Nutrition impact assessment procedures for dual-purpose chicken breed interventions in Ethiopia
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Executive summary

A cluster-randomized study design was used to evaluate the effect of the Agriculture to Nutrition (ATONU) and African Chicken Genetics Gain (ACGG) programs interventions on the primary outcome of dietary diversity among women of reproductive age in smallholder poultry producing households in Ethiopia and Tanzania. The study also examined the effect of the interventions on women’s and young children’s nutritional and anaemia status. The clusters used were kebeles, the smallest administrative unit in Ethiopia. Kebeles participating in the ACGG intervention were randomly assigned to one of two treatment arms: (1) ACGG alone, or (2) ACGG+ATONU. Using the same sampling frame of kebeles used by the ACGG program, non-ACGG kebeles were selected for the third arm, (3) control (no intervention). Data were collected at three time points: baseline prior to the start of ATONU interventions, midline, and endline after completion of ATONU interventions. Questionnaires were administered by trained interviewers and were captured on electronic tablets. Questionnaires administered to household heads and women of reproductive age collected data on nutrition knowledge, decision-making on household budgets and expenditure, agricultural activities, diet, child feeding and health, and related domains. Anthropometric and anaemia assessments were conducted among women of reproductive age and children under the age of three years at study inception. In addition, a survey administered at the kebele level collected information on food availability and prices at local markets as well as a range of community services over a 12-month period.
Nutritional impact assessment overview

Nutritional assessment is the interpretation from dietary, laboratory, anthropometric, and clinical studies. It is used to determine the nutritional status of individual or population groups as influenced by the intake and utilization of nutrients (Larson-Meyer, Woolf and Burke 2018). Dwyer and Bailey (2019) reported that nutritional status represents the meeting of human body needs for nutritive and protective substances and the reflection of these in physical, physiological, and biochemical characteristics, functional capability, and health status. According to Kocanda et al. (2021), information about nutritional status is essential for identification of potential critical nutrients (at population groups at risk of deficiency); formulation of recommendations for nutrient intake; development of effective public health nutrition (PHN) programs for nutrition-related diseases prevention; and monitoring the efficiency of such interventions.

Literature describes three types of evaluation designs. In the simplest one, the whole targeted group is exposed to the intervention, and the outcome is measured against previously defined goals adequacy evaluation. The second evaluation design is known as plausibility evaluation, which requires quasi-experimental conditions, where one group receives an intervention while the other control group does not or receives a placebo. In this kind of design, the subjects are not randomized, and multivariate analysis is used to remove external factors and biases. This approach is more expensive than the previous one. The third type of evaluation design is a randomized, controlled, double-blind experimental trial, where subjects are randomly assigned to an intervention or control group.

Dietary intake assessment

The measurement of dietary intake is an important part of overall nutritional status assessment. Accurate and reliable dietary intake assessments and eating behaviour analyses make a considerable challenging for all researchers in the field of nutritional evaluation. The complexity of the human diet and the multivariate relationships between dietary factors and health should be acknowledged in the analyses and interpretation of dietary intake data. According to Thompson and Subar, approaches to food consumption assessment are numerous and the selection of the most appropriate method depends on research objectives, study hypothesis, needed level of accuracy and precision, characteristics of the defined study population, the desired type of data, as well as on available personnel and financial resources (Thompson and Subar 2017). Dietary assessment tools differ in observational perspective, time frame, method of administration, estimation of amount of food eaten, and conversion into food components (Naska, Lagiou and Lagiou 2017).

24-hour dietary recall

The 24-hour recall method, which is also known as the retrospective dietary assessment method involves an extensive interview where the individual recalls complete food and beverage consumption from the previous day or the preceding 24 hours. The interview is often structured, with a standardized and pretested protocol involving probing questions that help the respondent remember all the items consumed and relevant food description. This
method is unique as the information on food type, preparation methods, recipes, brand names of commercial products, and estimated portion size are usually required. In this method, when the respondent fails to provide adequate information, the interviewer should probe further to assure the necessary level of detail. The probing questions used to encourage the recall are asked in a neutral, non-directive, and non-judgmental manner (Scheffelaar, Janssen and Luijkx 2021). Potential errors in 24-hour dietary recalls could arise from the interviewer, respondent, or the method itself. They further outlined that interactions in this triangular system define the quality of 24-hour dietary recall measurement (Knippenberg, Jensen and Constas 2019). Intensive training of the interviewers and a well-developed quality control system are critical in obtaining reasonably accurate and complete reports with sufficient information for analysis. According to Gibson et al. (2017), the error of omission is introduced when respondents fail to report foods that were actually consumed, and error of commission when they report items that were not consumed during the recall day. On the other hand factors associated with the ability of retrieving information and recall accuracy such as gender, age, education level, intelligence, mood, interview setting, eating pattern consistency, ethnic background, and current nutritional status can also introduce errors (Volk et al. 2021). However, skilled interviewers, list of frequently forgotten foods, unhurried pace of interview, and related activities with food consumption from the recall day, may reduce errors caused by memory limitations (Harrison et al. 2017). To facilitate accurate recall, the multiple pass technique is used increasingly in dietary surveys and research studies. This approach, based on cognitive principles and practical experience, employs sequential passes in the interview according to a predefined pattern. Even though specific protocols may vary in number of stages and their scope, basic elements of the multiple-pass method are the same. First, the respondent provides an uninterrupted recall of the foods consumed the previous day, not necessarily in chronological order. This pass is followed by asking for any forgotten or omitted food items, and probing questions for more details about the intake (including time and occasion of consumption and quantities consumed). In the final step, the interviewer reviews the list of reported foods with the addition of food items, eating occasions, or relevant details if appropriate (Min 2021).

**Food frequency questionnaires (FFQs)**

Food frequency questionnaires (FFQs) are widely used instruments for dietary intake assessment in epidemiologic studies and are designed to measure habitual consumption over an extended period. They vary in listed food items, time frame of interest, response intervals specifying frequency of consumption, portion size reporting, and manner of administration (Kirkpatrick et al. 2019). Two basic elements of FFQs are a predefined limited food list and an accompanying ‘frequency of consumption’ section. The food list should be clear, concise, systematically structured, and carefully compiled according to the research objectives. According to Delgado et al. (2021), the list may be extensive to enable comprehensive evaluation of diet or focused on specific nutrients, food items and food groups, or dietary exposures related to certain diseases. The listed items should reflect common dietary habits of the studied population and be frequently consumed by a considerable number of individuals. Furthermore, selected foods should represent a major source of nutrient(s) of interest and should significantly contribute to interindividual variability in intake (Micha et al. 2018). Several strategies could be employed to assemble the most informative, culturally appropriate list. The selection of potentially relevant items may be based on previously conducted surveys, expert consultation, or derived from food composition tables or databases (FCDBs) and consumption data obtained in a pilot study using open-ended instruments (24-hour recalls or food records). Usually, the list is initially constructed based on the above-mentioned criteria, and further methodically reduced. Crochiere et al. (2021), however, caution that even though a longer food list enables a more detailed examination of nutrient intake, too long a questionnaire causes exhaustion and boredom of the participants that can negatively affect their accuracy, motivation, and willingness to complete the form. The frequency of consumption section is usually based on a multiple-choice response format, with the number of options ranging from 5–10. An alternate, open-ended format is a less-frequently used approach. Based on inclusion of portion size estimation, FFQs can be qualitative, semi-quantitative, and quantitative. Qualitative FFQs (also known as food propensity questionnaires or FPQs) lack additional information on portion sizes and provide only descriptive data on food-consumption patterns. Abbey and Meloy (2017) argue that the usual serving size can be left for respondents to describe in an open-ended manner. This allows more flexibility and could improve precision but is more extensive for subsequent data processing. FFQs can be both interviewers administered (in person or over the telephone) and
self-administered using the traditional paper-based or electronic form. Paper questionnaires are frequently designed to be close-ended and viable for optical scanning and automated processing to facilitate data entry and minimize the risk for error. Although the interviewer-administered approach increases the cost significantly, it is necessary in certain situations, such as low literate and numeracy skilled participants. In contrast to 24-hour recalls, interviewer training is less demanding, and a standardized food list reduces the between-interviewer variation. FFQs are convenient for large groups and provide an evaluation of long-term dietary exposure with modest participant burden compared to other dietary assessment methods, relatively low cost, and absence of reactivity. However, a major drawback of the FFQ method is the inherent substantial measurement error. Inaccuracies are introduced with incomplete food listings, memory reliance, self-reporting bias, and the cognitively complex procedures involved in retrospective estimation of portion sizes and frequencies of consumption (Jebena 2018).

**Anthropometric measurement and body composition**

According to Bagni et al. (2021), nutritional Status Assessment Anthropometry is a widely used, inexpensive, and noninvasive measure of the general nutritional status assessment at the individual and/or population level. One group of anthropometric measurements assesses body size and the other determines body composition. A combination of raw measurements is used to derive the anthropometric indices (weight-for age, body mass index (BMI), waist–hip circumference ratio etc.), which are used for the interpretation of nutritional status. Anthropometry can be used for various purposes depending on the anthropometric indicators selected. Selection of the best anthropometric indicators depends on sensitivity and specificity, and it will vary according to the age of the population, cut-off points used, the severity and the prevalence of the nutritional problems. Jimoh et al. (2018) reported that, nutritional assessment should consider which nutritional assessment system is used for screening, surveillance or intervention, and the objectives of the study. To interpret and evaluate anthropometric data and identify individuals at risk of malnutrition it is recommended to use the local or international reference data. For instance, child growth is internationally recognized as an important indicator of nutritional status and health in populations. For children under five years, it is recommended to use the World Health Organization (WHO) Child Growth Standards (length/ height for age, weight for age, weight for length, weight for height and BMI for age, head circumference for age, mid upper-arm circumference for age, subscapular skinfold for age, triceps skinfold for age) as the toolkit. According to Mailiza et al. (2018), worldwide implementation of these standards is still ongoing. The WHO growth reference data for 5- to 19-year-old children and adolescents are BMI for 5-to 19-year-old, height-for-age for 5- to 19-year-old, and weight-for-age for 5- to 10-year-old children. They are proposed to be used and readily available tools that facilitate analysis of nutritional status. BMI is a simple index of weight-for-height value, which is commonly used to classify underweight, overweight, and obese adults, at an individual level and in epidemiological studies. It is defined as the weight in kilograms divided by the square of the height in metres (kg m\(^2\). Beside using anthropometry to determine body composition, nowadays, several advanced and bioelectrical impedance analysis (BIA) methods such as hydro-densitometry (HD), air displacement plethysmography (ADP), dual-energy X-ray absorptiometry (DXA), magnetic resonance imaging (MRI), and quantitative magnetic resonance (QMR) are used. However, these methods cannot replace traditional anthropometric measures in large epidemiologic studies. Even more, these anthropometric measurement and indices are used in surveillance and monitoring at a national and international level to track global nutrition targets for 2025 (Tran et al. 2018).

**Nutritional impact assessment procedures used for the ACGG-ATONU project**

While implementing the International Livestock Research Institute (ILRI)-led ACGG-ATONU project, we have followed an approach detailing the research questions that could be addressed, explaining the impact pathways and possible tailored nutrition interventions, described the theory of change, outlined the work packages, described the ATONU institutional arrangements, described the inception and feasibility phase, and painted a picture of what the
success of the project would look like. ACGG-ATONU had implemented and tested five pathways integrating tailored nutrition interventions as explained below and depicted in Figure 1.

Pathway 1: **Food production for the household’s own consumption** is the most fundamental and direct pathway by which increased production translates into greater food availability and food security. Food production affects the food availability for household consumption as well as the prices for diverse foods. The different types of foods produced determine the impact of the production increase on diet quality. However, it is not always possible for a household to produce all the food they need. Most rural poor households and smallholder farm families end up as net buyers of food. Some households may, for instance, meet their staples requirements themselves while depending on markets for other products such as fruits and vegetables. Others may rely mainly on home gardens for fruits and vegetables. Whatever role production-for-income plays in this scenario is secondary to the primary purpose of producing food to meet the household’s own food requirements.

Pathway 2: **Income-oriented production for food and health.** This pathway assumes that nutrient-dense, diverse foods are available and affordable in local markets. As agricultural households become more market oriented, production-for-own-consumption becomes less significant relative to income from the sale of what is produced. The extra income is then used to buy more higher-quality and nutrient-dense food. The balance between quantity and quality affects the final impact of this additional income on the household’s consumption of energy and micronutrients. The effect of income on nutrition is not always linear or easy to predict – it is always modified by nutrition knowledge, social and behaviour change, social marketing, what is available, affordable, and convenient to purchase; who decides what is purchased; and the myriad factors that drive that decision. The translation of increased income into better child nutrition, in turn, depends on a series of intra-household factors and processes. These include women’s status, education, knowledge, health-related practices, decision-making power, income, and access to and use of health and sanitation services.

Pathway 3: **The empowerment of women** is a pathway that carries special significance for household nutrition outcomes and in particular for children’s health. Women’s empowerment incorporates multiple aspects including the decision-making power related to income, time, labour, assets, and knowledge or preferences of female community members. Women have consistently been found to be more likely than men to invest in their children’s health and well-being, and the income and resources that women control wield disproportionately strong effects on health and nutrition outcomes generally. Women who are reached by agricultural programs that relay information on nutrition issues appear to be particularly effective at delivering improved nutrition outcomes, and the effects appear to be most pronounced among the lowest income groups. Taken together, these characteristics make women natural priorities for agricultural interventions that aim at improving nutrition. However, agricultural development interventions have also been found to strongly affect women’s use of time as well as increasing their labour burden.

Pathway 4: **Lowering food retail prices by increasing food production** is another pathway linking agriculture to nutrition and is especially important in areas in which markets are less integrated. This is a policy-level pathway. For net consumers, reduced food prices enable greater access to food and essential nutrients, resulting in better health and productivity for the general workforce while also freeing additional household resources from food to other expenditure, including productive investments.

Pathway 5: **Nutrient-sensitive agricultural growth.** Overall agricultural growth at the macro level itself represents an indirect pathway to better nutrition through its contribution to macroeconomic growth and higher levels of national income, which can support nutritional improvements by reducing poverty. Increases in agricultural productivity have been vital factors in building sustained economic growth in both developed and developing countries and have major impacts on poverty.
A cluster-randomized study design was applied to evaluate the effects of the ATONU and ACGG interventions on the primary outcome of dietary diversity among women of reproductive age in smallholder poultry producing households in Ethiopia. The study also examined the effect of the interventions on women’s and young children’s nutritional and anaemia status. The clusters used were kebeles, the smallest administrative unit in Ethiopia. Kebeles participating in the ACGG intervention were randomly assigned to one of two treatment arms: (1) ACGG alone, or (2) ACGG+ATONU. Using the same sampling frame of kebeles used by the ACGG program, non-ACGG kebeles were selected for the third arm, (3) control (no intervention). Data were collected at three time points: baseline prior to the start of ATONU interventions, midline, and endline after completion of ATONU interventions. Questionnaires were administered by trained interviewers and were captured on electronic tablets. Questionnaires administered to household heads and women of reproductive age collected data on nutrition knowledge, decision-making on household budgets and expenditure, agricultural activities, diet, child feeding and health, and related domains. Anthropometric and anaemia assessments were conducted among women of reproductive age and children under the age of three years at study inception. In addition, a survey administered at the kebele level collected information on food availability and prices at local markets as well as a range of community services over a 12-month period.

A total of 2,117 households met the eligibility criteria and enrolled in the study at baseline. Among these, 710 households belonged to the ACGG arm, 709 households belonged to the ACGG+ATONU arm, and 698 households were in the control arm. Within this survey 60 villages were addressed. Data collection was successfully conducted at three time points: baseline in November-December 2016, midline in July-August 2017, and endline in April-May 2018. The kebele-level questionnaire was administered in each kebele at baseline and endline.

This study used a cluster randomized design to evaluate the two main interventions implemented by ACGG and ATONU (Figure 2): (1) distribution of high-producing chickens to households (ACGG); and (2) a BCC intervention on poultry-specific aspects of nutrition, water, sanitation and hygiene (WASH), women’s empowerment, and use of income combined with home gardening (ATONU). Villages already participating in ACGG were randomized to one of the two following arms:

1. ACGG alone
2. ACGG+ATONU
Selection of study area and sampling

The ACGG program was implemented in Addis Ababa and the four main regions of Ethiopia: Amhara, Oromia, Tigray and South. ACGG conducted its village selection process and began distributing chickens to households in July 2016. ATONU similarly began the implementation of its intervention shortly after distributing chickens to households starting in January 2017. For the evaluation, 20 non-ACGG kebeles were randomly selected to form a third arm to serve as a control group receiving no interventions. In the selection of their program kebeles, ACGG created a sampling frame of villages in their program areas that met their criteria of geographic diversity, poultry producing capacity, and number of smallholder households producing chicken. The non-ACGG kebeles participating in our evaluation were randomly drawn from the same sampling frame. Forty ACGG kebeles in the four main regions were randomized to receive either ATONU or no further intervention. The detailed sampling strategy is available in the baseline evaluation report (available at https://www.fanrpan.org/atonu-ethiopia-baseline-report).

Inclusion criteria

Households in one of the two ACGG treatment arms were eligible for inclusion if they met all of the following criteria:

1. Were participating in the ACGG program
2. Had at least one woman of reproductive age (15-49 years at enrollment)
3. Provided informed consent

Households in the control arm were eligible for inclusion if they met all the following criteria:

1. Met the criteria for participating in the ACGG program, namely, they had produced chickens for at least two years and were currently keeping no more than 50 chickens with interest to expand production in the future
2. Had at least one woman of reproductive age (15-49 years at enrollment)

3. Provided informed consent

Overall, we screened 40 households per kebele in each of the 40 ACGG kebeles and enrolled approximately 35 households per kebele, meeting the inclusion and exclusion criteria. From the 20 selected control kebeles, we screened approximately 50 households per kebele and enrolled approximately 35 households per kebele meeting the inclusion and exclusion criteria. In total, we screened 2,658 households and enrolled 2,117 households at baseline. At midline and endline, we enrolled newly born eligible index children under 36 months of age among the 2,117 households enrolled in the study.

**Study timeline**

Participating households were visited three times during the 19-month evaluation period i.e. during a baseline visit, a follow-up visit eight months after baseline, and a follow-up visit 19 months after baseline (Figure 2). Baseline data collection were conducted concurrently with ACGG’s distribution of chickens and prior to the beginning of implementation of the package of interventions by ATONU. At each visit, questionnaires were administered to the household head and women of reproductive age on nutrition knowledge, decision-making on household budgets and expenditure, agricultural activities, and related domains. At recruitment, if there was a child in the household under the age of 36 months, this child was identified as an index child. A child born in a participating household during the evaluation study was also identified as an index child if the household did not already have an index child enrolled. At each study visit, women were asked questions about their diet and, if an index child was present, on the feeding and health of the index child. Anthropometric and anaemia assessments were conducted among women of reproductive age and index children.

Figure 3: Project timeline for the ATONU trial, Ethiopia.
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Data collection

Baseline data collection was conducted during November – December 2016. Data were collected from 2,117 households. HemoCue measurements were conducted on 1,073 women and 438 children and dried blood spots (DBS) collected from 836 women and 318 children. Midline data collection was conducted 27 July – 29 August 2017. No HemoCue measurements or DBS were collected at midline.

At endline, HemoCue measurements were conducted on 1,062 women and 400 children. No DBS were collected at endline. More than 80 field workers worked in 20 teams to collect data from all regions over a period of four weeks during the midline and endline surveys. All field workers underwent training before carrying out each round of data collection.

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-meter 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.
References


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