONU Vs. ACGG | 0.04400 | 0.5911 | 0.9407 |

For improved chicken, the results of the adjusted linear mixed model presented in Table 25 showed that the number of improved chicken consumed was also higher in endline as compared to baseline. In addition, the change improved chicken consumption was significantly higher among subjects in ACGG+ATONU (β=1.2863, p=0.0059) and ACGG only (β=0.9125, p=0.0525) in comparison to subjects in control arms. But no significant difference in change of improved chicken consumption was observed between ACGG+ATONU and ACGG only (β=0.3738, p=0.3008)

**Table 25: Parameter estimates of the adjusted linear mixed model for difference in differences analysis of improved chickens consumption**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 0.02877 | 0.2023 | 0.8874 |
| **Time** | | | |
| Endline | 3.5778 | 0.3932 | <0.0001 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | 0.004499 | 0.1945 | 0.9815 |
| ACGG+ATONU | 0.02961 | 0.1915 | 0.8771 |
| Control | Reference | | |
| **Time*Treatment** | | | 0.0225 |

| | | | |
|---|---|---|---|
| Time*ACGG | 0.9125 | 0.4702 | 0.0525 |
| Time*ACGG+ATONU | 1.2863 | 0.4663 | 0.0059 |
| **Agro-ecological zone** | | | 0.0718 |
| Central | -0.1402 | 0.1578 | 0.3743 |
| Eastern | 0.2854 | 0.1894 | 0.132 |
| Southern Highlands | Reference | | |
| **Endline Wealth Index** | | | 0.0329 |
| Lowest | Reference | | |
| Second | 0.006073 | 0.2214 | 0.9781 |
| Middle | 0.2681 | 0.2203 | 0.2238 |
| Fourth | 0.2817 | 0.2208 | 0.2021 |
| Highest | 0.5942 | 0.2186 | 0.0066 |
| | **D-I-D coefficients** | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs. Control | 0.9125 | 0.4702 | 0.0525 |
| ACGG+ATONU Vs. Control | 1.2863 | 0.4663 | 0.0059 |
| ACGG+ATONU Vs. ACGG | 0.3738 | 0.3612 | 0.3008 |

### 3.11 Knowledge and Practices

**Household chicken production and use**

The overall average number of chicken kept by households was 22 and 17 at baseline and endline, respectively. Although the overall average number of chicken decreased, at the endline, more households in ACGG+ATONU treatment arms were keeping chicken (Table 26). There was a slight decrease in number of chickens kept at endline, and the highest decrease occurred in the Control treatment arm than ACGG and ACGG+ATONU treatment arms. The mean number of chickens kept/produced was slightly high in the Southern Highlands zone (24) at baseline and there was a slight decrease to about 20 at endline. The Central zone recorded the lowest mean number of chickens kept by participating households.

**Table 26: Household chicken production by treatment arms and zones (n, SD)**

| | Baseline | | | Endline | | |
|---|---|---|---|---|---|---|
| **Treatment/Zones** | **N** | **Mean** | **SE of Mean** | **N** | **Mean** | **SE of Mean** |
| CONTROL | 458 | 20.04 | 1.31 | 386 | 13.23 | 1.77 |
| ACGG | 453 | 22.48 | 1.77 | 446 | 19.77 | 2.09 |
| ACGG+ATONU | 481 | 21.89 | 2.09 | 512 | 17.99 | 1.49 |
| OVERALL | 1392 | 21.47 | 1.03 | 1344 | 17.21 | 1.08 |
| Zones | | | | | | |
| Central | 564 | 20.04 | 1.55 | 562 | 14.44 | 0.68 |
| Eastern | 287 | 20.15 | 1.33 | 240 | 18.45 | 2.42 |
| Southern Highlands | 541 | 23.68 | 1.88 | 542 | 19.54 | 2.22 |
| Overall | 1392 | 21.47 | 1.03 | 1344 | 17.21 | 1.08 |

Household chicken consumption increased at endline (average 4.9 p.a.) as compared to the baseline level (average 3.6 p.a.). The increase was higher among households in the ACGG (5.5 vs. 3.6) and ACGG+ATONU (5.5 vs. 3.5) treatment arms. In the Control treatment arm, the number of chicken slaughtered for household consumption remained the same (3.7) (Table 26). Similarly, the number of chicken sold in the ACGG and ACGG+ATONU treatment arms increased at endline (7.3)

compared to that in the baseline (5.2). The consumption and sale of improved chickens across treatment arms also increased at endline. Sale of improved chickens increased in all treatment arms at endline compared to baseline, with the highest sale reported in the Control treatment arm (47.7 vs. 0.9) (Table 27). At the endline, the number of eggs produced and sold in the period of seven days prior to the survey was lower in the Control and ACGG treatment arms but it increased in the ACGG+ATONU treatment arm compared to that reported at baseline (Table 27).

**Table 27: Uses of chickens and eggs by treatment arms**

| | Baseline | | | | | | | | Endline | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CONTROL | | ACGG | | ACGG+ ATONU | | OVERALL | | CONTROL | | ACGG | | ACGG + ATONU | | OVERALL | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **Uses of local chicken within the last 12 months** | | | | | | | | | | | | | | | | |
| Consumed | 3.7 | 0.4 | 3.6 | 0.3 | 3.5 | 0.2 | 3.6 | 0.2 | 3.7 | 0.3 | 5.5 | 0.5 | 5.5 | 0.3 | 4.9 | 0.2 |
| Sold | 4.4 | 0.6 | 5.6 | 0.8 | 5.4 | 0.7 | 5.2 | 0.4 | 5.0 | 0.5 | 9.8 | 1.7 | 7.1 | 0.8 | 7.3 | 0.7 |
| **Uses of improved chicken within the last 12 months** | | | | | | | | | | | | | | | | |
| Consumed | 0.2 | 0.03 | 0.3 | 0.03 | 0.3 | 0.1 | 0.3 | 0.03 | 1.5 | 0.7 | 4.5 | 0.6 | 5.3 | 0.5 | 4.8 | 0.4 |
| Sold | 0.9 | 0.2 | 1.0 | 0.2 | 1.0 | 0.2 | 1.0 | 0.1 | 47.7 | 22.8 | 15.2 | 5.9 | 14.9 | 4.1 | 15.9 | 3.6 |
| **Eggs production and sale within the last 7 days** | | | | | | | | | | | | | | | | |
| Produced | 9.5 | 1.3 | 8.7 | 0.8 | 8.8 | 1.5 | 9.0 | 0.7 | 6.9 | 0.5 | 13.0 | 1.3 | 18.2 | 8.1 | 13.7 | 3.5 |
| Sold | 5.1 | 1.8 | 4.7 | 1.1 | 3.3 | 1.0 | 4.3 | 0.8 | 1.2 | 0.4 | 4.6 | 0.8 | 10.8 | 7.6 | 6.3 | 3.2 |

**Vegetable processing**

Vegetables, especially traditional ones, are highly consumed in Tanzania (4.9 times a week; Njelekela et al., 2003; Weinberger and Swai, 2006) and one would expect to see significant contribution to micronutrient status. However, the methods of processing and preparation may influence the amount of micronutrients available for consumption and utilisation by the body. Some of the practices tested in this impact evaluation included time lapse between harvesting and preparation, duration of cooking, methods of cooking and sequence of cooking vegetables and staples. In addition, the evaluation looked into the way vegetables are washed and cut before cooking. At endline, 66% of the households cooked vegetables within an hour after picking compared to 43% at baseline and 75% of the households cooked their vegetables for less than 15 minutes at both baseline and endline. At endline 80% of the households cooked vegetables before preparing the staple, compared to 83% at baseline. However, in the ACGG+ATONU treatment arm there was a reduction in the number of households that prepare vegetables before staple (81% to 77%) (Table 24).

The methods used to cook vegetables included boiling, steaming, stewing and stir-frying. The most popular method for cooking vegetables was stir-frying. The popularity increased from 49% at baseline to 64% at endline. The proportion of households boiling or stewing vegetables declined from 26% to 23% and 13% to 9% between baseline and endline, respectively (Table 28). The way vegetables are washed also affects nutrients in the vegetables. Washing vegetables after cutting may lead to loss of nutrients through leakage. The proportion of households that washed vegetables after cutting declined from 13.2% at baseline to 9.8% at endline. This means that more households washed vegetables before cutting at endline (90.2%) compared to baseline (86.8%). The proportion of increase was highest among the ACGG/ATONU treatment arm (5.2%) followed by ACGG (4.3%) and the Control treatment arm had the least increase (0.8%). A high proportion (96%) of households washed vegetables in a container at both baseline and endline. Cutting of vegetables is a common practice in many households, but differ in the size to which vegetables are cut before cooking. In this evaluation, 59% of the respondents indicated that they cut vegetables into small sizes at both baseline and endline. However, the proportion of households that cut vegetables into small sizes decreased by 3% in ACGG/ATONU treatment arm but increased by 2.5% and 1.8% in the ACGG and Control treatment arms, respectively (Table 28).

**Table 28: Vegetable preparation**

| | Baseline | Endline |
|---|---|---|

| Answer Options | Control | | ACGG | | ACGG+ ATONU | | Overall | | Control | | ACGG | | ACGG+ ATONU | | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| **How soon do you cook?** | | | | | | | | | | | | | | | | |
| After 1 to 12 hours | 59 | 12.9 | 55 | 12.1 | 61 | 12.7 | 175 | 12.6 | 97 | 17.9 | 72 | 14.4 | 90 | 16.0 | 259 | 16.1 |
| Stays overnight | 1 | 0.2 | 4 | 0.9 | 1 | 2.0 | 6 | 0.4 | 3 | 0.6 | 3 | 0.6 | 3 | 0.5 | 9 | 0.6 |
| Within 1h of picking | 199 | 43.4 | 205 | 45.3 | 202 | 42.0 | 606 | 43.5 | 339 | 62.5 | 340 | 67.9 | 386 | 68.8 | 1065 | 66.4 |
| Not applicable | 199 | 43.4 | 189 | 41.7 | 217 | 45.1 | 605 | 43.5 | 103 | 19.0 | 86 | 17.2 | 82 | 14.6 | 271 | 16.9 |
| **How long do you cook vegetables?** | | | | | | | | | | | | | | | | |
| < 15 Min | 340 | 74.2 | 338 | 74.6 | 362 | 75.3 | 1040 | 74.7 | 379 | 69.9 | 386 | 77.0 | 435 | 77.5 | 1200 | 74.8 |
| 15 to 30 Min | 97 | 21.2 | 106 | 23.4 | 104 | 21.6 | 307 | 22.1 | 138 | 25.5 | 103 | 20.6 | 110 | 19.6 | 351 | 21.9 |
| 31 to 60 Min | 21 | 4.6 | 9 | 2.0 | 15 | 3.1 | 45 | 3.2 | 25 | 4.6 | 10 | 2.0 | 14 | 2.5 | 49 | 3.1 |
| > 60 Min | | | | | | | | | 0 | 0 | 2 | 0.4 | 2 | 0.4 | 4 | 0.2 |
| **When do you cook vegetables? Before or after staple?** | | | | | | | | | | | | | | | | |
| After | 79 | 18.1 | 53 | 12.3 | 82 | 18.2 | 214 | 16.2 | 91 | 16.8 | 95 | 19.0 | 120 | 21.4 | 306 | 19.1 |
| Before | 355 | 81.2 | 369 | 85.8 | 366 | 81.3 | 1090 | 82.8 | 444 | 81.9 | 401 | 80.0 | 432 | 77.0 | 1277 | 79.6 |
| Same time | 3 | 0.7 | 8 | 1.9 | 2 | 0.4 | 13 | 1.0 | 7 | 1.3 | 5 | 1.0 | 9 | 1.6 | 21 | 1.3 |
| **Method used to cook vegetables** | | | | | | | | | | | | | | | | |
| Boiling | 109 | 23.8 | 120 | 26.5 | 128 | 26.6 | 357 | 25.6 | 145 | 26.8 | 118 | 23.6 | 114 | 20.3 | 377 | 23.5 |
| Other | 24 | 5.2 | 23 | 5.1 | 32 | 6.7 | 79 | 5.7 | 3 | 0.6 | 0 | 0 | 2 | 0.4 | 5 | 0.3 |
| Steaming | 32 | 7.0 | 21 | 4.6 | 33 | 6.9 | 86 | 6.2 | 21 | 3.9 | 20 | 4.0 | 12 | 2.1 | 53 | 3.3 |
| Stewing | 53 | 11.6 | 64 | 14.1 | 68 | 14.1 | 185 | 13.3 | 39 | 7.2 | 49 | 9.8 | 51 | 9.1 | 139 | 8.7 |
| Stir-frying | 240 | 52.4 | 225 | 49.7 | 220 | 45.7 | 685 | 49.2 | 334 | 61.6 | 314 | 62.7 | 382 | 68.1 | 1030 | 64.2 |
| **How long do you cook vegetables?** | | | | | | | | | | | | | | | | |
| Larger sizes | 38 | 8.3 | 38 | 8.3 | 36 | 7.5 | 112 | 8.0 | 48 | 8.9 | 47 | 9.4 | 55 | 9.8 | 150 | 9.4 |
| Medium | 121 | 26.4 | 128 | 28.3 | 133 | 27.7 | 382 | 27.4 | 152 | 28.0 | 143 | 28.5 | 190 | 33.9 | 485 | 30.2 |
| Small sizes | 275 | 60.0 | 264 | 58.3 | 280 | 58.2 | 819 | 58.8 | 335 | 61.8 | 304 | 60.7 | 310 | 55.3 | 949 | 59.2 |
| **When do you wash them?** | | | | | | | | | | | | | | | | |
| After cutting | 62 | 13.5 | 63 | 13.9 | 59 | 12.3 | 184 | 13.2 | 69 | 12.7 | 48 | 9.6 | 40 | 7.1 | 157 | 9.8 |
| Before cutting | 396 | 86.5 | 390 | 86.1 | 422 | 87.7 | 1208 | 86.8 | 473 | 87.3 | 453 | 90.4 | 521 | 92.9 | 1447 | 90.2 |
| **How do you wash your vegetables?** | | | | | | | | | | | | | | | | |
| Don't wash | 1 | 0.2 | 2 | 0.4 | 1 | 0.2 | 4 | 0.3 | 4 | 0.7 | 7 | 1.4 | 4 | 0.7 | 15 | 0.9 |
| In a container | 436 | 95.2 | 441 | 97.4 | 469 | 97.5 | 1346 | 96.7 | 532 | 98.2 | 475 | 94.8 | 535 | 95.4 | 1542 | 96.1 |
| On running water | 21 | 4.6 | 10 | 2.2 | 11 | 2.3 | 42 | 3.0 | 6 | 1.1 | 19 | 3.8 | 22 | 3.9 | 47 | 2.9 |

**Vegetable Consumption**

At endline more than 90% of women consumed green leafy vegetables in their households within the last 7 days preceding the survey (Figure 28). Consumption of other vegetables was slightly higher in the Control treatment arm (51%) compared to ACGG and ACGG+ATONU treatment arms (48%). About 48% of the women in the ACGG+ATONU consumed vegetables daily, 30% in the Control and 45% in the ACGG treatment arms (Figure 29).

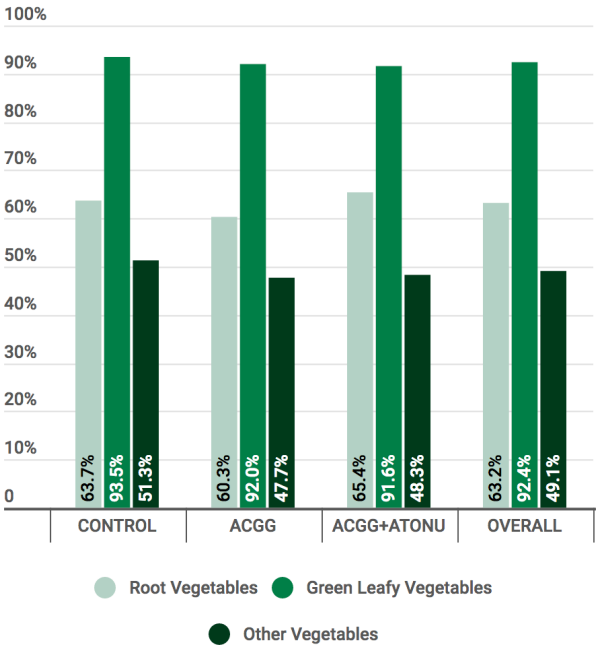



**Figure 28: 7-day vegetable consumption by women by treatment arms at endline**

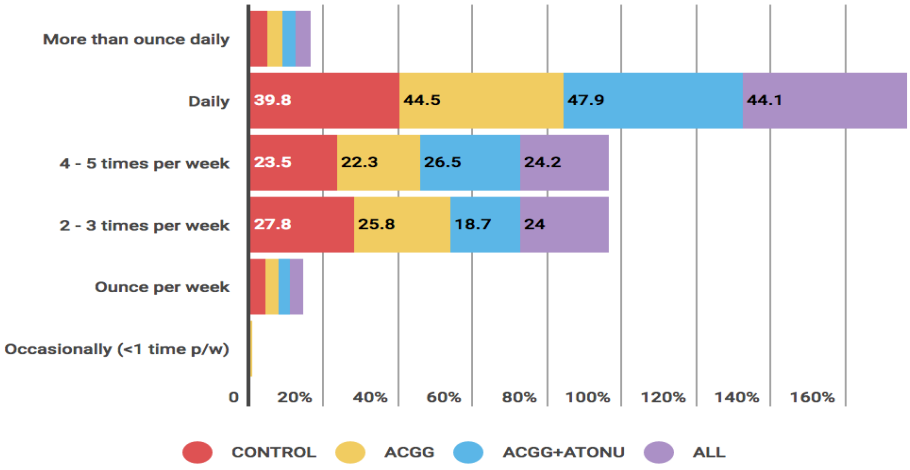



**Figure 29: Frequency of vegetable consumption by women 7 days preceding the survey by treatment arms at endline**

Home garden was the main source of vegetables consumed by women in all treatment arms. About 62%, 71% and 75% of the women in the Control, ACGG and ACGG+ATONU treatment arms, respectively obtained vegetables from home gardens (Table 29). About 38% of the households used the women's income to purchase vegetables and this was similar in all treatment arms. However, joint income for purchase of vegetables was used by 34% of the households in ACGG+ATONU, 32% in ACGG and 25% in Control treatment arms (Figure 30).

**Table 29: Source of vegetables consumed by women**

| Vegetable source | CONTROL | | ACGG | | ACGG+ATONU | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Own garden | 315 | 62.1 | 328 | 71.1 | 383 | 74.5 |
| Gathering | 53 | 10.5 | 31 | 6.7 | 26 | 5.1 |
| Gifts from friends and family | 59 | 11.6 | 45 | 9.8 | 38 | 7.4 |
| Purchased from Market | 128 | 25.2 | 95 | 20.6 | 103 | 20.0 |

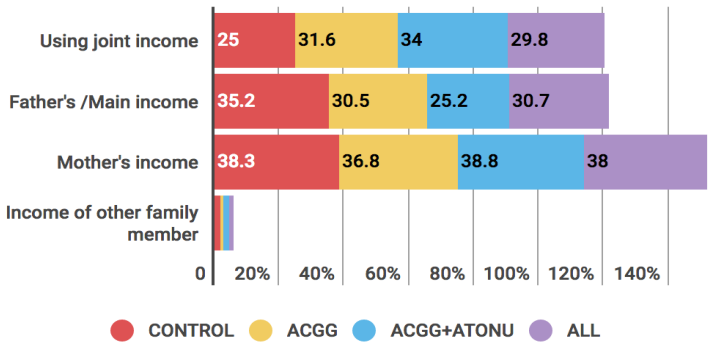
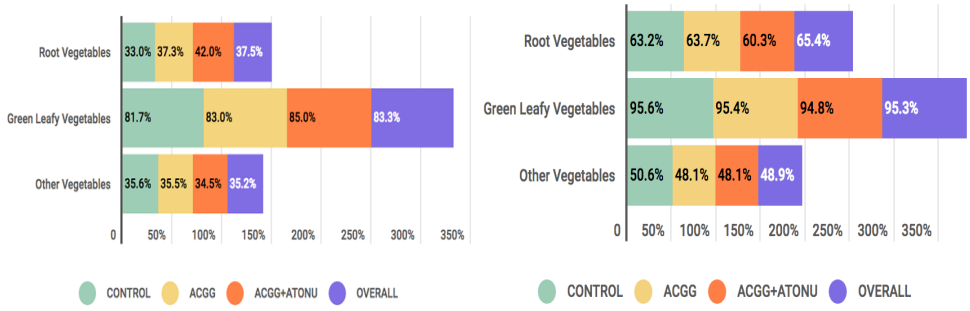



**Figure 30: Income used to purchase vegetables at endline**

**Household vegetable consumption**

Consumption of all types of vegetables increased at endline compared to baseline (Figure 31). The proportion of households that consumed green leafy vegetables increased from 83% at baseline to 95% at endline in all treatment arms. Similarly, the overall proportion of households that consumed root vegetables increased from 38% to 65% and that of other vegetables from 35% to 49%.



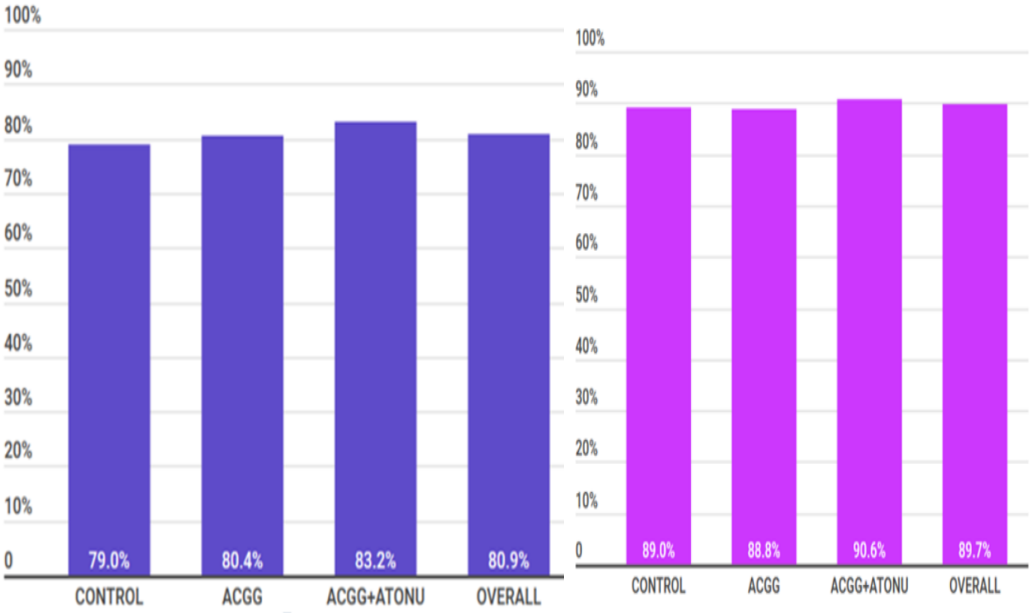

**Baseline** **Endline**

**Figure 31: Household consumption of vegetables at baseline and endline**

**Vegetable consumption analysis**

Overall, household vegetable consumption within 24 hour prior to the survey was higher at endline (89.7%) compared to baseline (80.9%) (Figure 32). At baseline, the consumption of vegetable was not significantly different across treatment arms ($\chi^2$= 2.1087, p= 0.3484). The proportion of households that consumed vegetables in the Control treatment arm was 79% and in the ACGG and ACGG+ATONU treatment arms was 80.4% and 83.2%, respectively. For all treatments arms, vegetable consumption was higher at endline than at baseline (89.9% for Control, 88.8%% in ACGG only and 90.6% in ACGG+ATONU treatment arms). The magnitude of the difference in vegetable consumption increased by 10% (from 79% to

89%) in Control treatment arm, and in ACGG and ACGG+ATONU treatment arms it increased by 8.4% (from 80.4% to 88.8 %) and 7.4% (from 83.2% to 90.6%), respectively.




**Baseline** **Endline**

**Figure 32: Proportion of households consuming vegetable by treatment arms within 24 hour at baseline and endline**

According to the adjusted GEE (Table 30) the change in vegetable consumption from baseline to endline was not significantly different across treatment arms. The magnitude of the D-I-D Odds ratio (OR) for ACGG treatment arm was 0.98, and it was not significant at α=0.05 (p=0.9463). Likewise, for ACGG+ATONU treatment arm the D-I-D Odds ratio was 1.06 (p = 0.8370). In addition, no significant difference in the magnitude of change of vegetable consumption at baseline and endline was observed between ACGG+ATONU and ACGG treatment arms (OR=1.08, p=0.7901).

**Table 30: Empirical based parameter estimates (β) and Odds ratio (OR) of the adjusted GEE for difference in difference analysis of household vegetable consumption**

| **Parameter** | **Estimate** | **Standard Error** | **P-Value** |
|---|---|---|---|
| Intercept | 1.4886 | 0.1714 | <0.0001 |
| Time | | | |
| Endline | 0.7486 | 0.1858 | <0.0001 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | 0.0735 | 0.1688 | 0.663 |
| ACGG+ATONU | 0.2656 | 0.1702 | 0.1186 |
| Control | Reference | | |
| **Time*Treatment** | | | |
| Time*ACGG | -0.0179 | 0.2661 | 0.9463 |
| Time*ACGG+ATONU | 0.0581 | 0.2823 | 0.837 |
| **Zone** | | | **0.0041** |
| Central | 0.1753 | 0.1226 | 0.1527 |
| Eastern | -0.3007 | 0.1378 | 0.0291 |
| Southern | Reference | | |
| **Endline Family Wealth Index** | | | **0.0090** |
| Lowest | Reference | | |
| Second | -0.4976 | 0.1642 | 0.0024 |
| Middle | 0.0322 | 0.1778 | 0.8562 |
| Fourth | -0.2151 | 0.1762 | 0.2222 |
| Highest | -0.0428 | 0.1785 | 0.8107 |

| | | | |
|---|---|---|---|
| | D-I-D adjusted Odds ratio (AOR) | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs CONTROL | 0.98 | 0.2614 | 0.9463 |
| ACGG+ATONU Vs CONTROL | 1.06 | 0.2991 | 0.8370 |
| ACGG+ATONU Vs ACGG | 1.08 | 0.3079 | 0.7901 |

### 3.12 Women Empowerment

**Decisions on expenditure from own and household income**

Adults, i.e. husband and wife and or elder children or other relatives, usually make household decisions either individually or jointly. At endline, almost 50% of the respondents made decisions regarding expenditure of household income jointly and husbands only made a third of income decisions. This was the trend in all treatment arms. At endline, 53% of the respondents' made joint decisions on food expenditure compared to 51% at baseline. In the ACGG+ATONU treatment arm, 56% of the respondents made joint decisions compared to 52% and 55% in the Control and ACGG treatment arms, respectively. At endline, a higher proportion of women (25.5%) decided on food expenditure compared to men (18.5%). Similarly, more women at endline made decisions on their own income than at baseline (37% vs. 28%) (Table 31).

**Table 31: Decisions on expenditure from own and household income by treatment arms in surveyed area**

| | Control | | ACGG | | ACGG+ATONU | | Overall | |
|---|---|---|---|---|---|---|---|---|
| **N** | **458** | **542** | **453** | **501** | **481** | **561** | **1392** | **1604** |
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** |
| **Decisions regarding expenditure of household income** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| Husband | 30.1 | 28.2 | 28.9 | 24.4 | 32.2 | 20.9 | 30.5 | 24.4 |
| Wife | 11.1 | 20.1 | 10.4 | 18.8 | 8.7 | 19.3 | 10.1 | 19.4 |
| Husband and wife jointly | 47.8 | 48.7 | 49.5 | 54.6 | 48.2 | 56.2 | 48.5 | 53.2 |
| Someone else in the household | 1.3 | 1.5 | 1.8 | 1.4 | 1.3 | 1.3 | 1.4 | 1.4 |
| Woman (single headed household) | 9.6 | 1.5 | 9.5 | 0.8 | 9.6 | 2.3 | 9.6 | 1.6 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Decisions on food expenditures** | **CONTROL** | | **ACGG** | | **ACGG+ATONU** | | **OVERALL** | |
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** |
| | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| Husband | 17.3 | 22.3 | 19 | 18.6 | 19.5 | 14.8 | 18.6 | 18.5 |
| Wife | 19.9 | 26 | 18.8 | 24.4 | 18.9 | 26 | 19.2 | 25.5 |
| Husband and wife jointly | 52.2 | 48.9 | 51 | 54.8 | 49.9 | 55.6 | 51 | 53.1 |
| Someone else in the household | 0.9 | 1.3 | 1.8 | 1.4 | 1.7 | 1.1 | 1.4 | 1.2 |
| Woman (single headed household) | 9.8 | 1.5 | 9.5 | 0.8 | 10 | 2.5 | 9.8 | 1.6 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Decisions on expenditure of your own income** | **CONTROL** | | **ACGG** | | **ACGG+ATONU** | | **OVERALL** | |
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** |
| | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| Husband | 14.4 | 12 | 13.0 | 12.6 | 11.9 | 9.5 | 13.1 | 11.3 |
| Wife | 27.7 | 41.9 | 28.5 | 34.7 | 28.5 | 35.8 | 28.2 | 37.5 |
| Husband and wife jointly | 46.3 | 43 | 46.8 | 49.7 | 48.2 | 51 | 47.1 | 47.9 |
| Someone else in the household | 1.3 | 1.1 | 1.3 | 1.4 | 1.0 | 0.7 | 1.2 | 1.1 |
| Woman (single headed household) | 10.3 | 2 | 10.4 | 1.6 | 10.4 | 3 | 10.3 | 2.2 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Decision-making on household budgets by treatment arms in surveyed area**

Intra-household decisions refer to negotiations that occur between members of a household (in most cases by-spouses) in order to arrive at decisions regarding the household unit, whether to purchase food for the household or to pay school fees for children. At endline, there was a slight improvement (81%) on the capacity of women to make decision on household budgets related to their own income expenditure compared to what was observed at baseline (76%). However, women had no influence on decisions about budgeting for income owned by other household members (Table 32 & 33).

**Table 32: Decision-making on household budgets**

| | CONTROL | | ACGG | | ACGG+ATONU | | OVERALL | |
|---|---|---|---|---|---|---|---|---|
| **N** | **458** | **541** | **453** | **499** | **481** | **559** | **1392** | **1599** |
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** |
| | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| **Women contribution to decisions on own budget** | | | | | | | | |
| Always | 76.2 | 77.8 | 75.7 | 82 | 76.09 | 83.7 | 76.01 | 81.2 |
| Sometimes | 17.9 | 15.9 | 18.8 | 12.8 | 18.5 | 13.2 | 18.39 | 14 |
| Rarely | 4.4 | 4.8 | 4.4 | 4 | 4.37 | 1.8 | 4.38 | 3.5 |
| Never | 1.5 | 1.5 | 1.1 | 1.2 | 1.04 | 1.3 | 1.22 | 1.3 |
| Total | 100 | 100 | 100.0 | 100 | 100 | 100 | 100 | 100 |
| **Women contribution to decisions on household budget** | | | | | | | | |
| | | | | | | | | |
| | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| Always | 64.9 | 67.6 | 63.1 | 77 | 68.61 | 77.6 | 65.59 | 74.1 |
| Sometimes | 28.8 | 22.9 | 28.5 | 16.8 | 23.91 | 16.9 | 27.01 | 18.9 |
| Rarely | 5.5 | 7.8 | 6.4 | 5.4 | 6.44 | 4.1 | 6.11 | 5.7 |
| Never | 0.9 | 1.7 | 2.0 | 0.8 | 1.04 | 1.4 | 1.29 | 1.3 |
| Total | 100 | 100 | 100.0 | 100 | 100 | 100 | 100 | 100 |
| **Women contribution to decisions on other household members' budgets** | | | | | | | | |
| | | | | | | | | |
| | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| Always | 42.6 | 32.6 | 39.1 | 39.9 | 40.8 | 40.1 | 40.8 | 37.5 |
| Sometimes | 22.5 | 20.6 | 26.1 | 21.6 | 24.3 | 18.8 | 24.3 | 20.2 |
| Rarely | 17 | 15.1 | 10.6 | 15.4 | 15.8 | 14.9 | 14.5 | 15.2 |
| Never | 17.9 | 31.7 | 24.3 | 23.1 | 19.1 | 26.2 | 20.4 | 27.1 |
| Total | 100 | 100 | 100.0 | 100 | 100 | 100 | 100 | 100 |

Most women indicated that they 'always' made decisions on food purchased in the household in all treatment arms at baseline and endline. The improved capacity of women to make decisions on own income expenditure, household income and income from other family members was more pronounced in ACGG and ACGG+ATONU treatment arms at endline than in the Control treatment arm (Table 33).

**Table 33: Decision-making on household expenditure**

| | CONTROL | | ACGG | | ACGG+ATONU | | OVERALL | |
|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** | **Baseline** | **Endline** |
| **N** | **458** | **541** | **453** | **499** | **481** | **559** | **1392** | **1599** |
| | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| **Women contribution to decisions on expenditure on own income** | | | | | | | | |
| Always | 74.7 | 79.8 | 76.2 | 80.5 | 73.4 | 82.7 | 74.7 | 81.0 |
| Sometimes | 19.2 | 14.2 | 19.4 | 14.5 | 20.4 | 12.1 | 19.7 | 13.6 |
| Rarely | 4.59 | 4.3 | 3.31 | 4 | 5.41 | 3.2 | 4.5 | 3.8 |
| Never | 1.5 | 1.7 | 1.1 | 1 | 0.8 | 2 | 1.1 | 1.6 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |
| **Women contribution to decisions on expenditure on household income** | | | | | | | | |
| Always | 61.7 | 67.7 | 60.9 | 76 | 64.7 | 74.6 | 62.5 | 72.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sometimes | 30.6 | 25.1 | 31.6 | 18.2 | 28.5 | 19.7 | 30.1 | 21.1 |
| Rarely | 7 | 5.7 | 5.1 | 5.2 | 5.82 | 3.9 | 6 | 4.9 |
| Never | 0.7 | 1.5 | 2.4 | 0.6 | 1.04 | 1.8 | 1.4 | 1.3 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |
| **Women contribution to decisions on expenditure on income from other household members** | | | | | | | | |
| Always | 42.1 | 33.3 | 39.9 | 41.3 | 40.9 | 39 | 41.0 | 37.8 |
| Sometimes | 25.3 | 18.1 | 24.3 | 20.4 | 25.6 | 18.8 | 25.1 | 19.1 |
| Rarely | 14.9 | 16.8 | 11.5 | 14.8 | 13.72 | 14.3 | 13.4 | 15.3 |
| Never | 17.7 | 31.8 | 24.3 | 23.5 | 19.8 | 27.9 | 20.6 | 27.8 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |
| **Women contribution to decisions on what foods to purchase** | | | | | | | | |
| Always | 74.2 | 76.2 | 71.7 | 80 | 73.6 | 78.8 | 73.2 | 78.3 |
| Sometimes | 17.9 | 17.4 | 23.4 | 14.6 | 21.2 | 17.2 | 20.8 | 16.5 |
| Rarely | 6.3 | 5 | 2.9 | 4.4 | 4.6 | 2.2 | 4.6 | 3.8 |
| Never | 1.5 | 1.4 | 2.0 | 1 | 0.6 | 1.8 | 1.4 | 1.4 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |

**Women empowerment in decision making on household budgets and expenditure**

Women empowerment was assessed using 10 questions adopted from Women's Empowerment in Agriculture Index (WEAI). To compute an empowerment indicator for each item, each question, was recoded as 1, an indication that the subject was empowered in that particular item or 0 if not. The ten questions together with recoding system were as follows:

*Decisions on expenditure of household income* (Q1)
"When decisions are made regarding expenditure of household income, who normally decides?" (Response options were: 1 =Husband, 2= Wife, 3= Husband and wife jointly, 4 =Someone else in the household, 5 =Someone outside the household) (Coded 1=wife or Husband and wife jointly and 0= Husband, someone else in the household, or someone outside the household).

*Decision on food expenditure (Q2)*
"When decisions are made regarding food expenditure who normally takes the decision*?"*
(Response options were: 1 =Husband, 2= Wife, 3= Husband and wife jointly, 4 =Someone else in the household, 5 =Someone outside the household) (Coded 1=wife or Husband and wife jointly and 0= Husband, Someone else in the household, or Someone outside the household).

*Decision on expenditure of your own income (Q3)*
"When decisions are made regarding expenditure of your own income, who normally decides?" (Response options were: 1 =Husband, 2= Wife, 3= Husband and wife jointly, 4 =Someone else in the household, 5 =Someone outside the household) (Coded 1=wife or Husband and wife jointly and 0= Husband, Someone else in the household, or Someone outside the household).

*Contribution in decisions about budgeting income on own income expenditure (Q4)*
"To what extent do you contribute to the decisions about budgeting income on own income expenditure?" (Response options were: 1= Always, 2= Sometimes, 3 = Rarely, 3 = Never) (Coded 1 =Always and 0 = Sometimes, =Rarely or Never).

*Contribution in decisions about budgeting income on household income expenditure (Q5)*
*"*To what extent do you contribute to the decisions about budgeting income on household income expenditure?" (Response options were: 1= Always, 2= Sometimes, 3 = Rarely, 3 = Never) (Coded 1 =Always and 0 = Sometimes, =Rarely or Never).

*Contribution in decisions about budgeting income from other household members(Q6)*
"To what extent do you contribute to the decisions about budgeting income from other household members?" (Response options were: 1= Always, 2= Sometimes, 3 = Rarely, 3 = Never) (Coded 1 =Always and 0 = Sometimes, =Rarely or Never).

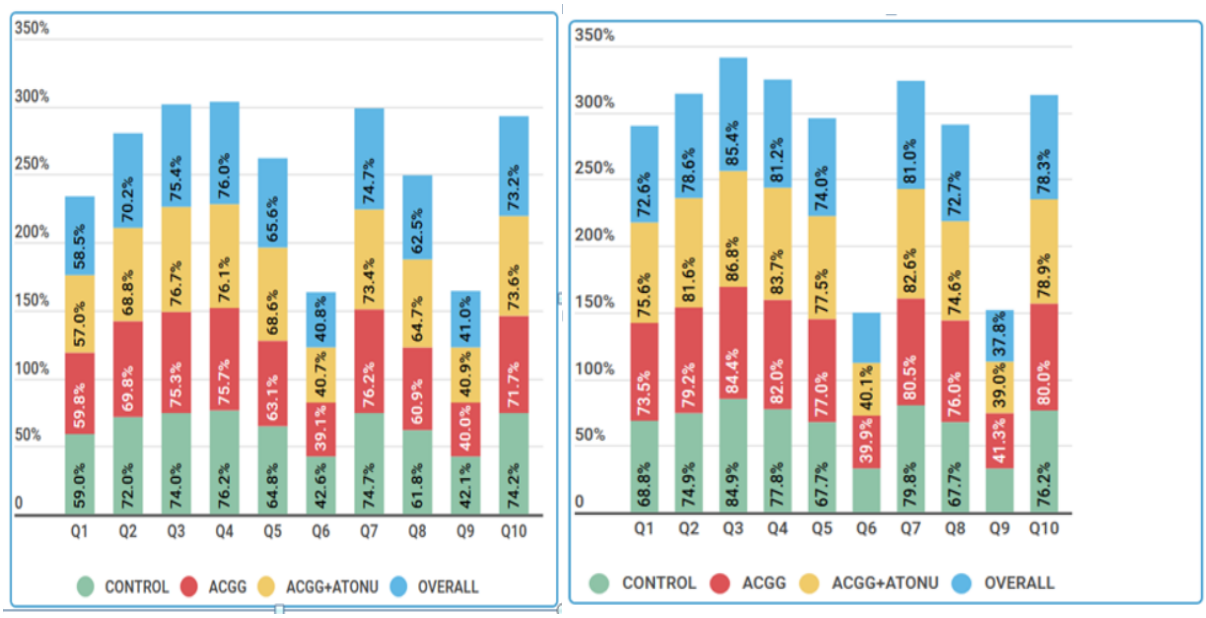
*Contribution in making decisions about expenditures on own income (Q7)*
"To what extent do you contribute in making decisions about expenditures on own income?" (Response options were: 1= Always, 2= Sometimes, 3 = Rarely, 3 = Never) (Coded 1 =Always and 0 = Sometimes, =Rarely or Never).

*Contribution in about expenditures on household income(Q8)*
To what extent do you contribute in making decisions about expenditures on household income? (Response options were: 1= Always, 2= Sometimes, 3= Rarely, 3= Never) (Coded 1=Always and 0= Sometimes, =Rarely or Never).

*Contribution in making decisions about expenditures on income from other household members (Q9)*
"To what extent do you contribute in making decisions about expenditures on income from other household members?" (Response options were: 1= Always, 2= Sometimes, 3 = Rarely, 3 = Never) (Coded 1 =Always and 0 = Sometimes, =Rarely or Never).

*Contribution in making decisions about what foods to purchase (Q10)*
"To what extent do you contribute in making decisions about what foods to purchase?" (Response options were: 1= Always, 2= Sometimes, 3 = Rarely, 3 = Never) (Coded 1 =Always and 0 = Sometimes, =Rarely or Never).

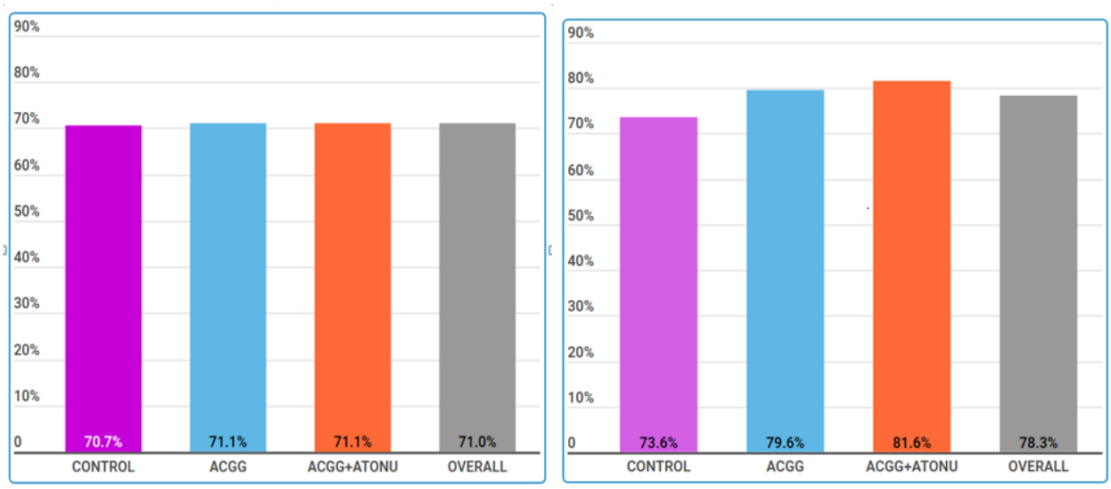
To obtain the overall women empowerment status, women empowerment score was calculated by summing the empowerment indicators of all ten questions outlined above. The score ranged from 0 to 10, and women with empowerment scores of 5 and above were considered to be empowered. Figure 33 shows the proportion of empowered women for all ten questions at baseline and endline. At baseline, the question that women were most empowered on was *contribution in decisions about budgeting income on own income expenditure* (Q4) (76%), followed by decision on *expenditure of her own income (Q3)* (75.4%) and *contribution in making decisions about expenditures on own income (Q7)* (74.7%). At endline, the most reported empowerment questions were *decision on expenditure of own income (Q7)* (85.4%), *contribution in decisions about budgeting income on own income expenditure (Q4)* (81.1%) and *contribution in making decisions about expenditure on own income (Q3)* (81%).




**Baseline** **End line**

**Figure 33: Proportion of women involved in decision making on household budget and expenditure at baseline and endline**

Figure 34 presents, the proportion of women empowerment in decision making on household budgeting and expenditure across treatment arms at baseline and endline. Overall, the proportion of empowered women was higher at endline (78.3%) compared to baseline (71%). At baseline, no significant difference in the proportion of empowered women was observed across treatment arms ($\chi^2$ =0.0197, p=0.9902); whereby 71.1% of the women in ACGG and ACGG+ATONU and 70.7% of the women in Control treatment arms were empowered. Across all treatment arms, the proportion of empowered women was higher at endline compared to baseline; 73.6% in the Control treatment arm, 79.6% in ACGG and 81.6% in ACGG+ATONU treatment arms. The magnitude of the difference in empowerment of women in the Control treatment arm improved by 2.9% (70.7% to 73.6%), and in ACGG and ACGG+ATONU treatment arms improved by 8.5% (71.1% to 79.6%) and 10.5% (71.1% to 81.6%), respectively. The magnitude of the difference in women empowerment observed in ACGG+ATONU treatment arm was 7.6% higher than that observed in the Control treatment arm (10.5% versus 2.9%) and was 2% higher than in ACGG treatment arm (10.5% versus 8.5%).




**Baseline** **Endline**

**Figure 34: Proportion of women empowered in decision making across treatment arms at baseline and endline**

The adjusted repeated measure GEE (Table 34), indicates the magnitude of the D-I-D Odds ratio (OR) for ACGG was 1.10, and was not significant at α=0.05 (p=0.6540). For ACGG+ATONU, the D-I-D Odds ratio was 1.56, and was significant (p=0.0473). This means that, the proportion of empowered women at baseline and at endline was significantly higher in ACGG+ATONU compared to Control treatment arms. This suggests that, the training on budgeting and decision-making helped to improve women empowerment at endline. However, based on the study design used, the difference in women empowerment could be attributed to the implementation of the training on budgeting and decision-making not by the change due to time i.e. baseline and endline. Moreover, no significant difference in women empowerment was observed between ACGG+ATONU and ACGG treatment arms (OR= 1.41, p=0.1215).

**Table 34: Empirical based parameter estimates (β) and Odds ratio (OR) of the adjusted GEE for difference in difference analysis of women empowerment**

| **Effect** | **Estimate** | **Standard Error** | **P-Value** |
|---|---|---|---|
| Intercept | 0.6235 | 0.2125 | 0.0033 |
| **Time** | | | |
| Endline | 0.2503 | 0.1516 | 0.0988 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | -0.0155 | 0.1495 | 0.9172 |
| ACGG+ATONU | -0.0182 | 0.1473 | 0.9017 |
| Control | Reference | | |
| **Time*Treatment** | | | |
| Time*ACGG | 0.0963 | 0.2148 | 0.654 |
| Time*ACGG+ATONU | 0.4415 | 0.2226 | 0.0473 |
| **Zone** | | | |
| Central | 0.2532 | 0.096 | 0.0084 |
| Eastern | 0.3475 | 0.1234 | 0.0049 |
| Southern | Reference | | |
| **Endline Head education level** | | | |
| No formal education | Reference | | |
| Primary education | 0.1132 | 0.1921 | 0.5557 |
| Secondary education | -0.0771 | 0.2245 | 0.7311 |

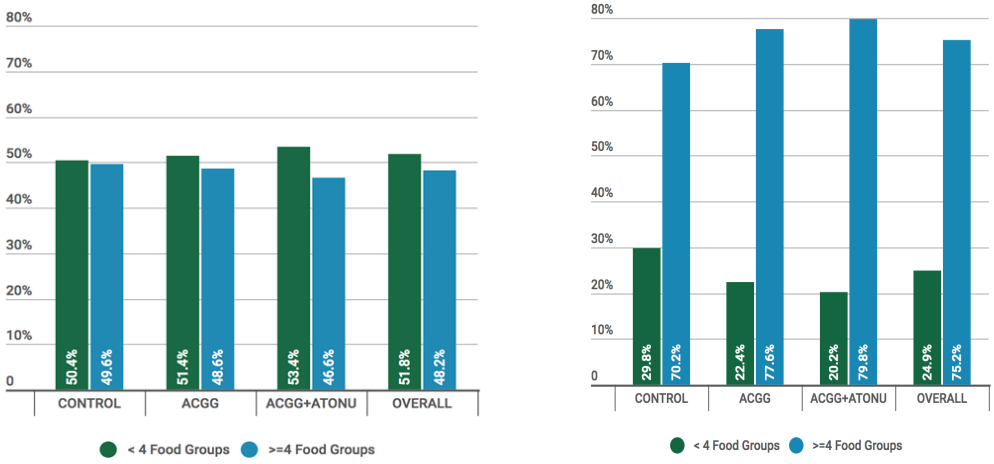
| | | | |
|---|---|---|---|
| Tertiary education | 0.4588 | 0.2805 | 0.1019 |
| | | | |
| | **D-I-D adjusted Odds ratio (AOR)** | | |
| Label | Estimate | Standard Error | P-Value |
| ACGG Vs CONTROL | 1.10 | 0.2365 | 0.6540 |
| ACGG+ATONU Vs CONTROL | 1.56 | 0.3461 | 0.0473 |
| ACGG+ATONU Vs ACGG | 1.41 | 0.3149 | 0.1215 |

### 3.13 Dietary Diversity

**Children's Dietary Diversity**

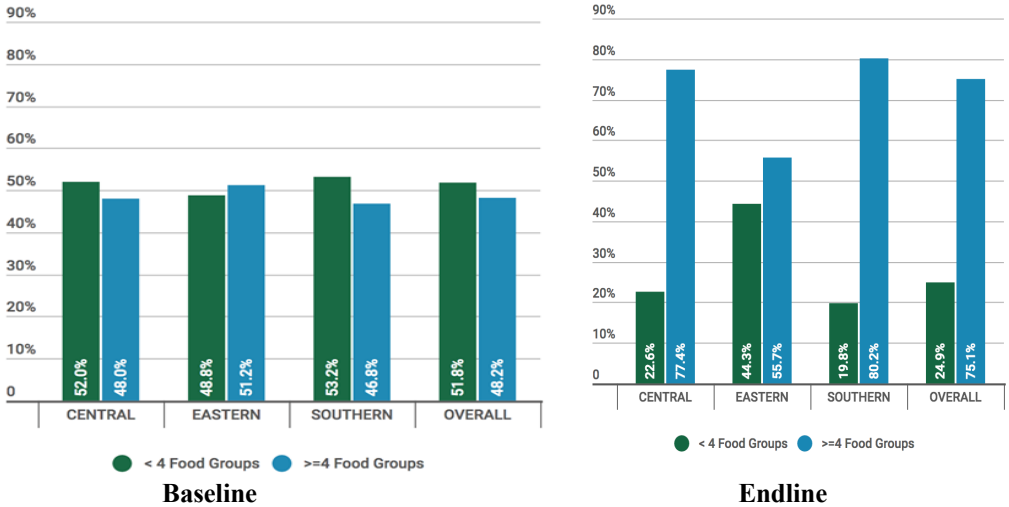
**Dietary diversity among children by 24-hour recall**

The number of children fed more than four food groups increased between baseline (48%) and endline (75%). At endline, the ACGG+ATONU treatment arm had a higher proportion (80%) of children who received more than four food groups compared to ACGG only (78%) and Control (70%) (Figure 35). Almost all treatment arms and zones had the same proportion of children who were fed less than 4 food groups at baseline. At endline, the proportion of children fed more than 4 food groups in all the treatment arms increased. At endline, all zones showed a significant proportion of children who were fed more than 4 food groups compared to those who were given less than 4 food groups (Figure 36).




**Baseline** **Endline**

**Figure 35: Food groups consumed by children across treatment arms at endline and baseline**



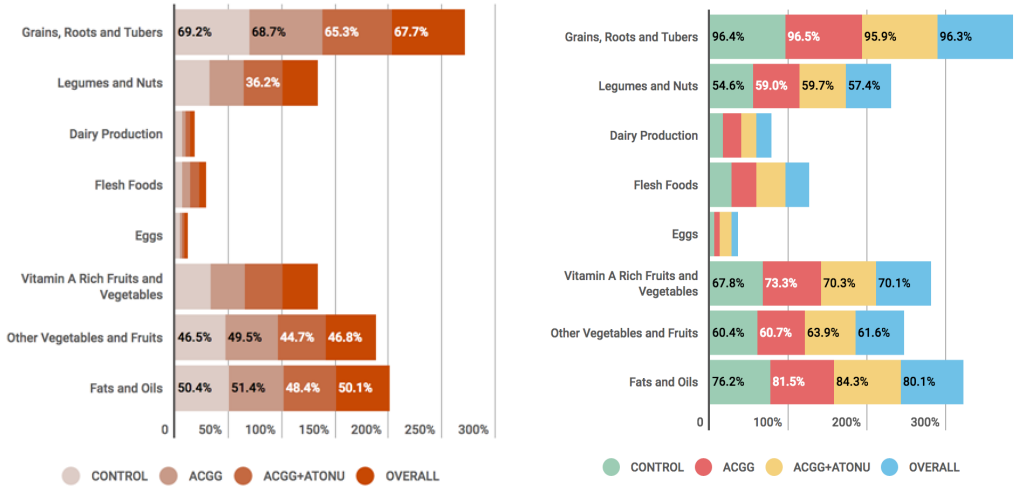

**Baseline** **Endline**

**Figure 36: Food groups consumed by children across zones at endline and baseline**

**Types of foods given to children**

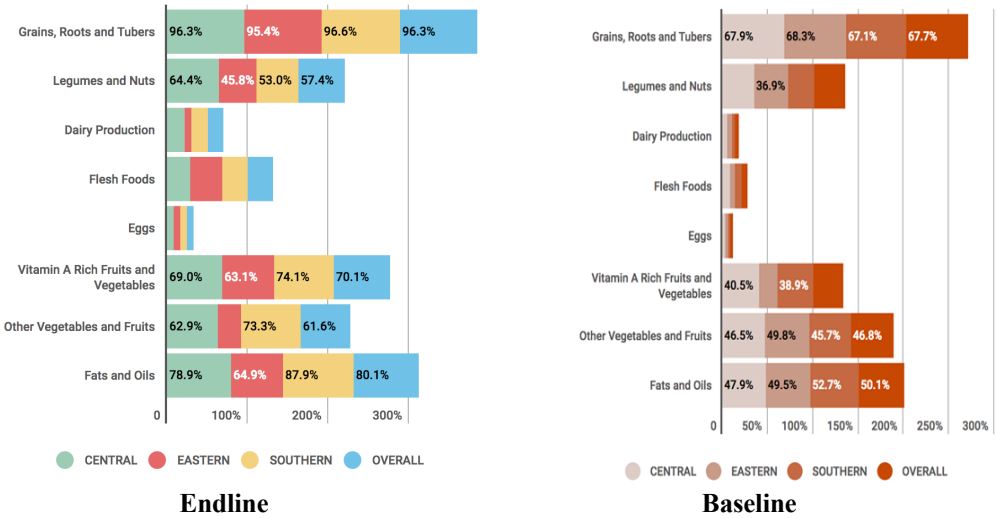
Overall, the most consumed food group for children at baseline across the treatment arms and in all zones was cereals (68%). Oils and fats were consumed by 50%, other vegetables and fruits by 47%, legumes and nuts by 33%, vitamin A rich fruits and vegetables by 33% (Figure 37). At baseline, the food groups consumed by children were similar across treatment arms and zones.

At endline, both treatment arms and zones had more proportions of children that increased the consumption of the same food groups (Figure 37 & 38). Overall, 96% of the children in the treatment arms consumed cereals, oils and fats (80%), vitamin A rich fruits and vegetables (70%), other vegetables and fruits (62%), legumes and nuts (57%) (Figure 37). In all treatment arms and zones, consumption of dairy products, flesh foods and eggs by children increased from 4.5% 7.3%, and 2.9% at baseline to 19.2%, 31.2% and 8.6% at endline, respectively (Figure 37 & 38).




**Baseline** **Endline**

**Figure 37: Food groups consumed by children across treatment arms at endline and baseline**




**Endline** **Baseline**

**Figure 38: Food groups consumed by children across zones at endline and baseline**

**Inferential analysis for 24-hour children's dietary diversity score (CDDS)**

The mean children's dietary diversity scores across treatment arms are presented in Table 35. The mean dietary diversity among children was 3.13, ranging between 3.04 and 3.21 (95% CI= 3.0428, 3.2115). Children's dietary diversity score was not significantly different across the treatment arms (F=0.20, p=0.8159). The mean children's dietary diversity score was 3.16, 3.14 and 3.09 for the Control, ACGG and ACGG+ATONU treatment arms, respectively.

**Table 35: The mean distribution of 24 hour children's dietary diversity score by treatment arms at baseline**

| Variable | N | Mean | SE | 95% CI | p-value |
|---|---|---|---|---|---|
| Overall | 1392 | 3.1272 | 0.0421 | 3.0428 - 3.2115 | |
| **Treatment arms** | | | | | 0.8159 |
| Control | 458 | 3.1550 | 0.0764 | 3.0021 - 3.3079 | |
| ACGG | 453 | 3.1391 | 0.0726 | 2.9939 - 3.2843 | |
| ACGG+ATONU | 481 | 3.0894 | 0.0683 | 2.9528 - 3.2259 | |

**Difference in difference analysis for 24-hour children's dietary diversity score**

The unadjusted model presented in Table 36 showed that the change in children's dietary diversity at endline was significantly higher in ACGG+ATONU treatment arm compared to Control treatment arm (β=0.3595, p=0.0249). However, the rate of change in dietary diversity score was not significant for ACGG treatment arm in comparison to Control treatment arm (β=0.2855, p=0.0796). No significant difference was observed between ACGG+ATONU and ACGG treatment arms (β=0.07406, p=0.6529).

**Table 36: Parameter estimates of the unadjusted linear mixed model for difference in differences analysis of 24 hour children dietary diversity score**

| Effect | Estimate(β) | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 3.155 | 0.07702 | <0.0001 |
| Time | | | <0.0001 |
| Endline | 0.8652 | 0.1119 | <0.0001 |
| Baseline | Reference | | |
| Treatments | | | |
| ACGG | -0.01595 | 0.1092 | 0.8839 |
| ACGG+ATONU | -0.06562 | 0.1076 | 0.542 |
| Control | Reference | | |
| Time*Treatment | | | 0.0601 |
| Time*ACGG | 0.2855 | 0.1628 | 0.0796 |
| Time*ACGG+ATONU | 0.3595 | 0.1602 | 0.0249 |
| | | | |
| | **D-I-D** | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs CONTROL | 0.2855 | 0.1628 | 0.0796 |
| ACGG+ATONU Vs. CONTROL | 0.3595 | 0.1602 | 0.0249 |
| ACGG+ATONU Vs. ACGG | 0.07406 | 0.1646 | 0.6529 |

The adjusted treatment effect on 24-hour children's dietary diversity score is presented in Table 37. The magnitude of the D-I-D coefficient for ACGG+ATONU versus Control treatment arms was 0.3585, and it was significant at α=0.05 (p=0.0268). This means that, the change in children's dietary diversity score from baseline to endline was significantly higher in ACGG+ATONU treatment arm than in the Control treatment arm. This suggests that participation in ACGG+ATONU treatment helped to improve children's dietary diversity. However, no significant difference was observed for ACGG treatment arm compared to Control treatment arm (β=0.2897, p= 0.0784) as well as when ACGG+ATONU was compared to ACGG treatment arm (β=0.06889, p=0.6785). Nevertheless, there was a significant difference in children's dietary diversity score across zones (p=**0.0095**). Estimated mean children's dietary diversity score was significantly lower among children from Eastern zone compared to Southern Highlands zone (β=-0.2647, p=0.0042). The Central zone had lower children's dietary diversity score (β=-0.01869, p=0.7958) but not significant. Ownership of improved chicken was not associated with children dietary diversity score (p=0.2509).

**Table 37: Parameter estimates of the adjusted linear mixed model for difference in differences analysis of 24 hour children's dietary diversity score**

| **Effect** | **Estimate(β)** | **Standard Error** | **P-Value** |
|---|---|---|---|
| Intercept | 3.1255 | 0.1037 | <0.0001 |
| **Time** | | | |
| Endline | 0.8609 | 0.1133 | <0.0001 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | -0.06884 | 0.1119 | 0.5385 |
| ACGG+ATONU | -0.1242 | 0.1103 | 0.2605 |
| Control | Reference | | |
| **Time*Treatment** | | | 0.0630 |
| Time*ACGG | 0.2897 | 0.1645 | 0.0784 |
| Time*ACGG+ATONU | 0.3585 | 0.1618 | 0.0268 |
| **Agro-ecological zone** | | | **0.0095** |
| Central | -0.01869 | 0.07222 | 0.7958 |
| Eastern | -0.2647 | 0.09233 | 0.0042 |
| Southern Highlands | Reference | | |
| **Ownership of Improved Chickens** | | | |
| Yes | 0.09285 | 0.08084 | 0.2509 |
| No | Reference | | |
| **Endline Family Wealth Index** | | | 0.1403 |
| Lowest | Reference | | |
| Second | 0.02887 | 0.1011 | 0.7752 |
| Middle | 0.1024 | 0.1026 | 0.3181 |
| Fourth | 0.2454 | 0.1041 | 0.0185 |
| Highest | 0.148 | 0.1072 | 0.1675 |
| | | | |
| | **D-I-D coefficients** | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs. CONTROL | 0.2897 | 0.1645 | 0.0784 |
| ACGG+ATONU Vs CONTROL | 0.3585 | 0.1618 | 0.0268 |
| ACGG+ATONU Vs. ACGG | 0.06889 | 0.1662 | 0.6785 |

The magnitude of the difference calculated from the least square means results indicated that: the estimated mean children's dietary diversity score increased by 0.86 (3.1824 to 4.0434) in the Control treatment arm, 1.15 (3.1136 to 4.2642) and 1.22 (3.0582 to 4.2777) in ACGG and ACGG+ATONU treatment arms, respectively. Children in ACGG and ACGG+ATONU treatment arms had their estimated mean dietary diversity increased by 0.29 and 0.36, respectively more than in children of the Control treatment arm (Table 38).

**Table 38: The Adjusted Estimated Least Square Means of the fitted Model**

| Effect | Time | Treatment | Estimate | Standard Error | P-Value |
|---|---|---|---|---|---|
| Time | Endline | | 4.1951 | 0.05587 | <0.0001 |
| Time | Baseline | | 3.1181 | 0.04957 | <0.0001 |
| Treatment | | ACGG | 3.6889 | 0.06179 | <0.0001 |
| Treatment | | ACGG+ATONU | 3.668 | 0.05999 | <0.0001 |
| Treatment | | Control | 3.6129 | 0.06451 | <0.0001 |
| Time* Treatment | Endline | ACGG | 4.2642 | 0.0914 | <0.0001 |
| Time* Treatment | Endline | ACGG+ATONU | 4.2777 | 0.08859 | <0.0001 |
| Time* Treatment | Endline | Control | 4.0434 | 0.08776 | <0.0001 |
| Time* Treatment | Baseline | ACGG | 3.1136 | 0.08021 | <0.0001 |
| Time* Treatment | Baseline | ACGG+ATONU | 3.0582 | 0.07783 | <0.0001 |
| Time* Treatment | Baseline | Control | 3.1824 | 0.0839 | <.00001 |

**Analysis of 24-hour household dietary diversity**

Table 39 displays baseline and endline 24-hour mean household dietary diversity scores (HDDS) across treatments arms, together with associated p-values of the F-test. Overall, the mean household dietary diversity score was 5.2 at baseline and 5.6 at endline. At baseline, the mean dietary diversity scores were 5.2, 5.1 and 5.3, for Control, ACGG and ACGG+ATONU treatment arms, respectively. There was no significant difference in HDDS across the treatment arms; as the 95% confidence intervals for Control, ACGG and ACGG+ATONU treatment arms seemed to overlap in each treatment arm. This was also supported by the p-value of the F-test (p=0.45), which means that there was no significant difference in 24-hour household dietary diversity score at the baseline. However, there was a significant difference in 24-hour household dietary diversity score by treatment arms at the endline (p=0.0036).

**Table 39: The Mean distribution of 24 hour household dietary diversity score by treatment arm**

| | Baseline | | | | Endline | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | N | Mean | SE | P-value | N | Mean | SE | P-Value |
| Overall | 1392 | 5.19 | 0.05 | | 1604 | 5.64 | 0.07 | |
| **Treatment arms** | | | | 0.45 | | | | 0.0036 |
| Control | 458 | 5.17 | 0.10 | | 542 | 5.35 | 0.11 | |
| ACGG | 453 | 5.11 | 0.09 | | 501 | 5.66 | 0.11 | |
| ACGG+ATONU | 481 | 5.27 | 0.08 | | 561 | 5.90 | 0.12 | |

**Difference in difference analysis for 24-hour household dietary diversity score**

Table 40 presents the results of the unadjusted linear mixed model for difference in difference analysis of 24-hour household dietary diversity score. The time and treatment interaction was significant (p=0.0347), suggesting that the change in household dietary diversity score at endline was significantly different across the treatment arms. The average change in HDDS was significantly higher in ACGG (β=0.3238, p=0.0297) and ACGG+ATONU (β=0.3402, p=0.0206) treatment arms compared to the Control treatment arm. The estimated mean dietary score increased by 0.23 in the Control treatment arm, and by 0.56 (0.2312+0.3238) and 0.57 (0.2312+0.3402) in the ACGG and ACGG+ATONU treatment arms, respectively. However, the rate of change in 24-hour household dietary diversity score between ACGG+ATONU and ACGG treatment arms was not significant (β=0.01637, p=0.9116).

**Table 40: Parameter estimates of the unadjusted linear mixed model for difference in differences analysis of 24 hour household dietary diversity score**

| Effect | Estimate(β) | Standard Error | P-Value |
|---|---|---|---|
| | | | |
| Intercept | 5.178 | 0.1018 | <0.0001 |
| Time | | | <0.0001 |
| Endline | 0.2312 | 0.1049 | 0.0275 |
| Baseline | Reference | | |
| Treatment | | | |
| ACGG | -0.06076 | 0.1441 | 0.6733 |
| ACGG+ATONU | 0.09361 | 0.1429 | 0.5124 |
| Control | Reference | | |
| Time*Treatment | | | 0.0347 |
| Time*ACGG | 0.3238 | 0.1489 | 0.0297 |
| Time*ACGG+ATONU | 0.3402 | 0.1468 | 0.0206 |
| | | | |
| | **D-I-D** | | |
| Label | Estimate | Standard Error | P-Value |
| ACGG Vs CONTROL | 0.3238 | 0.1489 | 0.0297 |
| ACGG+ATONU Vs CONTROL | 0.3402 | 0.1468 | 0.0206 |
| ACGG+ATONU Vs ACGG | 0.01637 | 0.1474 | 0.9116 |

The adjusted repeated measures of regression model summarized in Table 41 shows that the change in HDDS from baseline to endline was significantly different across the treatment arms (p=**0.0346**). The change in HDDS was significantly higher among households in ACGG (β=0.3273, p=0.0296) and ACGG+ATONU (β=0.3438, p=0.0205) treatment arms compared to households in the Control treatment arm. No significant difference was observed between ACGG+ATONU and ACGG (β=0.01651, p=0.9117). The analysis was adjusted for zone, ownership of improved chicken at endline and family wealth index at endline. In addition, the change in dietary diversity was significantly associated with zones (p=**0.0017**), ownership of improved chickens (p=0.0289) and family wealth index (p**<0.0001)**. The estimated mean HDDS was significantly lower among households from Central (β=-0.2193, p=0.016) and Eastern zone (β =-0.3792, p=0.0006) than those in Southern Highlands zone. The estimated mean HDDS was significantly higher among households with improved chickens than that with no improved chickens (β=0.1501, p=0.0289). With respect to family wealth index, it was observed that household with Middle (β=0.4433, p<0.0001), fourth (β=0.4709, p<0.0001) and highest wealth index (β=0.6942, p<0.0001) had significantly higher estimated mean HDDS as compared to those households with lowest wealth index.

**Table 41: Parameter estimates of the adjusted linear mixed model for difference in difference analysis of 24 hour household dietary diversity score**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 5.0526 | 0.1213 | <0.0001 |
| **Time** | | | |
| Endline | 0.2328 | 0.1059 | 0.028 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | -0.2176 | 0.1407 | 0.1222 |
| ACGG+ATONU | -0.04514 | 0.1393 | 0.7459 |
| Control | Reference | | |
| **Time*Treatment** | | | **0.0346** |
| Time*ACGG | 0.3273 | 0.1504 | 0.0296 |
| Time*ACGG+ATONU | 0.3438 | 0.1483 | 0.0205 |
| **Zone** | | | **0.0017** |
| Central | -0.2193 | 0.09101 | 0.016 |

| | | | |
|---|---|---|---|
| Eastern | -0.3792 | 0.1111 | 0.0006 |
| Southern Highlands | Reference | | |
| **Own Improved Chickens at endline** | | | |
| Yes | 0.1501 | 0.06864 | 0.0289 |
| No | Reference | | |
| **Endline Family Wealth Index** | | | **<0.0001** |
| Lowest | Reference | | |
| Second | 0.1347 | 0.09006 | 0.1349 |
| Middle | 0.4433 | 0.0911 | <0.0001 |
| Fourth | 0.4709 | 0.09216 | <0.0001 |
| Highest | 0.6942 | 0.09468 | <0.0001 |
| | | | |
| | **D-I-D Coefficients** | | |
| Effect | Estimate | Standard Error | P-Value |
| ACGG Vs CONTROL | 0.3273 | 0.1504 | 0.0296 |
| ACGG+ATONU Vs CONTROL | 0.3438 | 0.1483 | 0.0205 |
| ACGG+ATONU Vs ACGG | 0.01651 | 0.1489 | 0.9117 |

Based on the estimated least square means presented in Table 42, the HDDS in the Control treatment arm increased by 0.23 (5.2768 to 5.5096), and that in ACGG and ACGG+ATONU treatment arms increased by 0.56 (5.0592 to 5.6193) and 0.57 (from 5.2316 to 5.8082), respectively.

**Table 42: The adjusted estimated least square means of 24-hour household dietary diversity**

| Effect | Time | Treatment | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Time | Endline | | 5.6457 | 0.05059 | 2793 | 111.6 | <0.0001 |
| Time | Baseline | | 5.1892 | 0.06046 | 2793 | 85.83 | <0.0001 |
| Treatment | | ACGG | 5.3392 | 0.07517 | 2793 | 71.03 | <0.0001 |
| Treatment | | ACGG+ATONU | 5.5199 | 0.07397 | 2793 | 74.62 | <0.0001 |
| Treatment | | Control | 5.3932 | 0.07773 | 2793 | 69.38 | <0.0001 |
| Time* Treatment | Endline | ACGG | 5.6193 | 0.08257 | 2793 | 68.05 | <0.0001 |
| Time* Treatment | Endline | ACGG+ATONU | 5.8082 | 0.08128 | 2793 | 71.46 | <0.0001 |
| Time* Treatment | Endline | Control | 5.5096 | 0.08462 | 2793 | 65.11 | <0.0001 |
| Time* Treatment | Baseline | ACGG | 5.0592 | 0.1009 | 2793 | 50.14 | <0.0001 |
| Time* Treatment | Baseline | ACGG+ATONU | 5.2316 | 0.09863 | 2793 | 53.04 | <0.0001 |
| Time* Treatment | Baseline | Control | 5.2768 | 0.1026 | 2793 | 51.42 | <0.0001 |

**Endline minimum dietary diversity for women**

Minimum dietary diversity for women (MDDW) was assessed using two methods, (1) 24-hour dietary recall, and (2) food frequency questionnaires (FFQ) administered to participating women. In the 24-hour recall method, women recalled all foods consumed in the last 24 hours prior to the survey day; and in the FFQ method, women were asked to recall how frequently they consumed foods in the last 7 days from a provided list of common foods. The reported foods were converted to food groups based on the ten food groups as recommended by Food and Agriculture Organization (FAO & FHI 360, 2016) on Minimum Dietary Diversity for Women (MDD-W) index. The ten food groups include (1) Grains, white roots and tubers, and plantains; 2. Pulses (beans, peas and lentils); 3. Nuts and seeds; 4. Dairy; 5. Meat, poultry and fish; 6. Eggs; 7. Dark green leafy vegetables; 8. Other vitamin A-rich fruits and vegetables; 9. Other vegetables and 10. Other fruits. A women's dietary diversity score (DDS) was computed as the sum of food groups consumed out of the 10 possible food groups. In this study, dietary diversity for women was not determined at baseline survey, so the results are presented for the endline survey only.

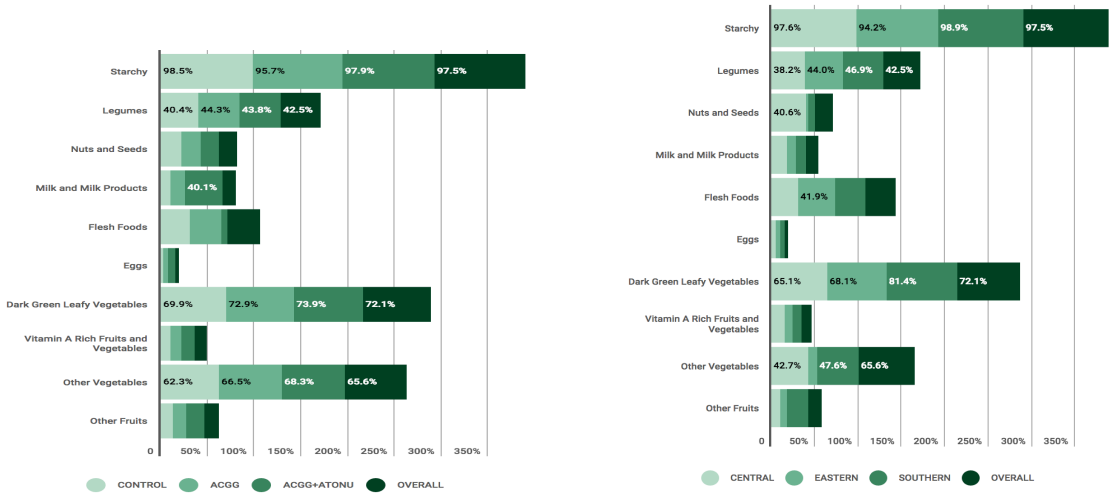
**24-hour dietary diversity score for women**

Table 43 presents the distribution of dietary diversity scores across treatment arms, zone and nutrition knowledge when diets were measured by 24-hour dietary recall method. Overall, mean dietary diversity score for women was 3.8 (95% CI: [3.7 to 3.8]). The mean women dietary diversity score for ACGG + ATONU treatment arm was 3.97 (95% CI: [3.85, 4.10]), 3.75 (95% CI: [3.62, 3.88]) for ACGG treatment arm and 3.59 (95% CI: [3.49, 3.69]) for the Control treatment arm. The ACGG + ATONU treatment arm had a higher mean DDS compared to the other two treatment arms. The mean WDDS was highest in the Southern Highlands zone (3.92) (95% CI: [3.82, 4.01]), followed by the Central zone (3.89) (95% CI: [3.78, 4.00]) and lastly by the Eastern zone (3.15) (95% CI: [2.99, 3.32]). Women in the higher wealth index quintile had the highest mean DDS of 4.04 (95% CI: [3.85, 4.2]), followed by middle Wealth Index quintile, which had a mean DDS of 3.91 (95% CI: [3.23, 3.46]). Nutritional knowledge index was also linked to mean DDS for women at endline. The highest nutrition knowledge index quintile also recorded the highest mean DDS of 4.06 (95% CI: [3.86, 4.25]), followed by middle and fourth nutrition knowledge index.

**Table 43: The mean distribution of 24 hour women dietary diversity score by treatment arms zones and nutrition knowledge index: endline**

| Variable | N | Mean | SE | 95% CI | |
|---|---|---|---|---|---|
| | | | | Lower boundary | Upper boundary |
| Overall | 1604 | 3.7638 | 0.0349 | 3.6953 | 3.8324 |
| **Treatment arms** | | | | | |
| Control | 475 | 3.5873 | 0.0515 | 3.4864 | 3.6883 |
| ACGG | 399 | 3.7494 | 0.658 | 3.6203 | 3.8785 |
| ACGG+ATONU | 426 | 3.9742 | 0.0639 | 3.8488 | 4.0996 |
| **Agro-ecological zone** | | | | | |
| Central | 535 | 3.8897 | 0.0569 | 3.7782 | 4.0013 |
| Eastern | 241 | 3.1535 | 0.0824 | 2.9920 | 3.3150 |
| Southern Highlands | 524 | 3.9160 | 0.0480 | 3.8219 | 4.0102 |
| **Family Wealth Index** | | | | | |
| Lowest | 286 | 3.3432 | 0.0583 | 3.2288 | 3.4578 |
| Second | 258 | 3.7248 | 0.0668 | 3.5936 | 3.8560 |
| Middle | 267 | 3.9139 | 0.0722 | 3.7723 | 4.0554 |
| Fourth | 257 | 3.8171 | 0.0841 | 3.6522 | 3.9820 |
| Highest | 250 | 4.0400 | 0.0986 | 3.84651 | 4.2335 |
| **Nutrition Knowledge Index** | | | | | |
| Lowest | 452 | 3.6770 | 0.0562 | 3.5667 | 3.7872 |
| Second | 145 | 3.6207 | 0.1005 | 3.4236 | 3.8178 |
| Middle | 202 | 3.7525 | 0.0834 | 3.5889 | 3.9161 |
| Fourth | 289 | 3.7647 | 0.0742 | 3.6191 | 3.9103 |
| Highest | 212 | 4.0566 | 0.0984 | 3.8635 | 4.2497 |

At endline, the most consumed food groups in the previous 24 hour among surveyed women were starchy foods (98%), dark green vegetables (72%), other vegetables (66%), and legumes (43%) (Figure 39).




**Endline (treatment arms)** **Endline (zones)**

**Figure 39: Food groups consumed by women in the last 24 hour across treatment arms and zones at endline**

**Linear mixed model for 24-hour women dietary diversity score at endline**

The results of the fitted linear mixed model for 24-hour women's dietary diversity score (WDDS) are presented in Table 44. Analysis was adjusted for zone, ownership of improved chicken at endline and endline family wealth index. The results of the adjusted model showed that 24-hour women dietary diversity score was significantly higher among subjects in ACGG+ATONU (β=0.2448, p=0.0279) treatment arms than in the Control treatment arm. There was no significant differences in WDDS between ACGG+ATONU and ACGG (β=0.1237, p=0.2536). Likewise , no significant difference was observed among women in ACGG and control arms(β =0.1211, p=0.2759) .Women in the Eastern zone had a lower estimated mean WDDS compared to that of women in the Southern Highlands zone (β=-0.8078, p<0.0001).

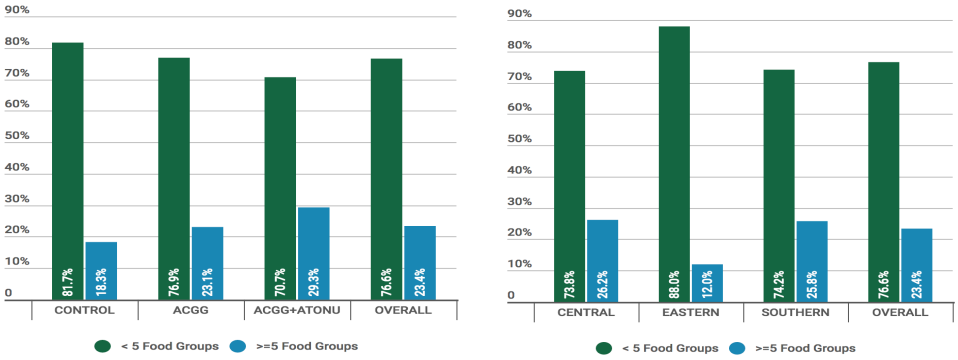
**Table 44: Parameter estimates of the linear mixed model for 24 hour women dietary diversity score at endline**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 3.4621 | 0.1035 | <0.0001 |
| **Treatment arms** | | | |
| ACGG Vs Control | 0.1211 | 0.1111 | 0.2759 |
| ACGG+ATONU Vs Control | 0.2448 | 0.1112 | 0.0279 |
| ACGG+ATONU Vs ACGG | 0.1237 | 0.1083 | 0.2536 |
| **Agro-ecological zone** | | | |
| Central | -0.07749 | 0.09804 | 0.4294 |
| Eastern | -0.8078 | 0.123 | <0.0001 |
| Southern Highlands | Reference | | |
| **Own Improved Chickens endline** | | | |
| Yes | 0.02521 | 0.0856 | 0.7684 |
| No | Reference | | |
| **Endline Family Wealth Index** | | | <0.0001 |
| Lowest | Reference | | |
| Second | 0.3261 | 0.1056 | 0.0021 |
| Middle | 0.464 | 0.1062 | <0.0001 |
| Fourth | 0.3778 | 0.1096 | 0.0006 |
| Highest | 0.6425 | 0.1136 | <0.0001 |

**Minimum dietary diversity for women**

The Minimum Dietary Diversity for Women (MDD-W) is a dichotomous indicator of dietary diversity score for women. A woman aged 15-49 years is able to meet minimum dietary diversity criteria if she consumes at least five out of ten food groups in the previous 24 hour. The proportion of women 15–49 years of age who reach this minimum in a population is used as a proxy indicator for higher micronutrient adequacy, one important dimension of diet quality (FAO and FHI 360, 2016). The proportion of women who met the MDD-W by treatment arms and zone is shown in Figure 40.

Overall, 23.4% of the women met the criteria of MDD-W with significant difference across the treatment arms (chi square= 15.3, p= 0.0202). For example, in Control treatment arm only 18.3% of the women met the MDD-W criteria compared to 23.1% of the women in ACGG and 29.3% in ACGG+ATONU treatment arms. The MDD-W was also significantly different across zones (Chi square = 21.3, p= 0.0014), in which 26.2% of the women from Central zone met the MDD-W criteria compared to 12% and 25.8% of the women from Eastern and Southern Highlands zone, respectively (Figure 40).




**Endline (treatment arms)** **Endline (zones)**

**Figure 40: Minimum dietary diversity among women by treatment arms and zones**

**Generalized Estimating Equation (GEE) for the effect of the treatment on MDD-W**

The GEE was used to assess the association between the treatment and Minimum Dietary Diversity among women, while accounting for clustering of the villages. The analysis was adjusted for zone, ownership of improved chicken and endline family wealth index. The results of the fitted GEE presented in Table 45 revealed that intervention was not associated with likelihood of attaining minimum dietary diversity (p= 0.3467). However factors associated with minimum dietary diversity score were zone (p=0.0227) and family wealth index (p <.0001) Women from Eastern zone were significantly less likely to meet minimum dietary diversity criteria compared to women from Southern Highlands zone (AOR=0.36, p=0.0003). Women from the Central zone had lower adjusted Odds ratio of attaining minimum dietary diversity score than women from the Southern Highlands zone (AOR=0.90, p=0.5527), but the difference was not significant.

**Table 45: The results of the GEE for the effect of the intervention on MDD-W**

| **Variable** | **Adjusted Analysis** | | |
|---|---|---|---|
| | **AOR** | **SE** | **P-value** |
| **Treatment arms** | | | 0.3467 |
| ACGG Vs Control | 1.11 | 0.2295 | 0.6100 |
| ACGG+ATONU Vs Control | 1.42 | 0.3292 | 0.1265 |
| ACGG+ATONU Vs ACGG | 1.28 | 0.2700 | 0.2394 |
| **Agro-ecological zone** | | | |
| Central | 0.90 | 0.1562 | 0.5527 |
| Eastern | 0.36 | 0.1028 | 0.0003 |
| Southern Highlands | Reference | | |
| **Own Improved Chickens endline** | | | |
| Yes | 0.93 | 0.1361 | 0.6183 |
| No | Reference | | |
| **Endline Family Wealth Index** | | | <0.0001 |
| Lowest | Reference | | |
| Second | 2.29 | 0.5760 | 0.0010 |
| Middle | 2.96 | 0.8057 | <0.0001 |
| Fourth | 2.71 | 0.755 | 0.0004 |
| Highest | 5.32 | 1.3969 | <0.0001 |

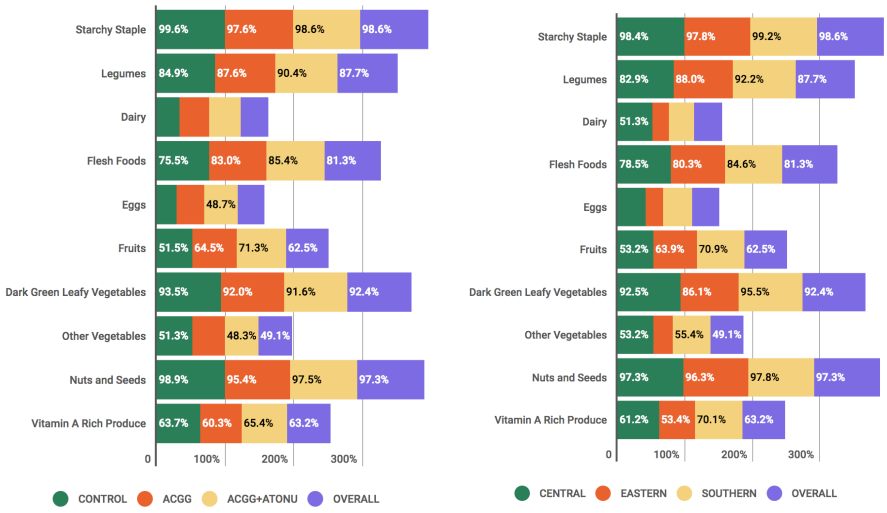
**Women dietary diversity score by 7-day dietary recall**

Table 46 provides the mean women dietary diversity score (WDDS) by the 7-day recall method. When diets were measured using 7-day dietary recall approach, the overall 7-day the mean dietary diversity score (DDS) was 7.1 (95% CI: [6.94 to 7.29]. The score was higher than the DDS measured using 24-hour dietary recall method (mean=3.8). The mean scores in the treatment arms were 7.4 (95% CI: [7.14, 7.70]) for ACGG + ATONU, 7.1 (95% CI: [6.86, 7.38]) for ACGG and 6.8 (95% CI: [6.49, 7.11]) for the Control treatment arm. The highest mean DDS for women was observed in the Southern Highlands zone, 7.4 (95% CI: [7.20, 7.73]) followed by the Central zone, 7.1 (95% CI: [6.89, 7.32]) and Eastern zone 6.5 (95% CI: [6.11, 6.79]). The mean 7-day DDS by household wealth index indicated that the highest wealth index quintile had the highest mean DDS of 7.7 (95% CI: [7.44, 7.98]) and the lowest wealth index quintile had the lowest mean DDS of 6.3 (95% CI: 6.04, 6.54). Similarly, mean DDS score among was similar for those with second (7.3155), fourth (7.1736) and highest (7.3187)

**Table 46: The mean distribution of 7-day women dietary diversity score by treatment arms and other selected household characteristics at endline**

| Variable | N | Mean | SE | 95% CI | |
|---|---|---|---|---|---|
| | | | | Lower boundary | Upper boundary |
| Overall | 1604 | 7.1178 | 0.0902 | 6.9374 | 7.2983 |
| **Treatment arms** | | | | | |
| Control | 542 | 6.8007 | 0.1561 | 6.4883 | 7.1131 |
| ACGG | 501 | 7.1218 | 0.1298 | 6.8620 | 7.3815 |
| ACGG+ATONU | 561 | 7.4207 | 0.1396 | 7.1413 | 7.7000 |
| **Agro-ecological zone** | | | | | |
| Central | 637 | 7.1068 | 0.1053 | 6.8960 | 7.3175 |
| Eastern | 324 | 6.4506 | 0.1712 | 6.1079 | 6.7933 |
| Southern Highlands | 643 | 7.4650 | 0.1304 | 7.2039 | 7.7260 |
| **Family Wealth Index** | | | | | |
| Lowest | 320 | 6.2875 | 0.1247 | 6.0379 | 6.5371 |
| Second | 321 | 6.9034 | 0.1289 | 6.6455 | 7.1614 |
| Middle | 321 | 7.2617 | 0.1176 | 7.0263 | 7.4970 |
| Fourth | 321 | 7.4206 | 0.1041 | 7.2123 | 7.6289 |
| Highest | 321 | 7.7134 | 0.1342 | 7.4449 | 7.9819 |
| **Nutrition Knowledge Index** | | | | | |
| Lowest | 555 | 6.9892 | 0.1191 | 6.7510 | 7.2274 |
| Second | 168 | 7.3155 | 0.1934 | 6.9285 | 7.7025 |
| Middle | 245 | 6.9673 | 0.1276 | 6.7121 | 7.2226 |
| Fourth | 363 | 7.1736 | 0.1146 | 6.9442 | 7.4029 |
| Highest | 273 | 7.3187 | 0.1019 | 7.1148 | 7.5226 |

The types of food groups consumed by of women over a period of 7 days (7-day recall) across treatment arms and zones were starchy food group, which was consumed by 99% of women, nuts and seeds by 97% and legumes by 88% (Figure 41). However, the types of food groups consumed by women in the Control treatment arm were not very different from that reported in the other treatment arms. However, eggs were consumed by almost 49% of women respondents in the ACCG+ATONU treatment arm (Figure 41).




**Endline (treatment arms)** **Endline (zones)**

**Figure 41: Food groups consumed by women (7-day recall) across treatment arms and zones at endline**

**Linear mixed model for 7-day women's dietary diversity score at endline**

Table 47 provides parameter estimates of the linear mixed model for the effect of treatment on 7-day women's dietary diversity. The analysis was adjusted for zone endline family wealth index and ownership of improved chicken at endline. 7 days women's dietary diversity score was not associated with treatment (p= 0.1235). A significant difference in 7-day women's dietary diversity score was observed across zones (p<0.0001). Women in the Central (β=-0.4602, p=0.0007) and Eastern zones (β= -1.094, p<0.0001) had significantly lower average dietary diversity compared to women in the Southern Highlands zone. Moreover,7 days women dietary diversity score was gradually increased with family wealth index.

**Table 47: Parameter estimates of the linear mixed model for 7-day women's dietary diversity score at endline**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 6.6626 | 0.1444 | <0.0001 |
| **Treatment arms** | | | 0.1235 |
| ACGG Vs. Control | -0.01501 | 0.1516 | 0.9211 |
| ACGG+ATONU Vs. Control | 0.2484 | 0.1499 | 0.0977 |
| ACGG+ATONU vs. ACGG | 0.2635 | 0.1435 | 0.0666 |
| **Agro-ecological zone** | | | <0.0001 |
| Central | -0.4602 | 0.1359 | 0.0007 |
| Eastern | -1.094 | 0.1657 | <0.0001 |
| Southern Highlands | Reference | | |
| **Own improved chicken at endline** | | | |
| Yes | 0.1999 | 0.1052 | 0.0576 |
| No | Reference | | |
| **Family Wealth Index** | | | <0.0001 |
| Lowest | Reference | | |
| Second | 0.5004 | 0.1316 | 0.0001 |
| Middle | 0.7967 | 0.1331 | <0.0001 |
| Fourth | 0.9884 | 0.1357 | <0.0001 |
| Highest | 1.3371 | 0.1405 | <0.0001 |

### 3.14 General nutrition knowledge

In this survey, the nutrition knowledge was measured using four questions, namely meaning of nutrition, meaning of malnutrition, causes of malnutrition and ways to eradicate malnutrition. The question on meaning of nutrition consisted of seven possible answers of which four were correct answers. Meaning of malnutrition question consisted of three correct answers out of five responses. Likewise, causes of malnutrition had eight responses of which seven were correct. Regarding

the ways to eradicate malnutrition, there were ten correct answers out of twelve. Each correct answer was allocated a score of 1 and a wrong answer a score of 0. Scores from the four questions were summed up to a maximum score of 24, indicating the highest level of general nutrition knowledge, which was then classified into the following three knowledge quintiles: Low, middle and high levels. The mean general nutrition knowledge score at baseline was 2.4 (SE: 0.06) and at endline it was 2.7 (SE: 0.11). The mean general nutrition knowledge score at baseline did not vary significantly with treatment arms (p=0.3911). It was 2.3 for the Control, 2.5 for ACGG and 2.4 for ACGG+ATONU treatment arms. However, the mean general nutrition knowledge score at endline showed significant variation across treatment arms (p<0.0001) and it was 2.1, 3.0 and, 3.1 for Control, ACGG and ACGG+ATONU treatment arms, respectively (Table 48).

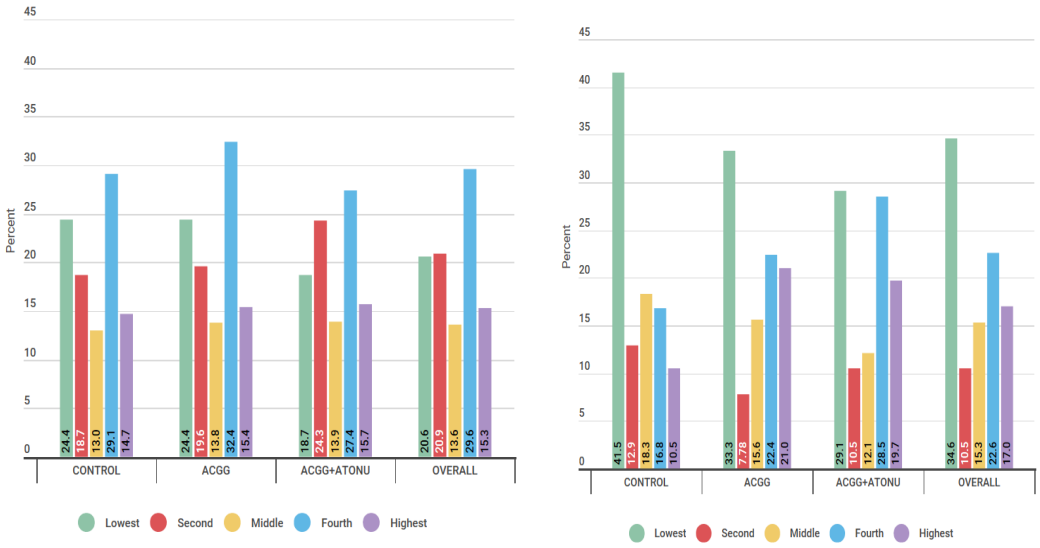
Similarly, zones showed slight improvement in the mean nutritional knowledge scores between baseline and endline. The mean nutritional knowledge score changed from 2.5 at baseline to 2.7 at endline for the Central zone; 2.2 at baseline and 3.4 at endline for the Eastern zone. Nevertheless, there was no difference in average nutrition knowledge in the Southern Highlands zone between baseline (2.5) and endline (2.5) (Table 48).

**Table 48: Mean distribution of general nutrition knowledge by treatment arms and zones at baseline and endline**

| | Baseline | | | | Endline | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **n** | **Mean** | **SE** | **p-Value** | **N** | **Mean** | **SE** | **p-Value** |
| | | | | | | | | |
| Overall | 1473 | 2.4 | 0.06 | | 1604 | 2.74 | 0.11 | |
| **Treatment arms** | | | | 0.3911 | | | | <0.0001 |
| Control | 491 | 2.3 | 0.11 | | 542 | 2.07 | 0.12 | |
| ACGG | 479 | 2.5 | 0.09 | | 501 | 3.04 | 0.17 | |
| ACGG+ATONU | 503 | 2.4 | 0.1 | | 561 | 3.12 | 0.16 | |
| **Zone** | | | | 0.2947 | | | | 0.0011 |
| Central | 595 | 2.5 | 0.1 | | 637 | 2.67 | 0.17 | |
| Eastern | 309 | 2.2 | 0.13 | | 324 | 3.44 | 0.24 | |
| Southern Highlands | 569 | 2.5 | 0.07 | | 643 | 2.46 | 0.11 | |

**Nutrition knowledge quintiles**

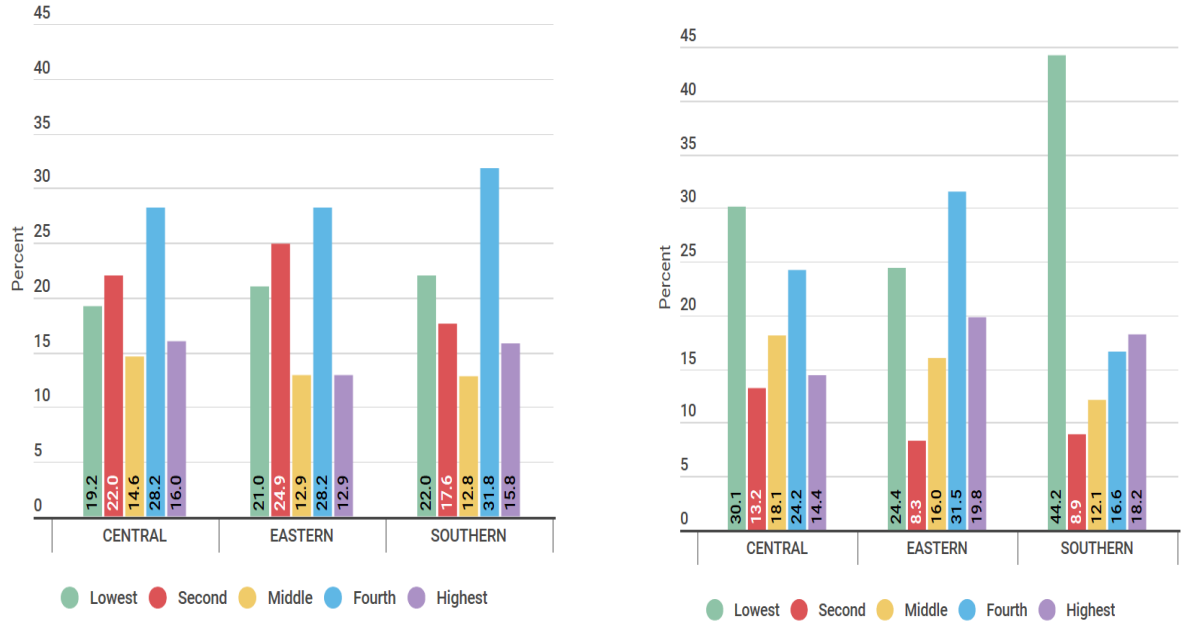
The proportion of respondents who were in the highest nutrition knowledge quintile increased from 15.3% at baseline to 17% at endline (Figure 42). This was an increase of 2 percentage points. The ACGG only treatment arm showed the highest (6%) increase in the proportion of respondents who were in the highest nutrition knowledge quintile from 15.4% at baseline to 21.0% at endline. The ACGG +ATONU treatment arm showed an increase of 4% from 15.7% at baseline to 19.7% at endline. For the Control treatment arm, the proportion of respondents in the highest nutrition knowledge quintile decreased slightly from 14.7% at baseline to 10.5% at endline.




**Baseline** **Endline**

**Figure 42: Nutritional knowledge index quintiles across treatment arms at baseline and endline**

At endline, 19.8% of the respondents in the Eastern zone were in the highest nutrition knowledge quintile. This was an increase of 7% from baseline (12.9%). Other zones showed a small magnitude of increase in the proportion of respondents in the highest nutritional knowledge quintile. In the Central zone, it was 2% and for the Southern Highlands zone it was 2% (Figure 43).




**Baseline** **Endline**

**Figure 43: Nutritional knowledge index quintiles across zones at baseline and endline**

**Difference-in-difference analysis for general nutrition knowledge score**

Table 49 presents the results of the fitted unadjusted linear mixed model. The rate of change in nutrition knowledge at endline for respondents in the ACGG treatment arm was significantly higher than that of subjects in the Control treatment arm (β=0.4475, p=0.0407). However, the change in nutrition knowledge at baseline and endline was not significant for respondents in ACGG+ATONU treatment arm compared to respondents in Control (β=0.3850, p=0.0747) treatment arms. Likewise, there was no significant difference in the ACGG+ATONU treatment arm compared to ACGG treatment arm (β=-0.06247, p=0.7737).

**Table 49: Parameter estimates of the unadjusted linear mixed model for difference in differences general nutrition knowledge**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| Intercept | 2.3131 | 0.1136 | <0.0001 |
| Time | | | 0.0022 |
| Endline | 0.02851 | 0.1536 | 0.8527 |
| Baseline | Reference | | |
| Treatment | | | |
| ACGG | 0.1963 | 0.1616 | 0.2246 |
| ACGG+ATONU | 0.1154 | 0.1598 | 0.4703 |
| Control | Reference | | |
| Time*Treatment | | | 0.088 |
| Time*ACGG | 0.4475 | 0.2188 | 0.0407 |
| Time*ACGG+ATONU | 0.385 | 0.2159 | 0.0747 |
| | D-I-D | | |
| Label | | | |
| ACGG Vs. CONTROL | 0.4475 | 0.2188 | 0.0407 |
| ACGG+ATONU Vs. CONTROL | 0.385 | 0.2159 | 0.0747 |
| ACGG+ATONU Vs. ACGG | -0.06247 | 0.2173 | 0.7737 |

The results of the analysis of the adjusted model are presented in Table 50. The average nutrition knowledge was significantly higher among respondents from Eastern zone compared to those from Southern Highlands zone (β =0.3681, p=0.0030). However, no significant difference was observed between Central zone and Southern Highlands zone (β=0.1257, p=0.2212).

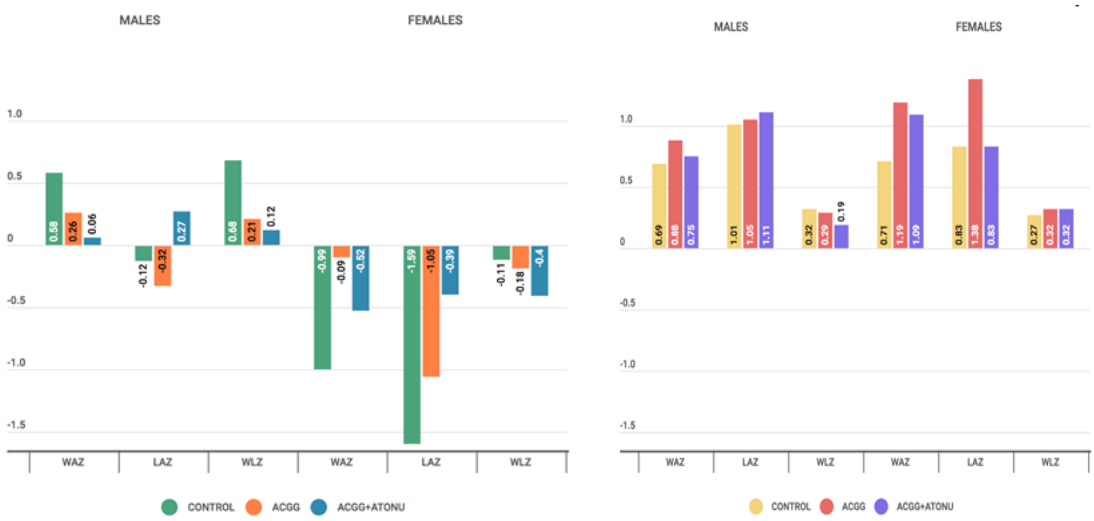
**Table 50: Parameter estimates of the adjusted linear mixed model for difference in differences general nutrition knowledge**

| Effect | Estimate | Standard Error | P-Value |
|---|---|---|---|
| **Intercept** | 2.1877 | 0.1240 | <0.0001 |
| **Time** | | | |
| Endline | 0.02851 | 0.1536 | 0.8527 |
| Baseline | Reference | | |
| **Treatment** | | | |
| ACGG | 0.1918 | 0.1569 | 0.2216 |
| ACGG+ATONU | 0.1136 | 0.1550 | 0.4636 |
| Control | | | |
| **Time*Treatment** | | | 0.0839 |
| Time*ACGG | 0.4475 | 0.2186 | 0.0407 |
| Time*ACGG+ATONU | 0.3850 | 0.2159 | 0.0747 |
| **Agro-ecological zone** | | | |
| Central | 0.1257 | 0.1027 | 0.2212 |
| Eastern | 0.3681 | 0.1240 | 0.0030 |
| Southern Highlands | Reference | | |
| | | | |
| | | D-I-D | |
| Label | | | |
| ACGG Vs CONTROL | 0.4475 | 0.2186 | 0.0407 |
| ACGG+ATONU Vs CONTROL | 0.3850 | 0.2159 | 0.0747 |
| ACGG+ATONU Vs ACGG | -0.06247 | 0.2173 | 0.7737 |

### 3.15 Nutritional Status of Children

**Age 0 – 2 years**

The Z scores for children below two years of age for male and female children improved at endline, whereby mean Z-scores were positive for all indicators and in all treatment arms (Figure 44). Mean LAZ scores for female children at the endline improved in all treatment arms from -1.59 to 1.19. At baseline, mean LAZ for male children below 2 years of age was -0.12 and -0.32 for Control and ACGG treatment arms, respectively and +0.27 for ACGG+ATONU treatment arm. At endline, mean LAZ scores for male children changed to 1.0 and 1.11 for the Control, ACGG and ACGG+ATONU treatment arms. At baseline, mean WLZ for male children was positive in all treatment arms and the mean WLZ for all female children in all treatment arms was negative. Mean WLZ in male children in the Control treatment arm decreased from 0.68 at baseline to 0.32 at endline, indicating deterioration in nutritional status. In the ACGG and ACGG + ATONU treatment arms, mean WLZ scores at endline were positive. Changes in WLZ were higher among female children than male children (Figure 44).

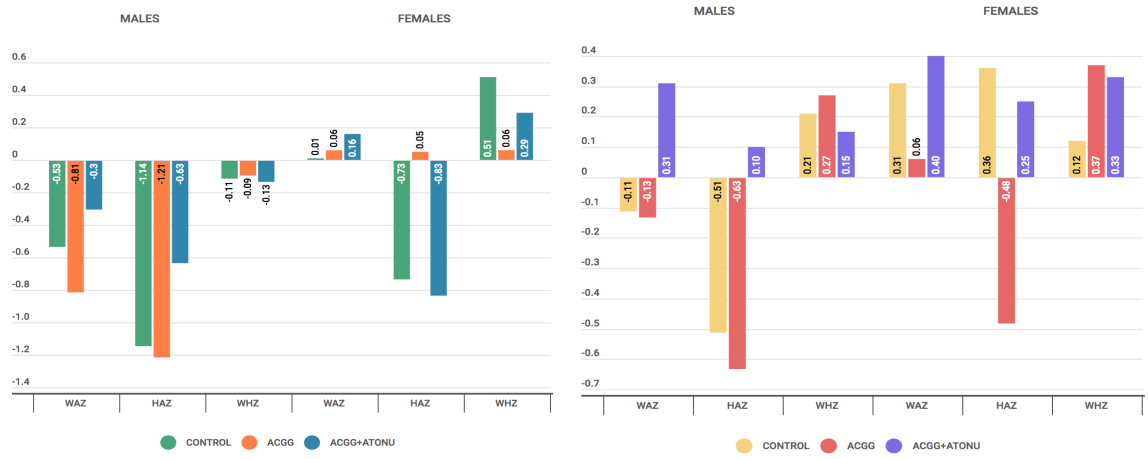



**Baseline** **Endline**

**Figure 44: Mean WAZ, HLZ, WLZ scores for children 0 – 2 years at baseline and Endline**

**Age 2-3 years**

At baseline mean WAZ scores for boys in the ACGG and ACGG+ATONU treatment arms was -0.81 and -0.3 respectively. At endline, there was a high improvement in the mean WAZ scores. The mean WAZ for boys was -0.13 and 0.31 in the ACGG and ACGG+ATONU treatment arms. Mean HAZ scores for male children improved in all treatment arms and were all positive. At endline, mean HAZ scores for female children in the Control and ACGG +ATONU treatment arms were better than in the ACGG treatment arm, whereby the mean HAZ score remained negative (Figure 45).

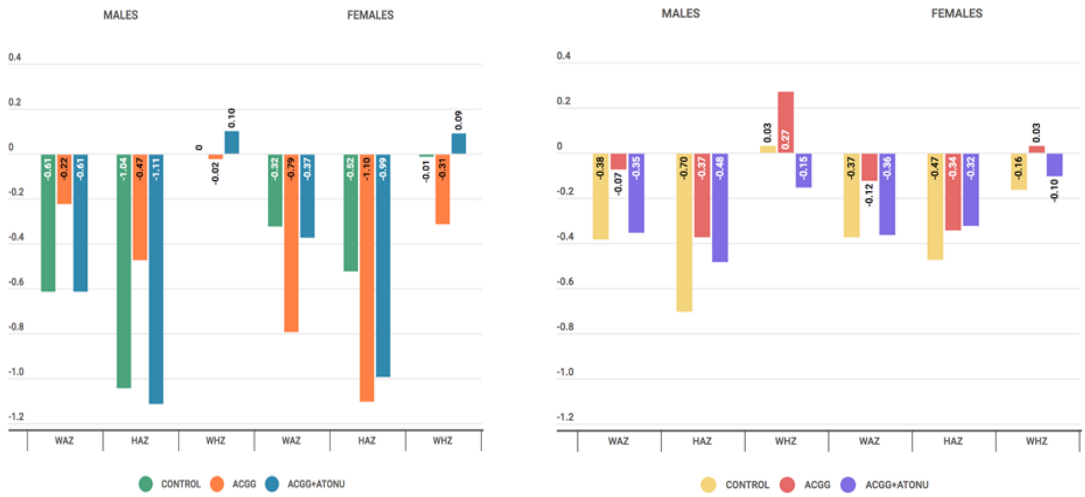



**Baseline** **Endline**

**Figure 45: Mean weight for age, height for age and weight for height z scores across gender for children 2 < 3 at baseline and endline**

**Children 3 to 4 years**

Mean weight for age z-scores (WAZ) were negative for all treatment arms and for both genders at baseline and endline (Figure 46). In the ACGG+ATONU treatment arm, mean WAZ scores for male children changed from -0.61 to -0.37. For female children, positive changes were noted in the ACGG treatment arm (-0.79 to -0.12). Mean HAZ scores were negative for all treatment arms in male and female children. However, there were some positive changes at endline compared to baseline (Figure 46). Mean WAZ was negative for male children at baseline and notable improvement was observed in ACGG treatment arm (-0.02 in baseline to 0.27 at endline). There was a negative change for ACGG+ATONU (0.1 at baseline vs. -0.15 at endline). A similar trend occurred among female children, where by those in the ACGG treatment arm improved from -0.31 at baseline to -0.03 at endline, with no change for the ACGG+ATONU treatment arm.




**Baseline** **Endline**

**Figure 46: Mean weight for age, height for age, weight for height and BMI for age z scores across gender for children 3 – 4 for baseline and endline**

### 3.16 Nutritional status of adults

Nutritional status of adults was assessed using body mass index (BMI). Table 51 presents results of the BMI of adults aged 20 years and above. At baseline, the prevalence of underweight among males was 3.4% and at endline 5.8%; a slight increase in the prevalence of underweight between the two survey periods. The prevalence of underweight was not statistically different among males in ACGG+ATONU (4%), Control (3.2%) and ACGG (3%) treatment arms at baseline (p=0.9324). The prevalence of underweight among females was 2.9%. The ACGG treatment arm had a higher (4.4%) prevalence of underweight among women than in the Control (3%) and ACGG+ATONU (1%) treatment arms. However, the differences were not statistically significant (p=0.063). The prevalence of overweight among males was 17.4% at baseline and 25% at endline and that of females was 28% at baseline and endline. In the ACGG + ATONU treatment arm, the prevalence of overweight among females was 30% at baseline and 28% at endline. This was slightly higher than in other treatment arms ACGG (27%) and Control (26.6%). At the endline, the prevalence of overweight among women was higher in the ACGG treatment arm (29.5%) compared to Control (28.6%) and ACGG + ATONU (27.6%) treatment arms. The difference was not statistically significant (p=1414). The prevalence of obesity was also high among adults, especially among females than males (Table 51). However, the prevalence was higher at baseline than at endline. In addition, males showed significant difference in prevalence of nutritional status among treatment arms at endline (p=0.0436).

**Table 51: Nutritional status (BMI) of adults age above20 years**

| **Baseline** | **Males** | | | | **Females** | | | |
|---|---|---|---|---|---|---|---|---|
| **BMI status (kg/m$^2$)** | **Control N=373** | **ACGG N=366** | **ACGG+ ATONU N=354** | **P-value** | **Control N=308** | **ACGG N=308** | **ACGG+ ATONU N=318** | **P-value** |
| | % | % | % | **0.9324** | % | % | % | **0.063** |
| Underweight | 3.2 | 3.0 | 4.0 | | 3.3 | 4.4 | 1.0 | |
| Normal weight | 54.4 | 57.1 | 57.6 | | 55.8 | 57.6 | 58.8 | |
| Overweight | 26.8 | 23 | 24.9 | | 26.6 | 27.4 | 29.9 | |
| Class 1 obesity | 10.7 | 11.8 | 9.6 | | 10.1 | 8.5 | 6.8 | |
| Class 2 obesity | 3.8 | 4.1 | 2.8 | | 2.3 | 1.6 | 3.3 | |
| Class 3 obesity | 1.1 | 1.1 | 1.1 | | 2.0 | 0.6 | 0.3 | |
| **Endline** | **Males** | | | | **Females** | | | |
| | **Control** | **ATON** | **ACGG+** | **p-value** | **Control** | **ATONU** | **ACGG+** | **p-** |

| | N=269 | U N=293 | ATONU N=309 | | N=546 | N=492 | ATONU N=568 | values |
|---|---|---|---|---|---|---|---|---|
| | % | % | % | | % | % | % | |
| Underweight | 6.3 | 4.4 | 6.8 | | 4.6 | 3.3 | 5.3 | |
| Normal weight | 73.6 | 66.6 | 75.7 | | 55.3 | 50.2 | 48.1 | |
| Overweight | 16.7 | 22.2 | 13.3 | **0.0436** | 28.6 | 29.3 | 27.6 | **0.1414** |
| Class 1 obesity | 1.1 | 4.8 | 2.6 | | 8.4 | 10.8 | 13.7 | |
| Class 2 obesity | 0.4 | 1.0 | 0.7 | | 2.0 | 3.9 | 3.5 | |
| Class 3 obesity | 1.9 | 1.0 | 1.0 | | 1.1 | 2.6 | 1.8 | |

**BMI classification**
**Underweight: <18.5; Normal weight: 18.5-24.9; Overweight: 25.00-29.9; Class 1 obesity: 30.0-34.9; Class 2 obesity: 35.0-39.9; Class 3 obesity: >=40**

## 4. CONCLUSION

The aim of the evaluation was to determine the impact of ATONU interventions on a range of nutrition indicators for target members of participating households implementing the ACGG project. These included Social Behaviour Change Communication (SBCC) on nutrition education and hygiene, expenditure on nutritious food, women empowerment to influence changes in women's agency and time use and promotion of home gardens to increase vegetable production for improving dietary diversity. It was evident that increased production of improved and local chickens led to an increase in the number of eggs that were available to the household for consumption as well as for sale. This was observed more in the ACGG+ATONU treatment arm, where households had a higher number of chickens compared to the other treatment arms. This led to increased consumption of both chicken meat and eggs at endline. Nutrition education and hygiene as well as promotion of home gardens, coupled with increased consumption of eggs and chicken meat, improved dietary diversity among children and women. However, dietary diversity score for women was only assessed at the endline survey. The DDS for household, children and women increased significantly in all treatment arms. However, DDS in ACGG+ATONU treatment arm was significantly higher than in the Control treatment arm. There were no significant differences between DDS (household, children and women) between ACGG+ATONU and ACGG treatment arms. An increase in dietary diversity in children was associated with increased consumption of foods from the following food groups: cereals, oils and fats, eggs, fruits and vegetables. This implies that the nutrition education intervention had an impact on dietary diversity of households. The introduction and establishment of home gardens, with the assumption that households were now producing more vegetables through home gardens, led to an improvement in vegetable production and consumption. This implies that vegetable production had a positive effect on food access and improved dietary diversity.

Although general nutrition knowledge increased at endline, DID analysis did not show a significant difference between treatment arms.

Improvement on capacity of women to make decisions on own income expenditure and household income was more in ACGG+ATONU than in ACGG treatment arms at endline than at baseline. Joint decision making on food expenditure improved with ACGG+ATONU compared to ACGG treatment arm. The social behaviour change communication influenced women participation in decision making within the households.

**Recommendation**

All agricultural interventions in Tanzania and indeed other countries, apart from fulfilling specific objectives, should be directed to have an ultimate outcome/goal of improving the nutritional wellbeing of the final beneficiaries. Development of agricultural interventions needs to incorporate nutrition considerations in the planning and implementation of activities to ensure that the interventions are nutrition-sensitive so as to result in both improved agricultural productivity and nutrition.

**Policy implications of the results**

The results of this survey will be useful for influencing nutrition programming in districts and regions. It can also be used to develop nutrition packages for inclusion in other national development programmes in agriculture, livestock and community development. Policy makers can use this information to create awareness for advocacy and to inform interventions that can improve public health and nutrition in the country. The information can also be used to plan similar nutrition interventions in other areas in the country or improving the design of programmes that are already being implemented.

**Study limitations and suggestions for improvement of future research**

The presence of other on-going nutrition-sensitive intervention programmes implemented by other partners in the study areas might have influenced some of the outcomes in this study. Therefore, interpretation of these results should be made with caution. For example:

(i) In Central zone - WFP, Mwanzo Bora and World Vision were implementing nutrition interventions in some of the villages surveyed

(ii) Southern Highlands - e.g. Mwanzo Bora was active at Itipingi village

(iii) Eastern zone – Mwanzo Bora was active in some villages

Exposure time for the SBCC interventions was limited. Studies involving behavioural/attitudinal change require time, making it difficult to attribute all changes to these interventions. In future, when implementing such an assignment, more time should be allowed, with considerations that the participants are adult learners.

**General observations about the survey**

- Some respondents were very positive on the nutrition training; they specifically mentioned the component of education on child feeding practices.

- Some households that did not participate in the baseline survey were willing to participate in the endline survey because they were interested in nutrition education that was given. This can be presented as impact of the project.
- There were some organizations working in some of the villages visited for the endline survey. They were conducting nutrition education in selected households. For example, in Muhalala village, World Vision was implementing activities, including nutrition education where the target population was pregnant women and women of reproductive age with children below five years. The main nutrition topics were on diet diversification, promotion of production and consumption of orange fleshed sweet potatoes, and WASH etc.
- The enumerators were very good and generally highly motivated throughout the study duration. The coverage was good.
- There was a high level of commitment and support from both village officials and district officials. They are eagerly waiting for feedback of the key findings, especially on nutritional status and production levels.
- Respondents were very friendly and cooperated well. They were eager to learn if the study had observed any change in their situation. They looked forward to getting feedback of the results and key findings.

**Challenges**

1. The survey was conducted during the rainy season when farmers were busy in the fields. Therefore, enumerators had to wait for long hours for the farmers to return from farm fields.
2. There was uneven distribution of chickens because of failure of the ACGG project to deliver some breeds. As a result, some beneficiary households were not given chickens. Consequently, some of the households that did not receive chickens refused to participate in the endline survey. Some agreed to be interviewed but refused to go for anthropometric measurements.
3. Some places were hard to reach, considering that it was raining in most of the places around Morogoro, thus adding to logistical challenges and fear due to bad terrain (terrace and hills).
4. Most of the households surveyed comprised a man and a woman (Married/cohabit), but some men did not show up for anthropometric measurements. Therefore, the data will appear skewed towards women.
5. At baseline interviews, some farmers registered using different names other than the ones commonly used in the village, hence it was difficult to trace them during follow up. In addition, respondents, especially those from intervention villages, registered using different names in order to receive chickens. Therefore, it was a challenge to identify them as some of them had forgotten the names they had registered with.
6. Some Extension Officers and Village Officials (e.g. Village Executive Officers or Chairpersons) had been transferred to different villages and the replacement officials were still very new to the place. Therefore, it was difficult to trace some of the households, resulting in delays in starting the interviews and causing enumerators to stay in the field for long hours.
7. Although extension workers were aware of the survey and present in the villages, some of them were not supportive. However, village officials (Executive Officers and Chairpersons) were very supportive and helpful.

**Appendix:**

- ATONU Endline Questionnaire (Submitted soft copy)