IMPROVING NUTRITION IN CHILDREN UNDER FIVE IN BURKINA FASO: A ONE HEALTH APPROACH

By

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This dissertation is dedicated to my loved ones, who also sacrificed for my success.

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LIST OF ABBREVIATIONS

ASF	Animal Source Foods. For the purposes of this study, ASF refers specifically to livestock-derived animal source foods (milk, meat, and eggs).
ANCOVA	Analysis of Covariance. A statistical test for the differences between two or more groups which accounts for a covariate within the model.
A-WEAI	Abbreviated Women's Empowerment in Agriculture Index
BCC	Behavior Change Communication
cRCT	Cluster Randomized Controlled Trial
CU5	Children Under Five
Control	Control Research Arm or Control Group. This refers to the research arm that received no intervention but did receive two household chickens after completion of the *Un Oeuf* study.
ΔHHDM	Change in HHDM. This delta is the change from baseline to endline.
EC	Egg consumption in the past week.
ERB	Ethical Review Board
5DE	Five Domains of Empowerment. The name for the A-WEAI when it is only administered to women.
FTF	Feed the Future Initiative
Full	Full Research Arm, Full Intervention Arm, or Full Group. This refers to the research arm that received the full intervention implemented during the *Un Oeuf* study.
HHDM	Household decision-making. Within Chapters 2–5 this refers to household decision-making centered around egg consumption
HHDM-B	Household decision-making concerning what foods are bought for the household.
HHDM-E	Household decision-making concerning what is done with the household eggs.
HHDM-F	Household decision-making concerning what foods are fed to the children of the household.

HHDM-P	Household decision-making concerning how foods are portioned within the household.
HHS	Household survey. This refers to the household survey used to collect quantitative data for both the *Un Oeuf* and Enhance studies.
IRB	Institutional Review Board
INA	Integrated nutrition and agriculture
INERA	*Institut de l'Environnement et Recheres Agricoles* (Environmental Institute for Agricultural Research)
IFPRI	International Food and Policy Research Institute
IYC	Infants and young children. This age range is specific from birth until two years of age.
KAP	Knowledge, attitudes, and practices
LIC	Low-income country
LMIC	Low- and middle-income countries
MCH	Maternal and child Health
M3	Month Three. This refers to the timepoint of the third month of household data collection during the *Un Oeuf* study.
n	Sample size
N	Population size
p	*p*-value. The attained level of significance, below which a test is found statistically significant (i.e., $p < .05$)
Partial	Partial Research Arm, Partial Intervention Arm, or Partial Group. This refers to the research arm that received the partial intervention implemented during the *Un Oeuf* study.
SSA	Sub-Saharan Africa
UN	United Nations
Un Oeuf	*Un Enfant, Un Œuf, Par Jour* study. One Child, One Egg, Per Day. The official abbreviation for the cRCT study.
USAID	United States Agency for International Development

WE	Women’s Empowerment
WEAI	Women’s Empowerment in Agriculture Index
WHO	World Health Organization

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Major: Public Health – One Health

The consumption of animal source foods (ASF) such as milk, meat, and eggs, has been scientifically proven to mitigate and reverse malnutrition, especially in children under 5 (CU5), and is essential during critical times of development and growth (L. Iannotti & Lesorogol, 2014; C. G. Neumann, Murphy, Gewa, Grillenberger, & Bwibo, 2007). Additionally, many studies have shown the importance of a woman's level of household decision-making and empowerment on the nutritional outcomes of children, especially in regard to ASF consumption (Kabeer, 2005; Kariuki, Njuki, Mburu, & Waithanji, 2013). Burkina Faso is burdened by high rates of malnutrition, anemia, and linear growth stunting in CU5 (INDS, 2010). Like many developing countries, Burkina Faso has low rates of ASF consumption, particularly among women and children (Rogers et al, 1996) primarily due to barriers such as access, cost, knowledge, and decision-making power. This study uses a mixed methods approach to explore the role empowerment has on behavior change adoption to increase egg consumption in infants and young children(IYC); delivery models for increasing household livestock on behavior change adoption; impact of a nutrition-based behavior change intervention on women's empowerment; and sustainability and of a nutrition-based behavior change

intervention in Burkina Faso and the Sahel Region. This study aims to provide insight into the impact and sustainability of a nutrition-sensitive, livestock-based intervention on egg consumption in IYC in rural Burkina Faso.

CHAPTER 1
OPENING REMARKS

Introduction

The United States Agency for International Development (USAID) was created by President John F. Kennedy in 1961 and now serves to combat global hunger, as well as promote global health and support global stability (USAID, 2019). In 2010 under the Obama Administration, , USAID created the Feed the Future Initiative (FTF)—a collaboration of global researchers, donors, partner countries, and private sector partners—to help reach its goals to combat global hunger (USAID, 2020). Through FTF, many funding opportunities are supported by USAID to further research surrounding nutrition in low- and middle-income countries (LMIC) for combatting food insecurity and global hunger.

Responding to the call from USAID for a more holistic approach to counter malnutrition in CU5 in Burkina Faso, a team of researchers from the University of Florida and the *Institut de l'Environnement et Recheres Agricoles* (Environmental Institute for Agricultural Research; INERA) proposed a nutrition-sensitive livestock-centered behavior change intervention. The team proposed a cluster randomized controlled trial (cRCT) to test the impact of the intervention on egg consumption in the Kaya Department of rural Burkina Faso. The study was called the *Un Enfant, Un Oeuf, Par Jour* (One Child, One Egg, Per Day) study; henceforth referenced as 'the *Un Oeuf* study' or 'the cRCT'. The *Un Oeuf* study began in May 2018, formally launched the intervention in July 2018, and concluded in April 2019.

The cRCT aimed to increase egg consumption in CU5 through a multi-pronged intervention, which aimed to increase household livestock assets (specifically, chickens)

and to empower mothers through education on agriculture and nutrition and social support. The *Un Oeuf* study consisted of three research arms: the full research arm (also referred to as 'full intervention group' and referenced as 'Full') received household livestock assets through a gifting ceremony prior to the enrolled mothers beginning a ten-month training program of Integrated Nutrition and Agriculture (INA) trainings that ran the course cRCT. The partial research arm (also called the 'partial intervention group' and referenced as 'Partial') did not receive any household livestock assets during the course of the study, but mothers did participate in the same INA training program as the mothers in the Full. The control research arm (also known as the 'control group' or referenced as 'Control') received neither trainings nor household livestock assets during the cRCT. For a full explanation of the *Un Oeuf Study* see Stark et al. (2020).

The *Un Oeuf* study was designed based on empirical evidence supporting livestock ownership and women's empowerment as pathways to increasing animal source food (ASF; i.e., egg) consumption in infants and young children (IYC), and integration of nutrition-sensitive approaches, including behavior change communication (BCC) strategies, within the project. To assess its impact on egg consumption and other key variables of interest (i.e. household poultry production and household decision-making centered around egg consumption), the *Un Oeuf* study collected household data each month from July 2018 (baseline) to April 2019 (endline).

By the third month of data collection for the *Un Oeuf* study, monitoring data indicated that behavior was changing quickly. The team then solicited and secured additional Enhance funds to conduct a follow-up study to examine women's empowerment in a more holistic manner within the *Un Oeuf* study, as well as collect one

round of follow-up data collection in July 2019, three-months after the conclusion of the cRCT. This dissertation will analyze data collected during the *Un Oeuf* study, as well as the Enhance Follow-up study.

Background

Nutrition is a key component to development and a healthy life, especially for IYC and children under five (CU5) (Bain et al., 2013; Herman et al., 2014; Keunen, van Elburg, van Bel, & Benders, 2015). According to the life course model, childhood nutrition is not only the foundation upon which physical and cognitive development takes place, but also can impact the disability adjusted life years (DALYs) with which an adult lives (Herman et al., 2014). In particular, there is a critical window in childhood nutrition—the first thousand days—spanning from conception until two-years of age, during which future nutritional and health status can be greatly influenced (Cusick & Georgieff, 2016; Mameli, Mazzantini, & Zuccotti, 2016; Schwarzenberg & Georgieff, 2018; Wrottesley, Lamper, & Pisa, 2016). Unfortunately, for most of the world living in LMIC, especially SSA, malnutrition has become a fact of life for children (Bain et al., 2013).

Malnutrition is a global pandemic disproportionately affecting CU5 in LMIC, and being associated with 45% of all CU5 deaths (WHO, 2020). Malnutrition comes in two main subsets, undernutrition (i.e. underweight, stunting, and wasting) and overnutrition (i.e. overweight and obese). Some countries carry a “double-burden” of malnutrition, having public health crises centering around childhood populations that are under-nourished and over-nourished (Müller & Krawinkel, 2005; Shrimpton & Rokx, 2012). Undernutrition is the most common type of malnutrition in developing nations, with three types of undernutrition that are not exclusive to one another—underweight, stunting,

and wasting. Children who are stunted are low height-for-age; children who are wasted are low weight-for-height; and children who are underweight are low weight-for-age (Figure 1-1). Henceforth, in this document, the term ‘malnutrition’ will refer to these forms of undernutrition.

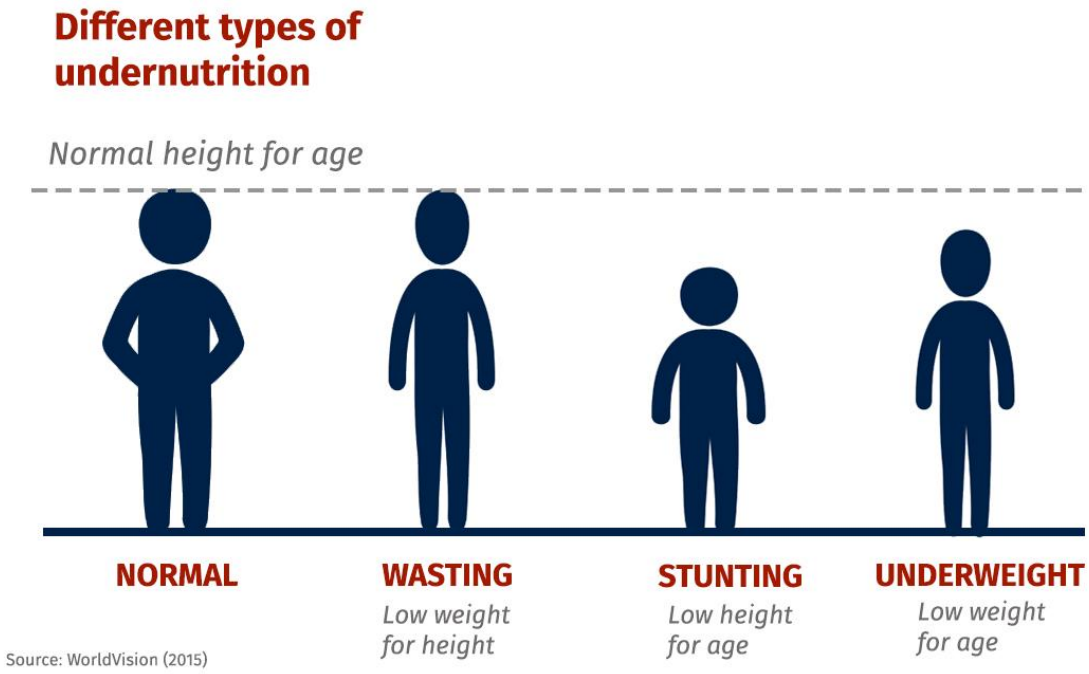

Figure 1-1. Depiction of the three types of undernutrition compared to normal.

Due to the severity of malnutrition plaguing the world, the United Nations has prioritized a global call to malnutrition by including it in the Sustainable Development Goals (SDGs) for “Zero Hunger” (WCF(UK), 2017). This call to action has spurred more research surrounding sustainable pathways for combatting malnutrition.[1]

Animal sourced food plays a crucial role in the mental development and physical growth of humans. The nutritional composition of ASF is unique, since it contains a

[1] The term “malnutrition” will be used throughout this document to refer to undernutrition and its subcategories of stunting, wasting, and underweight.

diversity of necessary micro- and macronutrients into one food source (J. de Bruyn et al., 2016; Hulett et al., 2014; Charlotte G. Neumann et al., 2003; Zhang, Goldsmith, & Winter-Nelson, 2016). Regular inclusion of ASF into the diet can improve the growth, nutritional status, cognitive development, and overall health of a child (Darapheak, Takano, Kizuki, Nakamura, & Seino, 2013; Charlotte G. Neumann et al., 2003).

Nutrition studies have shown that malnutrition may be mitigated and outcomes improved through a variety of intervention strategies, including education and empowerment of mothers through training programs on nutrition and safe animal husbandry practices, which converge in an effort to increase ASF consumption (Haselow, Stormer, & Pries, 2016; Olney, Pedehombga, Ruel, & Dillon, 2015). More recent studies have shown that an improved nutrient intake through the inclusion of ASF in the child's diet can be acutely achieved through egg consumption (L. L. Iannotti et al., 2017; Omer, Mulualem, Classen, Vatanparast, & Whiting, 2018). Unfortunately, despite increasing evidence indicating its benefits, ASF consumption is particularly low among women and children in SSA, and cultural beliefs and stigma further limit ASF consumption (Gittelsohn & Vastine, 2003; L. Iannotti & Lesorogol, 2014; Rogers, 1996; Ruel, Alderman, & Group, 2013; WCF(UK), 2017).

Two pathways associated with increased child ASF consumption and better childhood nutritional outcomes are household livestock ownership (Hetherington, Wiethoelter, Negin, & Mor, 2017; Jin & Iannotti, 2014; Mosites et al., 2015; Zezza) and women's empowerment through livestock ownership (Jin & Iannotti, 2014; Kariuki et al., 2013; Quisumbing et al., 2015). Household livestock ownership can lead to an increase in household livestock production, which allows households to increase dietary diversity

through both auto-consumption of ASF produced by their own livestock and the purchase of more diverse foods through sale of excess livestock and livestock-derived ASF—both of which have been witnessed when female-controlled livestock (i.e. poultry and small ruminants) is increased (Jin & Iannotti, 2014; Kariuki et al., 2013; Kristjanson et al., 2014).

Unfortunately, these pathways may be constricted by a lack of women's input or autonomy surrounding household decision-making, and lack of livelihood or means for women to secure ASF for children to consume (Azzarri, Zezza, Haile, & Cross, 2015; Hetherington et al., 2017; Kariuki et al., 2013). In order to open these pathways, it is necessary to understand the current state of women's empowerment in both the agricultural and livestock sectors within populations that have low ASF consumption, the level of household decision-making women have over nutrition-related decisions, and how a woman's livelihood impacts the health outcomes of children.

Behavior change is a complex combination of changing knowledge, attitudes and beliefs, and behavior expression (Simons-Morton, McLeroy, & Wendel, 2011). Behavior change can come with various levels of resistance, as well as unique barriers to change and facilitating factors from person to person. These nuances call for behavior change communication (BCC) that is specific to the study population, using either a culturally-sensitive or culturally-centered approach when possible (Basu & Dutta, 2009; Campbell et al., 1994; Simons-Morton et al., 2011). Behavior change is not instantaneous and requires both reinforcement and monitoring to reach success. When BCC packages are created using best-practices that suit the population and the desired behavior outcome, success is more attainable and sustainable (Simons-Morton et al., 2011). Regarding

behavior change concerning ASF consumption, interventions using a combination of training and monitoring are regarded as the gold standard (Omer et al., 2018; Ruel et al., 2013; Worsley, 2002).

The sustainability of behavior change surrounding ASF depends greatly on the sustainability of the intervention strategy. Milk-producing cattle require much more land and resources to sustain and produce than smaller milk-producing livestock such as goats and sheep (Nations, 2015; Smith et al., 2013; Tilman, Cassman, Matson, Naylor, & Polasky, 2002). This is extremely important to consider in the SSA region due to climate variability and climate change, which is greatly affecting the management of natural resources and water availability (Hanjra & Qureshi, 2010; Held, Delworth, Lu, Findell, & Knutson, 2005; Ickowicz et al., 2012; Johnson & Brown, 2014). Sustainable means of increasing livestock production, ASF availability, livelihood, women's empowerment, and ASF consumption are necessary. There is some evidence that a more sustainable approach may be through ownership of poultry and consumption of eggs (Ayele & Peacock, 2003; J. de Bruyn et al., 2016; Emam & Hassan, 2011; L. L. Iannotti et al., 2017; Omer et al., 2018). This research will focus on increasing chickens, as livestock assets, and increasing women's empowerment to increase egg consumption in CU5 in Burkina Faso.

Burkina Faso

Burkina Faso is a SSA, Western African country that is situated within the African Sahel—a region where food and nutritional security are among the lowest globally, thus representing a priority for the development sector (ECHO, 2017; FAO, 2016). Within its CU5 population, Burkina Faso has high rates of all forms of malnutrition (with an emphasis on stunting) and anemia (INSD, 2012). Much of this is due to high levels of

food insecurity, low dietary diversity, high reliance on a plant-based diet, and inadequate complementary feeding after the recommended breastfeeding period of six months (World Bank, 2018; Doka, Madougou, & Diouf, 2014). The severity of malnutrition among CU5 in Burkina Faso is high and is associated with high corresponding rates of under-five mortality (UNICEF, 2012). For children who live past the age of five, severe undernutrition often has significant negative impacts on their long-term physical and cognitive development, as well as their future economic potential and socioeconomic status in adulthood (Black et al., 2008; Frison, Smith, Johns, Cherfas, & Eyzaguirre, 2006; Herrador et al., 2015; Hulett et al., 2014).

The geographic focus for this research falls within the boundaries of the Centre Nord region of Burkina Faso, which has a population of over 1.5 million people and some of the highest rates of childhood malnutrition of the country (INDS 2010). The study population is located in the Sanmatenga Province, just under 100 miles north of the country's capital city, Ouagadougou. The Kaya Department was targeted due to its high rates of childhood malnutrition, food insecurity, rurality, and poverty-level, in addition to being part of the Feed the Future Zone of Influence. The main sources of livelihood in this region are small scale agriculture and livestock production (i.e. chickens, sheep, goats); however, household-level livestock assets are used for production to sell for income-generating purposes, as opposed for household ASF consumption (Aaron K. Christian et al., 2016), making it a prime study population for a nutrition-sensitive, livestock-centered behavior change intervention (Figure 1-2).

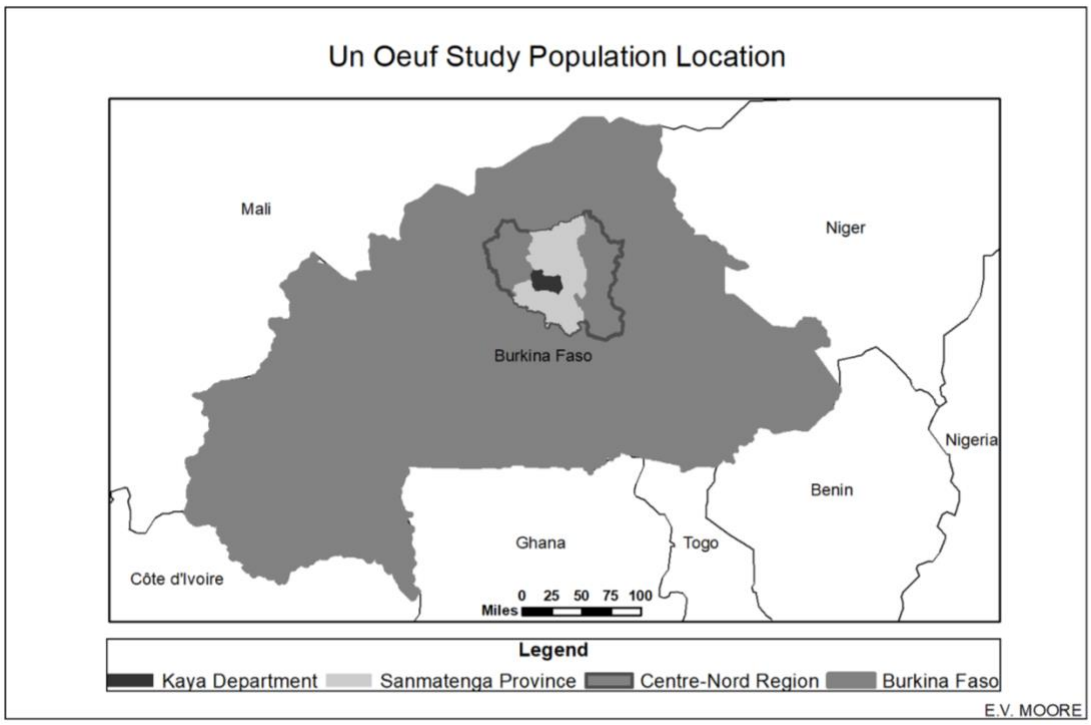

Figure 1-2. Map of the Un Oeuf and Enhance Follow-Up Study population at the Department level.

Eighteen villages were randomly selected for inclusion in the *Un Oeuf* study and were randomly assigned to three research arms (Full, Partial, and Control). Mother-child dyads (up to 15 per village) were randomly selected from eligible dyads in each village. The total study population consisted of 260 mother-child dyads. They were originally recruited, found eligible, and consented to participate in the *Un Oeuf* study then all were invited to continue participation in the Enhance Follow-up. For simplicity, each mother-child dyad referred throughout this document is referred to as “participant”. Infants and young children were the original age-range targeted for recruitment into the *Un Oeuf* study; however, due to availability and natural maturation of children within the study population, some children were older than 24 months at some point in the study. Resultingly, the term “infants and young children” or IYC is used only when referring the study population at baseline or within the overarching research aims; however, after

baseline data collection, the term “children”, “children under five”, or CU5 is used to more accurately reflect the age of the study population over time. Due to the longitudinal nature of this study, not all 260 participants who started the *Un Oeuf* study at baseline (July 2018) participated in the Enhance study at follow-up in July 2019.

Chapter Overviews

Chapter Two

Chapter two is a longitudinal study which examines four timepoints of interest: baseline, month 3 (M3), endline, and follow-up. Chapter 2 leverages the *Un Oeuf* study data and the follow up data to investigate how the timing of the components of the behavior change package—the INA trainings and the gifting of chickens—effects the rate of egg consumption. By examining the two components of the behavior change package (INA trainings and animal gifting) in various combinations of timing, afforded by looking at both studies together, important insights may be drawn for development practitioners. Chapter 2 explores the following hypotheses:

- **$H1_0$:** There is no significant difference in the behavior change adoption for feeding children chicken eggs between groups of women who simultaneously received both chickens and monthly INA trainings compared to women who only received monthly INA trainings
- **$H1_a$:** There is a significant difference in behavior change adoption for feeding children chicken eggs between groups of women who simultaneously received both chickens and monthly INA trainings compared to those who only received monthly INA trainings
- **$H2_0$:** There is no significant difference in behavior change adoption for feeding children chicken eggs between groups of women who received ten monthly INA trainings before receiving chickens compared to women who did not receive monthly INA trainings before receiving chickens.
- **$H2_a$:** There is no significant difference in behavior change adoption for feeding children chicken eggs between groups of women who received ten monthly INA

trainings before receiving chickens compared to women who did not receive monthly INA trainings before receiving chickens

Chapter two strives to answer the following research question: How does the timing of INA trainings in relation to the receipt of chickens affect the uptake of behavior change to increase chicken egg consumption in IYC? The objectives of Chapter 2 are to (1) examine the difference of behavior change adoption between the full and partial intervention groups of a nutrition-sensitive, livestock-centered behavior change intervention within a cRCT and (2) examine the difference in behavior change adoption between the partial intervention arm and control group, three-months after the receipt of livestock assets for participation in the cRCT. The primary outcome will be an assessment of the behavior change communication package effectiveness for the full and partial intervention arms within a nutrition-focused cRCT to yield the desired behavior change outcome.

Chapter Three

Chapter 3 is a longitudinal study examining data from baseline to endline of the *Un Oeuf* study. Chapter 3 will examine the relationship between women's empowerment and the adoption of behavior change to increase egg consumption among infants and young children, explore the role of women's empowerment in the effectiveness of the *Un Oeuf* intervention to increase egg consumption among children, and examine the effect of the intervention on women's empowerment. Chapter two proposes the following hypotheses:

- **$H1_0$:** Household decision-making at baseline has no significant association with the endline behavior of feeding IYC chicken eggs.
- **$H1_a$:** Household decision-making at baseline has a significant association with the endline behavior of feeding IYC chicken eggs.

- **$H2_0$:** An increase in women's empowerment has no significant association with the increase of egg consumption by IYC.
- **$H2_a$:** An increase in women's empowerment has a significant association with the increase of egg consumption by IYC.
- **$H3_0$:** There is no significant association between household decision-making and an adequate 5DE score.
- **$H3_a$:** There is a significant association between household decision-making and an adequate 5DE score.
- **$H4_0$:** Women's empowerment at endline has no significant association with the behavior of feeding IYC chicken eggs.
- **$H4_a$:** Women's empowerment at endline has a significant association with the behavior of feeding IYC chicken eggs.
- **$H5_0$:** The *Un Oeuf* cRCT intervention had no significant impact on women's empowerment.
- **$H5_a$:** The *Un Oeuf* cRCT intervention had significant impact on women's empowerment.

Chapter 3 seeks to answer five research questions: (1) Is there an association between the baseline household decision-making centered around egg consumption, and the behavior of feeding children eggs at endline?; (2) Is an increase in a woman's household decision-making associated with an increase in egg consumption by CU5 after the completion of a behavior change intervention aimed at increasing egg consumption?; (3) Is there a correlation between household decision-making and an adequate 5DE score at endline?; (4) Is there an association at endline between women's empowerment, as measured by the A-WEAI 5DE, and the behavior of feeding CU5 eggs?**;** (5) What effect, if any, did the *Un Oeuf* project have on women's empowerment?

Chapter 3 seeks to examine the difference in behavior change adoption between the full and partial intervention groups of a nutrition-sensitive, livestock-centered behavior

change intervention, as well as examine the difference in behavior change adoption between the partial intervention and control groups, three-months after the receipt of chickens, given in appreciation for participation in the cRCT. Chapter 3 aims to identify associations between (1) household decision-making centered around effectiveness of the BCC package in changing egg consumption, as well as (2) women's empowerment, in the full and the behavior of feeding IYC chicken eggs. The secondary outcome perceived impact the education-centric behavior change intervention had on women's empowerment.is the effectiveness of giving livestock to the partial intervention and control groups following the completion of a nutrition-focused cRCT to increase egg consumption.

Chapter Four

Chapter 4 is a longitudinal study examining the overall summary statistics from baseline, endline, and follow-up in conjunction with the qualitative data from endline and follow-up. Chapter 4 examines the sustainability and scalability of increasing household chickens as a means to improve nutrition in CU5 in Burkina Faso and the Sahel. It aims to answer the following research questions: (1) Is a nutrition-sensitive, livestock-centered intervention centered around animal gifting a sustainable pathway to reducing the effects of malnutrition among CU5 in Burkina Faso?, and (2) Is a nutrition-sensitive, livestock-centered intervention centered around animal gifting a sustainable pathway to reducing the effects of malnutrition among CU5 in other Sahelian countries?

Chapter Five

Chapter 5 will engage findings from the Chapters 2–4 will discuss the value of the research findings in the context of current best practices and future research.

Data

Data analyzed for this research were collected through multiple instruments, including a household survey, the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI), and Focus Group Discussions. Data were collected from all 260 participating households using encrypted tablets on the secure, web-based application, Research Electronic Data Capture (REDCap), in accordance with the UF's IRB policy for electronic data collection with human subjects. The survey included questions on household demographics, child health, household diet and nutrition, as well as related knowledge, attitudes, and practices (KAP) of the household and questions on household decision-making and egg consumption. Three graduate students from the University of Ouagadougou in Burkina Faso collected all quantitative data for all timepoints and were overseen by a local project manager. Qualitative data were collected using a subset of the data collection team, with a translator, as well as a community health worker who had rapport with the mothers. Detailed methodology for each type of data collected is included in each relevant chapter.

Quantitative data were collected by administering the HHS to all of the households available at baseline (households; n=260), endline (n=252), and follow-up (n=247). The A-WEAI was administered at endline in conjunction with the HHS.

Qualitative data were collected through focus group discussions, which were held to helps explain survey responses in a subsample of nine villages after both endline and follow-up quantitative data collections. A complete breakdown of qualitative data collection can be found in the fourth chapter.

Data Management and Analysis

Data were managed using REDCap. Microsoft Excel was used for data standardization, basic recoding, and cleaning. Rigorous quality control was conducted to ensure that all data were retrieved from the online repository in REDCap at each timepoint. After retrieval, all household surveys were checked for the correct ParticipantID by confirming the child's name and date of birth with the mother's name against the project's Master Participant List to ensure the correct child-mother dyad was surveyed under the correct ParticipantID for all analyzed timepoints. Data analyses were performed using IBM Statistical Packaging for the Social Sciences (SPSS; version 26) software on an encrypted computer suitable for human subjects' research. An in-depth data analysis section is provided Chapters 2–4 for the analyses performed therein.

Study Funding

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Ethical Approval

All participants of both the *Un Oeuf* and Enhance Follow-up studies received adequate information, prior to their participation, which allowed each individual participant to make a well-informed decision of whether or not to consent to participation in both studies. Informed consent was carried out on two separate occasions to properly inform participants. All members of the in-country research team were fluent in French

and the local language of Moré. Project documents that participants needed access to (participant information sheet and informed consent form) were translated from English into French and copies were provided to the University of Florida Institutional Review Board (IRB) and the Burkina Faso Ethical Review Board (ERB). Approval for all aspects of research presented herein was granted by the UF IRB and the Burkina Faso ERB prior to the collection of any data.

CHAPTER 2
ASSESSING THE EFFECTIVENESS OF TIMING MODELS FOR LIVESTOCK ASSET DELIVERY TO INCREASE EGG CONSUMPTION: FINDINGS FROM FOLLOW-UP TO THE *UN OEUF* STUDY

Introduction

Childhood undernutrition is a leading cause of death and comorbidity within the vulnerable demographics of children under five (CU5) and infants and young children (IYC) (Bain et al., 2013; Dror & Allen, 2011; Frison et al., 2006; Guerrant, Oriá, Moore, Oriá, & Lima, 2008; Müller & Krawinkel, 2005; UNICEF, 2019). Studies have shown that the inclusion of animal source foods (ASF) can mitigate the severity of malnutrition through the abundance and bioavailability of macro- and micronutrients in ASF (Coates, Colaiezzi, Bell, Charrondiere, & Leclercq, 2017; Frison et al., 2006; Harragin, 2006; C. Neumann, Harris, & Rogers, 2002). Unfortunately, a prerequisite to consuming household ASF is to first own household livestock which produce it—this can be a barrier for struggling households or people in a lower socioeconomic status. Additionally, many pastoralist and agropastorlist families sell household ASF to generate income that is then used to purchase less nutrient-rich foods that are more shelf-stable, cost less than ASF, and can be stretched to feed more mouths (Azzarri et al., 2015; Nakiganda et al., 2006). However, previous livestock studies show the importance that livestock ownership can have on ASF consumption in children (L. Iannotti & Lesorogol, 2014; Kariuki et al., 2013; Mosites et al., 2015; Smith et al., 2013; Workicho et al., 2016). Because much of the world's food- and nutrition-insecure populations also live in low-income countries, it is necessary to find a sustainable source of ASF that will aid in combatting and overcoming childhood malnutrition (Dror & Allen, 2011; Hetherington et al., 2017; Lutter & Rivera, 2003; UNICEF, 2019).

Studies have shown that ASF consumption in children is associated with household livestock assets (Azzarri et al., 2015; Hetherington et al., 2017; Kariuki et al., 2013; Mosites et al., 2015; Rawlins, Pimkina, Barrett, Pedersen, & Wydick, 2014; Smith et al., 2013). Many studies also show that ASF consumption can be bolstered by increasing household knowledge of both animal husbandry and nutrition (A. K. Christian et al., 2016; Jin & Iannotti, 2014; Ruel et al., 2013; Worsley, 2002). Studies also show the positive outcomes of increasing ASF consumption in children through these means (L. Iannotti & Lesorogol, 2014; L. L. Iannotti et al., 2017; Jin & Iannotti, 2014; Muslimatun & Wiradnyani, 2016; Charlotte G. Neumann et al., 2013). However, there is little research available on how to most effectively catalyze behavior change to increase ASF consumption using a combination of livestock assets, increasing knowledge, and/or both. Research identifying effective timing models – combinations of strategies to increase assets and improve knowledge, attitudes, and practices – are necessary.

Using seminal egg-consumption studies (L. L. Iannotti et al., 2017; Omer et al., 2018) as a guidepost and in keeping with the United Nations Sustainable Development Goals (3, 5, and 8)(WCF(UK), 2017) to improve child nutrition and decrease deaths among CU5, researchers at the University of Florida (UF), in partnership with the *Institut de l'Environnement et de Recherches Agricoles* (INERA) in Burkina Faso and Hawassa University, Ethiopia, designed a study to test a behavior change communication (BCC) package on child chicken egg consumption in the Kaya Department of rural Burkina Faso. Using data collected during that study, called the *Un Oeuf* study, and additional data collected during a follow-up study, this paper evaluates the effect of various timing

models that combine livestock assets—chickens, in this case—and nutritional education on a targeted behavior change: egg consumption among IYC.

Background

The *Un Oeuf* study team designed an innovative BCC intervention to improve egg consumption among IYC in rural villages within the Kaya Department of Burkina Faso. The intervention began in July 2018 (baseline) and ran through April 2019 (endline). A cluster randomized controlled trail (cRCT) was designed to test the impact a BCC package had on child egg consumption, both with and without the simultaneous receipt of livestock assets, consisting of the transfer of three chickens. A follow-up study, the Enhance Follow-up, examined the impact of livestock asset distribution *asynchronous* to the BCC package, as well as the impact of receiving livestock assets without an Integrated Nutrition and Agriculture (INA) training program. The additional round of data collection allowed the research team to better understand the effectiveness of the BCC packages and the effect that the timing of livestock asset receipt had on observed behavior change, as well as the sustainability of any behavior change observed during the *Un Oeuf* Study. In addition, it allowed for assessment of behavior change between the completion of the *Un Oeuf* study and the Enhance follow-up three months later.

Objectives

Utilizing data collected during the *Un Oeuf* and Enhance Follow-Up studies, this paper will compare the effect of various timing models of livestock assets and training on egg consumption in CU5 in rural Burkina Faso. To reach this objective, the paper will compare egg consumption after three distinct models of intervention delivery—(1) a synchronous timing model of attending an INA training program (10 trainings, one per

month) and receiving livestock assets, (2) an asynchronous timing model of attending an INA training program (10 trainings, one per month) *prior* to receiving livestock assets, and (3) another asynchronous timing model of receiving *one stand-alone* information/training session followed by receiving household livestock assets.

Methods

Study Location and Participant Selection

Data were collected in the Centre-Nord Region (Northern-Central Region) of Burkina Faso, where there is a high prevalence and incidence of child wasting and stunting (I. INSD, 2012). This region is located in the dry, Sahelian zone which is recognized as a climate-vulnerable area that relies primarily on livestock production and (limited) staple crop production for livelihood. The study population consists of 260 mother-child dyads from 18 rural villages across the Kaya Department of the Sanmatenga Province within the Centre-Nord Region.

For simplicity, each mother-child dyad is referred to as “participant”, unless referring to the survey respondent (mother) or egg consumption (child). Due to natural maturation of children in the study population, the term “infants and young children” is used to reference the study population at baseline or aims of the study; results from the study refer to them as “children” or “children under five”, reflecting the aging of the original sample over time. Due to the longitudinal nature of this study, not all 260 participants included at baseline were available at each analyzed timepoint in this research.

Study Design

This paper analyzes longitudinal data from the ten-month *Un Oeuf* and the post-trial, cross-sectional follow-up (Enhance Follow-up) using two timeframes of interest—

the first being from baseline to the month three (M3) and the second being from endline to the follow-up. The full study design and account of methodology employed in the *Un Oeuf* study is published elsewhere (Stark et. al., 2020). The Enhance Follow-up surveyed the same 260 participants in July 2019, three months after the April 2019 completion of the *Un Oeuf* study. This paper analyzes participants, within their respective research arms, from baseline to M3 and again from endline to follow-up.

Livestock and Training Timing models

The original three-armed cRCT was designed to include two separate treatment arms (full and partial) and a control group. The full treatment arm received synchronous delivery of the BCC package (monthly INA trainings, monthly home visits by key members of the *Un Oeuf* project team, and key message reinforcement) and livestock assets, through "gifting" to each child. A gifting ceremony was held, during which each child received three hens from a community champion. The INA training program was conducted by community health workers (CHW) and agricultural extension workers (AEW). The partial treatment arm received the same BCC package but did not receive chickens as part of the intervention and the control arm received nothing.

After the completion of the cRCT, a closing ceremony was conducted to share preliminary project findings with participants and community champions, to share best practices through an abbreviated training session for the control group, and, as designed, to provide two chickens to participants in the partial and control groups, who had not previously received any livestock asset, in appreciation of their participation. Due to security and logistical constraints at the time of the closing ceremony, CHWs and AEWs delivered the chickens to these participants between late May and early June 2019. Because participants in the partial and control groups received livestock

assets, researchers were able to examine differences in egg consumption between a synchronous and asynchronous model (full v. partial research arms), as well as between a model that included BCC package prior to receiving livestock assets and a model of livestock assets only (partial v. control research arms). For clarification on livestock asset timing and timing models see Table 2-1.

Data Collection, Management, and Quality Control

Data were collected from all 260 participating households using encrypted tablets on the secure, web-based application, Research Electronic Data Capture (REDCap), in accordance with the UF's IRB policy for electronic data collection. The survey included questions about the demographics, health, nutrition, agriculture, as well as related knowledge, attitudes, and practices (KAP) of the household and questions on household decision-making and egg consumption. A comprehensive household survey (HHS) was conducted at follow-up. Three graduate students from the University of Ouagadougou in Burkina Faso conducted data collection for the *Un Oeuf* and Enhance Follow-up studies. They were overseen by a local project manager.

Data were managed using REDCap. Microsoft Excel was used for data standardization, basic recoding, and cleaning. Rigorous quality control was conducted to ensure that all data were retrieved from the online repository in REDCap. All household surveys were checked for the correct ParticipantID by confirming the child's name and date of birth with the mother's name against the project's Master Participant List to ensure the correct child-mother dyad was surveyed under the correct ParticipantID for all analyzed timepoints.

Data Analysis

Data analysis was performed using IBM Statistical Packaging for the Social Sciences (SPSS; version 26) software on an encrypted computer suitable for human subjects' research. Primary data analysis was conducted by a series of a one-way analysis of covariances (ANCOVAs) to examine if significant differences in egg consumption at timepoints of interest (M3 and Follow-up) existed between participants receiving different timing models. Linear regressions were run to further investigate the impacts of explanatory variables embedded within the behavior change communication packages and timing of livestock asset delivery. For all linear regression models, simultaneous entry method was used for candidate variables and a significant *p*-value was determined to be a *p*-value of ≤ 0.05 expressed by any candidate variable after inclusion into the model. Previous analysis from the *Un Oeuf* study showed that the BCC intervention significantly increased egg consumption by the end of the project (McKune et al., 2020); analyses included here sought to further examine the impact of the *timing* of the intervention on egg consumption at timeframes that allow for comparison across timing models: between baseline to M3 and endline to follow-up, as seen below in Table 2-2.

Synchronous v. asynchronous timing models across both timeframes

In order to examine the importance of the synchronous timing model and its effect on behavior change, data were analyzed for two timeframes—(1) baseline to M3 and (2) endline to follow-up. A One-way ANCOVA was run for each of these timeframes to ascertain if any significant difference existed between the intervention groups. The dependent variable was the number of eggs consumed at the second timepoint (M3; follow-up), the fixed variable was the research arm, and the number of household

chickens at the beginning timepoint (baseline; endline) was used as the covariate. Additionally, a linear regression was run for each of the two timeframes, using the number of household chickens at the beginning timepoint (baseline for the first model; endline for the second model) as the covariate. Resultingly, the average number of eggs available to the child for consumption for each the second timepoint of analysis was respectively entered into the regression model as an explanatory variable. The dependent and independent variables remained the same.

Asynchronous timing model v. livestock assets only (endline to follow-up)

To answer the research question—did egg consumption increase more among children of women who had participated in a ten-month training program *prior* to receiving livestock assets or among children of women who only received livestock assets?—a one-way ANCOVA was conducted to examine any statistically significant differences in egg consumption at follow-up between the partial intervention and control group. The dependent variable was the number of eggs (continuous scale) consumed by the enrolled child in the seven days prior to data collection. The variable of egg consumption at endline was controlled for as covariate within the ANCOVA model. Further analysis was conducted to ensure a more robust answer to the research question; linear regression models were built using the same variables from the ANCOVA with the addition of the number of INA trainings as an explanatory variable. The regression model was built with a 95% confidence interval and model parameters for both entry and removal of 0.05 and 0.10, respectively.

Exploratory Data Analysis

To explore the importance of increasing livestock assets, further analysis was conducted to answer the question, “Does ‘gifting’ livestock assets impact behavior

change more than basic receipt of household livestock assets?" One-way ANCOVAs and linear regressions were run using the same timeframes and parameters of inclusion as primary analysis but utilizing the child's flock variable to explain the observed behavior change. As such, the covariate (at the first timepoint) and confounding variable (at the second timepoint) for these models was the number of hens owned by the child at the respective timepoints.

Ethical Approval

All study participants received information that allowed them to make a well-informed decision about whether to participate in this study. All members of the field research team were fluent in the local language of Moré and French. All project documents, including instruments and consent forms, were reviewed and approved by the UF IRB and the Burkina Faso Ethical Review Board (ERB) prior to data collection.

Results

At baseline, the enrolled children were an almost equal mix of males (51.2%) and females (48.8%). The average age of child at baseline was 9.9 months of age. By endline and follow-up, the mean ages of the male and female children were, 18.9 and 21.9 months, respectively. The summary statistics for number of household chickens at baseline, INA training attendance, and egg consumption in the past week (at the analyzed timepoints of M3, endline, and follow-up) are presented in Table 2-3 with baseline summary statistics for comparison.

Synchronous v. Asynchronous Timing Models from Baseline to Endline

To further understand the initial findings of McKune et al., which found a significant difference between the egg consumption in the full and partial (2020), a linear regression model established that both the intervention group and number of household

chickens at baseline were significantly associated with egg consumption $F(2, 215) = 176.665$, $p < 0.0005$, and that the intervention group and number of household chickens at baseline accounted for 62.2% of the variation in egg consumption with an adjusted R_2 of 61.8%, a large effect size (Cohen, 1988). The regression equation is as follows:

Synchronous v. Asynchronous Timing Models from Baseline to M3

A One-way ANCOVA was conducted to determine if there was a significant difference in the rate of behavior change adoption (i.e. egg consumption) between the research arms from the start of the intervention at baseline and M3 of data collection to examine the effectiveness of the synchronous timing model of receiving training and livestock assets. The number of household chickens at baseline were controlled for in the model. Only participants with both baseline and M3 data were used in this analysis (n=247; full=78, partial=86, control=83). Egg consumption was lowest in the control group (0.20 ± 0.694; 0.202 ± 0.177), medial by the partial intervention group (1.87 ± 1.890; 1.873 ± 0.173), and highest in the full intervention group (6.44 ± 1.911; 6.437 ± 0.182) after three months of the intervention. After adjustment for pre-intervention number of household chickens at baseline, it was determined there was a statistically significant difference between the timing models, $F(2, 243) = 322.368$, $p < 0.0005$, partial $\eta_2 = 0.726$. Post hoc analysis was performed using a Bonferroni correction factor and the number of eggs consumed in the past week at M3 were significantly greater in the full intervention when compared to both the partial intervention (adjusted mean difference of 4.564 (95% CI, 3.960 to 5.168), $p < .0005$) and control group (mean difference of 6.235 (95% CI, 5.623 to 6.846), $p < .0005$), as seen in Table 2-4. The full intervention group had the highest egg consumption at M3 between the three groups.

Asynchronous Timing v. Livestock Assets Only at Follow-up

To understand the importance of receiving training prior to receiving livestock plays in behavior change, a one-way ANCOVA was conducted between the partial and control research arms to determine the impact that attending 10-months of INA trainings *prior* to receiving livestock assets had on egg-consumption at follow-up, whilst controlling for the egg consumption and the number of INA trainings attended at endline (time point 1 in the analysis). Only participants with both endline and follow-up data were used in this analysis (n=167; partial=84, control=83). After receiving livestock assets subsequent to endline, egg consumption was lower at follow-up in the partial intervention group who completed a ten-month training program (2.63 ± 1.503; 2.417 ± 0.471), compared to the control group, who received one modified training session during the closing ceremony before receiving livestock assets (2.94 ± 1.889; 3.156 ± 0.476)[1]. After controlling endline covariates (number of INA trainings and egg consumption at endline), it was determined there was not a statistically significant difference in egg consumption between the partial intervention and control groups at follow-up, $F(1,163) = 0.659$, p-value = 0.418, partial $\eta^2 = 0.004$ (Table 2-4). A linear regression established that the intervention group and number of household chickens at endline was not significantly associated with egg consumption ($F(3, 163) = 1.822$, $p = 0.145$).

1 All ANCOVA results within the results section are shown in parentheses are represent the unadjusted mean ± standard deviation; adjusted mean ± standard error, unless directly stated.

Synchronous v. Asynchronous Timing Models from Endline to Follow-up

To determine if a statistically significant difference exists between the behavior change adoption (i.e. egg consumption) due to the asynchronous timing of training and livestock assets, a One-way ANCOVA between the research arms from the completion of training (endline) and receiving livestock assets to three months later at the follow-up data collection. The number of household chickens at endline were controlled for in the model. Only participants with both endline and follow-up data were used in this analysis (n=241; full=78, partial=82, control=81). Egg consumption was lowest in the partial intervention group (2.60 ± 1.506; 2.529 ± 0.187), marginally higher in the control group (3.01 ± 1.854; 2.965 ± 0.255), and highest in the full intervention group (5.74 ± 1.615; 5.614 ± 0.263). After adjustment for number of household chickens at endline, it was determined there was not a statistically significant difference between the partial intervention group and the control group; however, there was still a significant difference between the full intervention group and both the partial intervention and control groups, $F(2, 235) = 9.200$, $p < 0.0005$, partial $\eta^2 = 0.073$. Post hoc analysis was performed using a Bonferroni correction factor and the number of eggs consumed in the past week at endline were statistically significantly greater in the full intervention compared to the partial intervention (mean difference of 3.085 (95% CI, 2.307 to 3.863), $p < .0005$) and control group (mean difference of 2.650 (95% CI, 1.766 to 3.533), $p < .0005$) (Table 2-4). The partial intervention group had the lowest egg consumption at follow-up across the three groups.

Exploratory Analysis of Gifting v. Non-gifting Delivery Models

Additionally, to examine the roll that *gifting* played in the adoption of behavior change (egg consumption), both a One-way ANCOVA and linear regression were

conducted to determine if there was a significant difference in egg consumption at M3 of data collection between the research arms. To discern any significant difference between the groups in the ANCOVA, the number of hens owned by the child at baseline was used as the covariate. As in the previous model, only participants with both baseline and M3 data were used in this analysis (n=247; full=77, partial=86, control=83)—there is a one participant difference in the full group due to the survey respondent not answering the question about child hen ownership. Egg consumption was lowest in the control group (0.20 ± 0.694; 0.205 ± 0.176), medial by the partial intervention group (1.87 ± 1.890; 1.872 ± 0.173), and highest in the full intervention group (6.43 ± 1.911; 6.429 ± 0.183). After adjustment for pre-intervention number of hens owned by the child, it was determined there was a statistically significant difference between the intervention groups, $F(2, 242) = 319.057$, $p < 0.0005$, partial $\eta^2 = 0.725$. A Bonferroni correction factor was used and the number of eggs consumed in the past week at M3 were statistically significantly greater in the full intervention compared to the partial intervention (adjusted mean difference of 4.557 (95% CI, 3.949 to 5.165), $p < .0005$) and when compared to the control group (mean difference of 6.224 (95% CI, 5.611 to 6.837), $p < .0005$), also shown in Table 2-4. The full intervention group had the highest egg consumption at month three between the three groups.

For further exploration, a linear regression model was built using the baseline number of hens owned by the child as the covariate whilst the number of hens owned by the child at M3 was used as the explanatory variable for “gifting”. A linear regression model was conducted and established that after controlling for the number of hens owned by the child at baseline, the number of hens a child owned at M3 was

significantly associated with egg consumption at M3, $F(3, 241) = 243.244$, $p < 0.0005$. Additionally, the number of hens a child owns at baseline and month three, as well as the intervention group accounted for 75.2% of the variation observed in egg consumption at M3 (adjusted R_2=0.752), having a large effect size(Cohen, 1988). The linear regression equation for egg consumption was:

Lastly, to further examine the roll that *gifting* may have played in sustaining egg consumption in the full intervention arm at follow-up, a linear regression model tested differences between research arms from endline to follow-up. Within the model, the number of hens owned by the child at endline was controlled for in the model, whilst the number of hens owned by the child at follow-up was used as an explanatory variable. This model allows for looking at not only the timing of delivering an asset to a household, but also the importance of a child owning his or her own flock of hens, received as gifts from a community champion, on egg consumption. A linear regression model was conducted and established that after controlling for the number of hens the child owned at endline, the number of hens a child owned at follow-up was significantly associated with egg consumption at follow-up, $F23, 243) = 44.225$, $p < 0.0005$. Additionally, the number of hens a child owns at endline and follow-up, combined with the intervention group, accounted for 35.3% of the variation observed in egg consumption at follow-up (adjusted R_2=0.353), having a small effect (Cohen, 1988).

Discussion

Grounded in previous research and existing best practices for livestock development projects(Creswell, Klassen, Plano Clark, & Smith, 2011; Hetherington et al., 2017; Jin & Iannotti, 2014; Kariuki et al., 2013; Miller et al., 2014; Nakiganda et al., 2006), a culturally-centered BCC package was developed and tested in a cRCT, with

the aim of improving egg consumption in CU5 in rural Burkina Faso. A follow-up study was conducted to evaluate the effectiveness of the BCC package when embedded within models that have different timing of livestock asset delivery. The overarching project aim was to alter behavior of mothers to include eggs in the diets of children during critical windows of development, in the hope that child nutritional status would increase with sustained behavior change (Ayele & Peacock, 2003; Azzarri et al., 2015; Dror & Allen, 2011; Jin & Iannotti, 2014; Muslimatun & Wiradnyani, 2016; Zhang et al., 2016). To examine the differential impact the timing of receiving training and livestock assets impacts behavior change of ASF (egg) consumption, two strategies were developed—a synchronous timing model (*Un Oeuf* study full intervention) and an asynchronous timing model (*Un Oeuf* study partial intervention).

The timing of receiving livestock assets (synchronous v. asynchronous) and the delivery of an INA training program is of great interest to stakeholders and developers working to improve childhood nutrition in low-income countries through agricultural pathways. This project sought to explore whether a synchronous timing model was more effective than an asynchronous timing model, in which the participants completed a training program prior to the receipt of livestock assets. Furthermore, the project sought to determine if there was a significant difference between behavior change in participants who attended a training program versus participants who were simply given livestock assets for the household after a one-time training. Examining these different timing models is important since all three have different implications on both time and money invested. The implementation of the synchronous timing model is most costly at the outset, as it must deliver both livestock assets and a training program; the

asynchronous model has comparable costs, but costs are disbursed over time. Lastly, there is the Livestock Asset Only timing model which costs the least amount of money and time due to consisting of fewer chickens and no training. There is value in the examination of these timing models, as it provides insight into how money may best be used to facilitate behavior change to increase ASF consumption and better nutritional outcomes in CU5 in malnourished populations.

The results in Chapter 2 confirmed previous literature showing that the combination of owning livestock assets and receiving basic training on nutrition and agriculture are correlated to higher ASF consumption in children (Azzarri et al., 2015; Hetherington et al., 2017; Jin & Iannotti, 2014; Kariuki et al., 2013; Mosites et al., 2015). Additionally, these results are potentially important for actors in international development who are trying to understand how to best budget and plan for interventions that aim to increase ASF consumption to improve nutritional outcomes.

Results of this study showed that egg consumption was significantly higher among participants in the synchronous timing model, within which livestock assets and training were given together, compared to children whose mothers received the asynchronous timing model—and this result holds for all analyzed time points (M3, endline, and follow-up). Unexpectedly, egg consumption was *not* significantly different between participants in the asynchronous timing model and those who received livestock assets only. However, at follow-up the participants who received the synchronous timing model *sustained* a significantly higher egg consumption compared to those who received the asynchronous model and the livestock assets only model.

It would have been logical to assume that after receiving hens a shift in egg consumption proportional to the number of hens received would have been observed within the participants of the asynchronous timing model; however, this was not the case. This could imply that (1) the act of *gifting* livestock to a child may be more impactful than when the household, as a whole, receives livestock assets; (2) two hens were unable to produce enough eggs to allow for an additional increase in egg consumption; and/or (3) that the key piece is the synchronous timing model of training and assets to create the most behavior change. Because of these findings, it is imperative to discuss the nuance between all timing models and their implications on the behavior change adoption of feeding CU5 eggs to better child nutrition through this increase in ASF consumption.

While it has already been stated and shown that synchronous timing model of receiving the BCC packages in conjunction with livestock assets proved to significantly and positively increase egg consumption, it is important to further unpack the possible reasons for *why* this was observed within participants of the synchronous timing model at a much higher level than the others. Behavior change communication packages for the synchronous and asynchronous timing models were identical in nature (i.e. monthly trainings, household visits, and survey administration) with exception to the timing and number of livestock assets received. After completion of the *Un Oeuf* study, the partial intervention group not only received *fewer* livestock assets (two hens to the household rather than three from the community champion plus one from the family for a total of four hens), but also, the participants in the asynchronous timing model received the chickens in a fundamentally different manner. These participants were simply given two

chickens by project team members as gratitude for their participation and commitment of time to the research project, as opposed to being gifted chickens through a cultural pathway with social significance. When the full intervention children were *gifted* their chickens, a gifting ceremony was performed, during which a community champion ceremoniously presented chickens to the child, and this public action held great cultural significance. By gifting the children hens to add to their flocks, the hens and all of their eggs and hatchlings, became the child's. Because of this ownership, it is presumed to be culturally more appropriate for the child to consume the eggs produced by these hens, as opposed to selling those eggs at the market and depriving the child of the nutritional benefits. The importance of this symbolic gesture of gifting may explain the difference observed in the results associated with the different models of intervention received by the full (synchronous) and partial (asynchronous) intervention groups. This can be further supported to be the case by the fact that the number of household chickens at baseline was a low predictor for egg consumption at endline; however, at the analyzed timepoints of M3 and follow-up, the number of hens owned by the child at the time of the survey was a significant predictor of egg consumption. This could imply that gifting may be a cause of the significant behavior change; however, further and more specific research surrounding gifting of livestock assets is needed to confirm this interpretation of the results.

Alternatively, the results at M3 and follow-up suggest two other possible interpretations which are more apparent at the surface, which is that there was either (1) a necessary livestock threshold that was not breached when the partial and control groups received two chickens as gratitude for participation, or (2) that there is a

fundamental difference in the shift and reinforcement of behavior when there is a synchronized effort to increase livestock assets and knowledge through training. Regarding a threshold for livestock, it is important to note that though the receipt of two chickens was not enough to stimulate further behavior change in the participants of the asynchronous timing model, it was enough to catalyze a significant behavior change in the participants of the livestock assets only model. This implies that more research is needed to understand potential behavior change in ASF consumption derived from only giving livestock assets, but also that further research is needed to understand the synchronous and asynchronous timing models when the number and delivery of livestock assets are identical.

Limitations for this study include the attrition that occurred between endline and follow-up (with a loss of #? Observations in the control group). Additionally, since the giving of household livestock assets to the partial and control group was never intended to be an “intervention” (as it was conceived as compensation for participation), the partial and control groups received a lower number of chicken than the full group (thus limiting full comparability). There is potential demand bias within survey responses, due to the self-reported nature of key responses, which after ten months of steady data collection may have impacted response quality.

Conclusions and Recommendations

In conclusion, researchers witnessed the same level of behavior change in participants who participated in a 10-month training program prior to receiving livestock assets and those who only received livestock assets. The greatest behavior change was observed within the participants who synchronously received livestock assets and training. It is recommended that further research be conducted to understand the

importance of using a cultural pathway, such as gifting, to increase ASF consumption. It is also recommended that further research be conducted to further understand the nuance in timing models between the synchronous and asynchronous timing models by using increasing household livestock assets by the same method of delivery and number. Finding the most cost-efficient and effective method for increasing ASF consumption in CU5 is a global task necessary to combat the persistence of childhood malnutrition.

Table 2-1. Important study definitions

Project Definitions	
Synchronous Timing model	Administered to the full research arm of Un Oeuf study. Enrolled children were gifted three hens with the family contributing a fourth, subsequent to which the mothers attended monthly INA trainings for ten months.
Asynchronous Timing model	Administered to the partial research arm of the Un Oeuf study. Enrolled children were neither gifted nor given any livestock assets (hens). After the completion of the ten-month INA training program, subsequent to which the household received two hens.
Livestock Assets Only	Administered to the control group of the Un Oeuf study. Enrolled children were neither gifted nor given any livestock assets and mothers did not attend the ten-month training program. After the completion of the study, mothers received one training during an information session, along with project findings, subsequent to which the household received two hens.
Behavior Change Communication Package	The behavior change communication (BCC) package consisted of (1) a ten-month integrated nutrition and agriculture (INA) training program, (2) monthly home visits, and (3) key message reinforcement.
Gifting	A ceremonial presentation of livestock assets (three hens) to a child (enrolled in the full research arm) by a pre-identified community champion.
Giving	The delivery of livestock assets (2 hens) to households in the partial group, as part of the asynchronous timing model, and control group, as part of the livestock assets only timing model.
Egg Consumption	Number of eggs CU5 consumed in the past week, prior to data collection.

Table 2-2. Timeframes of data analysis with corresponding timing models examined

Timeframes of Data Analyses			
Timepoint 1	**Timepoint 2**	**Analyses**	**Timing models Examined**
Baseline	Month Three	ANCOVA Linear Regression	Synchronous v. Asynchronous
Endline	Follow-up	ANCOVA Linear Regression	Synchronous v. Asynchronous
Endline	Follow-up	ANCOVA Linear Regression	Asynchronous v. Livestock Assets

Table 2-3. Study population summary statistics for chicken ownership and egg consumption across timepoints of analysis.

			Research Arm							
			Control		Partial		Full		Total	
			Count (%)	Mean	Count (%)	Mean	Count (%)	Mean	Count (%)	Mean
Baseline	Child Chicken Ownership*	No	72 (84.7%)		70 (79.5%)		68 (84%)		210 (82.7%)	
		Yes	13 (15.3%)		18 (20.5%)		13 (16%)		44 (17.3%)	
	No. Household Chickens			5		9		9		8
	No. Child Chickens*			0		0		0		0
	Egg Consumption			**0**		**0**		**0**		**0**
M3	Child Chicken Ownership*	No	65 (78.3%)		56 (65.1%)		0 (0%)		121 (49.2%)	
		Yes	18 (21.7%)		30 (34.9%)		77 (100%)		125 (50.8%)	
	No. Household Chickens			1		1		2		1
	No. Child Chickens*			0		0		4		1
	Egg Consumption			**0**		**2**		**6**		**3**
Endline	Child Chicken Ownership*	No	58 (66.7%)		33 (38.4%)		0 (0%)		91 (36.1%)	
		Yes	29 (33.3%)		53 (61.6%)		79 (100%)		161 (63.9%)	
	No. Household Chickens			5		6		9		7
	No. Child Chickens*			2		2		8		5
	Egg Consumption			**1**		**2**		**6**		**4**
Follow-Up	Child Chicken Ownership*	No	0 (0%)		0 (0%)		0 (0%)		0 (0%)	
		Yes	84 (100%)		85 (100%)		78 (100%)		247 (100%)	
	No. Household Chickens			5		6		9		7
	No. Child Chickens*			2		2		5		3
	Egg Consumption			**3**		**3**		**6**		**4**

Note. *Child denotes the enrolled child participating in the study whose egg consumption is being monitored in all research arms, and the child who received hens as a result of gifting in the full research arm. Additionally, at all timepoints, some respondents chose not to answer this survey question.

Table 2-4. ANCOVA results for all models with the dependent variable of egg consumption.

Primary Analysis Results: Means and Variability Timing Model Analyses					
Synchronous v. Asynchronous Timing Models Baseline to M3: Egg Consumption at M3*					
		Unadjusted		Adjusted	
	N	Mean	SD	Mean	SE
Synchronous Delivery	78	6.44	1.911	6.437[a]	0.182
Asynchronous Delivery	86	1.87	1.890	1.873[a]	0.173
Livestock Assets Only	83	0.20	0.694	0.202[a]	0.177
Asynchronous Timing Model and Livestock Assets Only Endline to Follow-up: Egg Consumption at Follow-Up†					
		Unadjusted		Adjusted	
	N	Mean	SD	Mean	SE
Asynchronous Delivery	84	2.63	1.503	2.417[b]	0.471
Livestock Assets Only	83	2.94	1.889	3.156[b]	0.476
Synchronous v. Asynchronous Timing Models Endline to Follow-up: Egg Consumption at Follow-up*					
		Unadjusted		Adjusted	
	N	Mean	SD	Mean	SE
Synchronous Delivery	78	5.74	1.615	5.614[c]	0.263
Asynchronous Delivery	82	2.60	1.506	2.529[c]	0.187
Livestock Assets Only	81	3.01	1.615	2.965[c]	0.255
Gifting v. Non-Gifting Timing models Baseline to M3: Egg Consumption at M3‡					
		Unadjusted		Adjusted	
	N	Mean	SD	Mean	SE
Synchronous Delivery	77	6.43	1.911	6.429[d]	0.183
Asynchronous Delivery	86	1.87	1.890	1.872[d]	0.173
Livestock Assets Only	83	0.20	0.694	0.205[d]	0.176

Note. *covariate is the number of hens owned by the child at timepoint one of the analysis timeframe; †covariate is the number of INA trainings attended by endline; ‡covariate is the number of household chickens at timepoint one of the analysis timeframe

a. Covariates appearing in the model are evaluated at the following values: Number of Hens Child Owns at Endline = 3.03.

b. Covariates appearing in the model are evaluated at the following values: Endline: Eggs Consumed in Past Week = 1.54, Number of INA Trainings Attended by Endline = 3.70.

c. Covariates appearing in the model are evaluated at the following values: Number of Household Chickens at Endline = 11.35.

d. Covariates appearing in the model are evaluated at the following values: Number of Hens Child Owns at Baseline = .24.

CHAPTER 3
HOUSEHOLD DECISION-MAKING, WOMEN'S EMPOWERMENT, AND EGG CONSUMPTION IN CHILDREN UNDER FIVE IN RURAL BURKINA FASO

Malnutrition and Women's Empowerment

Malnutrition is one of the most long-suffering problems facing children under 5 (CU5) across the world, endemic to many low- and low-middle income countries, and a leading comorbidity in CU5 mortality (Bain et al., 2013; W. FAO, 2012; Müller & Krawinkel, 2005; UNICEF, 2019). The United Nations prioritizes this global issue with its inclusion in the Sustainable Development Goals (SDGs) for "Zero Hunger" (WCF(UK), 2017). Arguably, appropriate nutrition is the foundation upon which many other SDGs will be achieved, including good health and well-being, quality education, gender equality, decent work and economic growth, and reduced inequalities (WCF(UK), 2017). Researchers have shown women's empowerment (WE) is inextricably linked to the nutritional outcomes of children (Bhagowalia, Menon, Quisumbing, & Soundararajan, 2010; Cunningham, Ruel, Ferguson, & Uauy, 2015; Galiè A., Submitted; Workicho et al., 2016).

Nutrition studies have shown that malnutrition can be mitigated and outcomes improved through a variety of intervention strategies, including education and empowerment of mothers through training programs on nutrition and safe animal husbandry practices (Haselow et al., 2016; Olney et al., 2015), as well as improved nutrient intake through the inclusion of ASF in the child's diet, particularly through egg consumption (L. L. Iannotti et al., 2017; Omer et al., 2018). Animal source food consumption can improve the growth, nutritional status, cognitive development, and overall health of a child when it is regularly included in the child's diet, especially during critical times of development (Darapheak et al., 2013; Charlotte G. Neumann et al.,

2003). Unfortunately, both egg and ASF consumption are low in Burkina Faso, particularly among women and children. Additionally, the education level of women is also low, with many women not finishing primary school or attending secondary school—both of which are associated with childhood malnutrition and low women's empowerment (Haggblade et al., 2016; Jin & Iannotti, 2014; Oxaal, 1997). Furthermore, as in other parts of Africa, cultural beliefs and stigma further limit animal source food consumption, creating barriers that significantly constrain its consumption, in particular the consumption of chicken eggs, in Burkina Faso (L. Iannotti & Lesorogol, 2014; Rogers, 1996).

Empowering women and increasing their ownership of livestock can result in an increase of ASF consumption at a household-level—one method for achieving both of the aforementioned is through smallholder poultry farms (SHPF), which can help increase household-level food and nutrition security through an increase in food availability, income generation, and women's empowerment (Smith et al., 2013; Somé, 2013). Unfortunately, livestock producing households in Burkina Faso generally keep livestock for income generation, gifting to others, and socio-religious practices, rather than for increasing household consumption.

There is growing evidence that targeting and empowering mothers in livestock production and programing may improve child nutrition through increased ASF consumption (Jin & Iannotti, 2014). Primary female caregivers (referred to as mothers, henceforth) play an essential role in improving childhood nutrition; therefore, it is critical to involve and train them in livestock production. A more holistic approach that couples livestock and nutritional knowledge, attitudes, and practices is needed if the nutritional status of CU5 is to be bettered through the regular inclusion of ASF in their diets.

Women's Empowerment and Household Decision-making

Women's empowerment is sometimes critiqued as being an abstract concept, something difficult to measure, variable across contexts, and subject to interpretation; however, tools have been developed to both quantitatively and qualitatively capture metrics of women's empowerment. In 2012, the International Food Policy Research Institute (IFPRI), in collaboration with Oxford Poverty and Human Development Initiative (OPHI) and USAID's Feed the Future, launched a new and innovative tool designed to measure women's empowerment within the role of agricultural development—the Women's Empowerment in Agriculture Index (WEAI). This tool has since been modified in numerous forms, including an abbreviated version (A-WEAI), which focuses on 5 domains of women's empowerment and as used for this study. The application of these domains into research inquiries provides insight into the roles of women in the livestock sector (Malapit et al., 2017).

It has been shown that a woman's empowerment and household decision-making plays a critical role in determining the nutritional outcome of her children (Doss, 2013). Women's decision-making is a critical component of empowerment. It is important to understand that tools, such as the Women's Empowerment in Agriculture Index, have been created to measure women's overall empowerment. This tool uses multiple domains—production, resources, income, leadership, and time—to reflect upon a woman's level of empowerment. Furthermore, in order to understand the relationship between empowerment and ASF consumption, it is helpful to examine a woman's level of household decision-making specific to nutritional aspects of her family life that may either facilitate or constrain ASF consumption by her child(ren) (Agarwal, 1997; Ahmed, 2006; Richards et al., 2013; Seebens, 2011).

This study will examine domains of empowerment identified as encompassing a woman's overall level of empowerment, as well as domains of household decision-making tailored to decisions surrounding nutrition—particularly chicken egg consumption. While this may seem redundant, it is purposeful in nature, since the overall level of a woman's empowerment stems from Western notions of what an empowered woman should look like.

Burkina Faso

Burkina Faso is a low-income country (LIC) which suffers from high rates of malnutrition, anemia, and stunting in CU5 (I. INSD, 2012). Much of this burden is attributable to high levels of food insecurity, inadequate complementary feeding practices, and poor dietary diversity, reflecting a lack of animal source food (ASF) consumption (Stewart, Iannotti, Dewey, Michaelsen, & Onyango, 2013). As with many other low-income countries, the rate of child mortality in Burkina Faso is associated with the nutritional status of the children (UNICEF, 2012). Childhood malnutrition can cause severe disease that impairs a child's physical and mental development and increases the overall chance of mortality from other illnesses.

A gender gap exists in Burkina Faso, which has been identified by the United Nations Rights Development Programme via the Gender Gap Index (GGI) and is impacting the outcomes in MCH. The United Nations Development Programme ranked Burkina Faso 182nd in the world with a GII of 0.434—meaning that women are only 43 percent equal to men in Burkina Faso (2019). This inequality is far reaching, extending into educational, economic, health, nutrition, and decision-making inequalities between men and women. This severely impacts the nutritional and overall health outcomes in

children, since women's empowerment has long been shown to directly impact both (Ayele and Peacock, 2003; Kariuki, 2013; Nelson, 2009).

Un Oeuf Study

Responding to the call for a more holistic approach to combat malnutrition in CU5 in Burkina Faso, researchers from the University of Florida and the *Institut de l'Environnement et Recheres Agricoles* (Environmental Institute for Agricultural Research; INERA) designed a cluster randomized controlled trial (cRCT) called the *Un Oeuf* study to examine behavior change of egg consumption in the Kaya Department of rural Burkina Faso. The *Un Oeuf* study data collection began in July 2018 and concluded in April 2019. The *Un Oeuf* cRCT aimed to increase egg consumption in CU5 through increasing household livestock assets (chickens) and empowering mothers through education on agriculture and nutrition. The *Un Oeuf* study had three research arms consisting of (1) a full intervention group which enrolled children were gifted chickens at the onset of the project and enrolled mothers received monthly Integrated Nutrition and Agriculture (INA) trainings throughout the length of the project; (2) a partial intervention group in which enrolled mothers receive the same monthly INA trainings as the full intervention group; (3) and a control group which will received neither trainings nor livestock assets.

The study was designed to explicitly engage women's empowerment as a pathway to reaching its end goal, of egg consumption. The study targeted and trained rural mothers in integrative nutrition and agriculture, collecting data at baseline and endline on four dimensions of household decision-making related to egg consumption. Subsequently, and with additional funding, a follow-up study (the Enhance study) was conducted to examine women's empowerment in full, as indicated by the A-WEAI, at

endline of the *Un Oeuf* study in April 2019. Using household decision-making surrounding nutrition (as a proxy measurement for women's empowerment within the study) and women's empowerment at endline, as defined by the A-WEAI, this study aims to (1) examine the associations between both household decision-making surrounding nutrition and women's empowerment with chicken egg consumption among IYC, (2) test the effect of the *Un Oeuf* project on household decision-making surrounding nutrition, and (3) to explore the overall relationship between household decision-making and women's empowerment within the study population.

Methods

Study Location and Population

This study was conducted in the Kaya Department within the Sanmatenga Province of the Centre-Nord Region of Burkina Faso. The study population for this study (n=260) is identical to that of the Un Oeuf study, having enrolled those participants for the Enhance study. The full participant recruitment and enrollment protocol can be found in Starke et al. (2020). A total of 260 mother-child dyads were used for this study.

Study Design

This longitudinal study leverages data collected during baseline and endline of the cRCT through the Un Oeuf Study (July 2018–April 2019), and additional data from the Enhance Study, which was collected in conjunction with the Un Oeuf at endline (April 2019).

Data Collection Instruments

Household survey. For this study, a household was defined as a "shared cooking pot", as it is commonly defined within much of Western Africa. by the mother-child dyad enrolled in the study. The household survey (HHS) was successfully administered to

and completed by 260 mother-child dyads at baseline of the Un Oeuf study. The basic demographics, including gender, age, age at first live-birth, marital status (including if the husband has other wives), and education level of the respondent, were all controlled for within the study design of a cluster randomized controlled trial (cRCT).

The HHS sections relevant to this paper are those on household demographics; knowledge, attitudes, and practices of household child-feeding with an emphasis on egg consumption; and household decision-making (HHDM) data. The HHS section on knowledge, attitudes, and practices of household child-feeding was tailored to assess the observable behavior change across research arms, as well as to understand current and past feeding practices with an emphasis on egg consumption. The “gender empowerment” section of the Un Oeuf HHS was limited to understanding who makes household decisions surrounding nutrition and division of food resources. The aim was to assess the level of household decision-making the mother of each dyad had within her household and any effect on egg consumption from baseline to endline. Household decision-making surrounding nutrition included four variables—who decides (1) what foods are fed to children (HHDM-F), (2) what foods are bought (HHDM-B), (3) how foods are portioned (HHDM-P), and (4) what is done with household eggs (HHDM-E).

Abbreviated Women’s Empowerment in Agriculture Index. Quantitative women’s empowerment data were collected at a household-level using a validated survey instrument known as the Abbreviated Women’s Empowerment in Agriculture Index (A-WEAI). This questionnaire is a validated questionnaire designed to examine women’s empowerment within the agriculture sector. It was created to be administered to household-gender-pairs of men and women, with the score of the male counterpart allowing for gender parity assessment. When the A-WEAI tool is administered only to

women, the results are referred to as the Five Domains of Empowerment (5DE). In this study, the questions were only administered to women, thus generating an overall empowerment score based on the 5DE. The A-WEAI questionnaire was used to gather 5DE data within the same 260 households that responded fully to the HHS in the study population.

Data Collection

Quantitative data collected for this study were collected from all available mother-child dyads enrolled in the *Un Oeuf* study at the timepoints of baseline and endline. Women were surveyed using a questionnaire, which consisted of the *Un Oeuf* study household survey (HHS) and the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI). The HHS gathered basic household demographic information; livestock knowledge, attitudes, and practices; household nutrition; household decision-making; water and sanitation; egg consumption of the enrolled child; and other information (see Starke et al., 2020). The A-WEAI is designed to be implemented with men and women, and it uses gender parity in the final calculation. Gender parity is combined with the Five Domains of Empowerment (5DE) score, weighted .20 and .80, respectively, to yield the A-WEAI score. However, in this study only women were asked the A-WEAI questions, thus the findings are actually the 5DE. The 5DE questionnaire was tailored by local members of the study team, with assistance of in-country gender experts who have extensive experience and trained the team on implementation of the A-WEAI in Burkina Faso.

Data were collected using a team of graduate students from the University of Ouagadougou in Ouagadougou, Burkina Faso. The data collection team was trained for data collection for the *Un Oeuf* HHS by University of Florida researchers prior to the

start of the project. Additional training on implementation of the A-WEAI was provided in the Spring of 2019 prior to endline data collection, including a pilot test of 5DE data collection. The 5DE was administered in tandem with the HHS with mothers at endline in April 2019.

Data Management, Quality Control, and Preparation

Data management for data collected in both the *Un Oeuf* and Enhance studies was conducted in REDCap, while data organization, standardization, and cleaning procedures were carried out using Microsoft Excel and R Studio. Quality control was conducted with all longitudinal data, and mother-child dyads were verified by participant ID and household against enrollment information for each month of data collection.

The 5DE data were prepared and analyzed in R Studio by a researcher at the University of Florida, working in collaboration with IFPRI for R Studio validation. Indicators for each domain of empowerment were generated for each respondent then an overall 5DE score was generated. These indicators were used in linear regression models to examine the relationship between each subdomain of empowerment and behavior change (egg consumption) as captured by household surveys.

Data Analysis

All quantitative data were analyzed using IBM Statistical Packaging for the Social Sciences (SPSS). The data analyzed in this paper came from two survey instruments—(1) the *Un Oeuf* HHS, (2) A-WEAI. Household survey data was used for analysis of both household decision-making and egg-consumption, whilst data collected using the A-WEAI instrument was used for the analysis of women's empowerment. The primary variables used in this study include four variables on household decision-making and the variables for feeding the enrolled CU5 eggs (referred to within as "Egg

Consumption") and the overall 5DE adequacy score. The primary variables were derived from both the household survey and the A-WEAI. Data were analyzed for study population baseline and endline summary statistics, which can be seen, respectively in Table 3-5 and Table 3-6, stratified by research arm and total population.

HHDM and egg consumption at endline

Bivariate analyses were conducted using the binary dependent variable (egg consumption) against each of the four independent variables of household decision-making (HHDM-F, HHDM-B, HHDM-P, and HHDM-E) to test for independence at a study-population level and significance into the model. A standard *p*-value of ≤ 0.20 was necessary for inclusion into a binomial logistic regression model.[1] Only one HHDM variable was significant enough to be entered into the model—endline decision-making on who decides what to do with the household eggs (HHDM-E). To control for baseline HHDM-E, the baseline HHDM-E metric was entered into the model as a covariate, which was not found to be significant within the model.

A binomial logistic regression model was conducted with the confidence interval set to 95% and a corresponding *p*-value of significance of ≤ 0.05, to determine the effects of household decision-making centered around egg consumption on the likelihood that participants would feed their CU5 chicken eggs.

Change in HHDM (ΔHHDM) and egg consumption at endline

Bivariate analyses were conducted using the dependent variable (child eggs consumption in the past seven days) against each of the four categories representing

[1] Adjustment for a cluster effect within the models was deemed unnecessary following insignificant fisher's exact tests between all outcome variables of interest and clusters. The standard threshold value of 0.5 was used for predictability within all logistic regression models.

change and directionality of change in household decision-making surrounding nutrition to test for independence and significance for inclusion into the regression model (*p*-value of ≤ 0.20). Statistically significant variables were then included in a logistic regression model, where a standard *p*-value of ≤ 0.05 was used to represent significance. The only HHDM variable to show significance below $p = 0.2$ for inclusion into the model was the variable for deciding what is done with the household's chicken eggs. This variable is a four-category variable that examines the ΔHHDM from baseline to endline (Table 3-7).

A binomial logistic regression was performed to examine the effects a change in household decision-making centered around egg consumption (ΔHHDM-E) had on the likelihood that participants would feed their child chicken eggs.

Household decision-making and 5DE at endline

The four, bivariate variables for household decisions-making (HHDM-F, HHDM-B, HHDM-P, and HHDM-E), show whether or not a woman reported "self" (denoting that she has decision making power) or "other" (showing another person in the household makes that decision) at the timepoint of Endline. The adequacy score for the 5DE represents whether or not a woman was found to have an adequate score (empowerment) or inadequate score (disempowerment) at endline. A chi-squared test for association was carried out against each of the four HHDM variables against the bivariate 5DE score for inclusion into a logistic regression model. Variables that were found to have a significant ($p \leq 0.2$) were carried into a logistic regression model. A logistic regression model was built using variables found to be significant at the $p \leq 0.2$ value using 95% confidence intervals and listwise deletion. Variables were considered to have a significant relationship if results showed a final *p*-value of ≤ .05.

Relationship between *Un Oeuf* study and household decision-making

In this analysis, the three research arms of the *Un Oeuf* study (Control, Partial, and Full) represent the *Un Oeuf* study. A logistic regression was conducted to examine the relationship between the *Un Oeuf* study and household decision-making to better understand if any individual relationship existed between the *Un Oeuf* study and either of the household decision-making areas shown to have a significant relationship with the 5DE at endline—decision-making on what is done with the household eggs (HHDM-E) and how food is portioned (HHDM-P). All models were built using 95% confidence intervals and listwise deletion. Significance was determined to be any variable included into the regression model with a p-value ≤ .05.

Ethics Statement

All study participants received information that adequately allowed each participant to make a well-informed decision about whether to consent to participate in this study. All members of the in-country research team were fluent in the local language of Moré and French. Project documents were translated from English into French and copies were provided to the University of Florida Institutional Review Board (IRB) and the Burkina Faso Ethical Review Board (ERB). Both the UF IRB and the Burkina Faso ERB approved the study prior to the collection of any data.

Results

Household Decision-Making and Egg Consumption at Endline

A binomial logistic regression was executed to determine the effects of household decision-making centered around egg consumption on the likelihood that participants would feed their CU5 chicken eggs. Four variables on HHDM were examined for appropriate inclusion to the model, but only one was significant enough to be entered into the model—endline decision-making on who decides what to do with the household eggs. To control for baseline HHDM, the baseline HHDM metric for who decides what to do with the household eggs was entered into the model as a covariate. A logistic

regression model was conducted and found to be statistically significant, $\chi_2(2) = 15.50$, $p < .0005$. The model explained 11.4% (Nagelkerke R_2) of the variance in egg consumption and classified 86.8% of all cases correctly, and a non-significant Hosmer and Lemeshow Test ($p = .854$) showed that the data fit the model well. The model sensitivity was 100% with a positive predictive value was 86.83%. The covariate of HHDM-E at baseline was not found to be significant; however, it did show that women who reported "self" decision-making were 1.969 times more likely to feed their child eggs at endline. However, at endline, the relationship between HHDM-E and egg consumption was found to be significant ($p = .002$). Women who reported having "self" decision-making over what is done with the household eggs had 4.439 times higher odds of feeding their child chicken eggs than women who reported that someone else makes that decision. See Table 3-8 for results.

Change in HHDM and Egg Consumption at Endline

A binomial logistic regression was performed to examine the relationship between an observed change in household decision-making about egg consumption, defined by categories of change, and the mothers who feed their child chicken eggs at endline. As with the previous model, HHDM-E was the only variable to show significance below $p = 0.2$ and be included in the model. This variable is a four-category variable that examines the change in HHDM-E from baseline to endline (previously shown in Table 3-3). The logistic regression model was statistically significant, $\chi_2(3) = 14.027$, $p < .0005$. The model explained 9.9% (Nagelkerke R_2) of the variance in egg consumption and classified 86.5% of all cases correctly, and the Hosmer and Lemeshow goodness-of-fit test showed the model was a good fit ($p = 1.0$). The model sensitivity was 100% with a positive predictive value was 86.51%. The categories of HHDM of "positive change" and "positive sustainment" were found to be significant on egg consumption at endline ($p = .006$ and $p = .013$, respectively). Women who reported an increase in their decision-making about what is done with the household eggs, from someone else making the decision at baseline to their making the decision at endline, had 3.822 times higher odds of feeding their child chicken eggs than women who consistently reported that someone other than themselves makes that decision. Furthermore, women who reported making these decisions at baseline and sustaining that decision-making power had 6.662 times higher odds of feeding their child chicken eggs than women who did not make that decision. See

Table 3-9 for results.

HHDM and an 5DE Score at Endline

A chi-squared test for association was conducted between each of the four HHDM variables and the (adequate/inadequate) score of the 5DE. Of the four HHDM variables centered around feeding practices, two were found to have a significant ($p \leq 0.2$) association with the 5DE score—(1) who makes decisions about how foods are portioned and (2) who makes decisions about what to do with the household eggs. Subsequently, a logistic regression was performed to examine the relationship amongst HHDM-E and HHDM-P and either an adequate or inadequate 5DE score. The logistic regression model was statistically significant, $\chi_2(2) = 30.787$, $p < .0005$. The model explained between 11.7% (Cox & Snell R_2) and 15.7% (Nagelkerke R_2) of the variance 5DE adequacy and classified 66 % of all cases correctly, while Hosmer and Lemeshow test was not significant ($p = .882$) and showed the model to be a good fit. The model sensitivity was 64.2%, specificity was 67.4%, positive predictive value was 59.65%, and a negative predictive value was 71.43%. Both HHDM-E and HHMD-P were significant within the model ($p < .0005$ and $p = .012$, respectively), and showed that an increase in either resulted in an increase in likelihood for an adequate 5DE score. Women who reported making decisions about what is done with the household eggs were 2.876 times more likely to have an adequate 5DE score compared to women who reported others making those decisions. Similarly, women who reported making decisions about how food is portioned were 6.712 times more likely to have an adequate 5DE score compared to women who reported not making those decisions. See Table 3-10 for results.

Women's Empowerment (5DE) and Egg Consumption at Endline

A chi-squared test for association was performed to examine if any significant association exists between an adequate or inadequate 5DE score and egg consumption at endline. The test showed no significant relationship between the two variables. To further confirm these results, a logistic regression was performed that accounted for HHDM-E at baseline, and the model was not significant (p = .489) (
Table3-11).

Relationship between *Un Oeuf* study and Women's Empowerment

Since a significant relationship was shown to exist between an adequate 5DE score and HHDM-E and HHDM-P, logistic regressions were performed to explore the relationship between the *Un Oeuf* study research arms and the HHDM domains of who decides how foods are portioned (HHDM-P) and who decides what is done with the household eggs (HHDM-E). No significant relationship was observed between the research arms and HHDM-P (p = .531).

The logistic regression performed to examine the relationship between the research arms and HHDM-E was statistically significant, $\chi_2(2) = 19.091$, $p < .0005$. The Hosmer and Lemeshow Test (p = .997) confirmed the data to be a good fit for the model. The model explained between 7.3% (Cox & Snell R_2) and 9.8% (Nagelkerke R_2) of the variance 5DE adequacy and classified 61.8% of all cases correctly with a good model fit (Hosmer and Lemeshow, p = 1.0). The model sensitivity was 42.7%, specificity was 78.4%, positive predictive value was 63.29%, and a negative predictive value was 61.05%. The Full and Partial Research Arms were significant within the model with respective values of $p < .0005$ and p = .014 and showed that an increase in either resulted in an increase in likelihood that a woman, herself, makes decisions on household eggs. Results showed that women in the partial research arm were 2.186

times more likely, whilst women in the full research arm were 4.045 times more likely to make self-decisions on HHDM-E compared to women in the Control Arm (Table 3-12).

Discussion

Findings of these analyses contribute to the growing body of literature surrounding women's empowerment and animal source food consumption, underscoring that increasing a women's household decision-making ability surrounding the nutrition of her children is a direct pathway to increasing the ASF consumption of CU5 (Ayele & Peacock, 2003; Jin & Iannotti, 2014; Lépine & Strobl, 2013; Richards et al., 2013; Tolhurst, Amekudzi, Nyonator, Squire, & Theobald, 2008). While no significant relationships were shown to exist between egg consumption and an adequate or inadequate 5DE score, significant positive relationships were shown to exist between women's household decision-making HHDM-E and HHDM-P) and both egg consumption of CU5 and an adequate 5DE score. This is important, because , the A-WEAI does not directly account for household decision-making surrounding nutrition. Furthermore, studies show a woman's household decision-making is linked to her intrahousehold bargaining power, and must account for the decisions of her partner or the head of household if she does not identify as the head of household (Agarwal, 1997; Lépine & Strobl, 2013; Richards et al., 2013; Schmidt, 2012).

Intrahousehold bargaining power is extremely important to inspect within the concept of women's empowerment but can be difficult to understand when a study only includes women and leaves out the (other) heads of household. Intrahousehold bargaining power can be thought of as the weight one can exert on the scales of decision-making within the household—some women have full control of specific domains with the support of their spouses, while others do not have enough to tip the

scale in their favor (Agarwal, 1997; Ahmed, 2006; Seebens, 2011). Literature shows that many projects have examined women's empowerment and childhood nutrition through household surveys and anthropometrics; however, many times a validated means for assessing women's empowerment (WE) is often missing from these study designs (Bhagowalia et al., 2010; Doss, 2013). If a study does not include men directly in the design to be formally included in study, then it is up to the women to not only express what they have learned but to also sway decisions in their favor for the success of the intervention within their respective homes. This can be seen in the relationship established between those who experienced a positive change in their own decision-making and egg consumption—a woman who was not previously making decisions about eggs who reports making those decisions by the end of the project was 3.82 times more likely to feed her child eggs compared to a woman whose decision making power did not increase.

Regarding the impact of the Un Oeuf study on women's empowerment, it is apparent that the intervention successfully changed the level of household decision-making in decisions that significantly impact the consumption of ASF (eggs) in CU5. This is important, because although other studies have shown a relationship between empowering women through Western notions (represented by an adequate 5DE score in this study) and increasing ASF consumption in children, this is not the only approach to increasing ASF consumption in children—a more direct pathway may be possible by empowering women through autonomous HHDM surrounding nutrition. Prior to a woman being able to tip the scales in her favor toward adequate, overall empowerment (as indicated by the 5DE) it may be possible to change the balance of decision-making

within the household in a manner that is favorable to support behavior change that increases ASF consumption in CU5.

Limitations include the lack of women's empowerment data at baseline, which limited the ability to fully examine whether a change women's empowerment (as measured by the 5DE) would have been occurred within the study population, as well as the lack of men being surveyed for the gender parity portion of the data. An additional limitation to this study included the inability for survey respondents to show joint decision-making within their survey responses. One strength this study had was the partnership with gender experts in Burkina Faso. This collaboration allowed for rigorous training of data collectors to facilitate accurate data collection through the administering of the A-WEAI. Additional strengths include that by the time sensitive information was requested at the time of data collection for women's empowerment data, the research team had built exceptional rapport with the women in the study population, which aided in the response rate of all questions.

Conclusion

In conclusion, this study found that there is a significant relationship between household decision-making on eggs and the consumption of eggs by CU5. Secondly, a significant relationship existed between women who were able to change the autonomy of household decision-making on household eggs from someone else to themselves, as well as the women who were able to sustain that decision-making autonomy. Additionally, a significant relationship was shown to exist between a woman having an adequate 5DE score and her ability to make decisions about, both, what is done with the household eggs and how foods are portioned amongst the household members. Lastly, the *Un Oeuf* study was shown to impact the household decision-making on what

is done with household eggs, resulting in an increase of egg consumption by CU5 in a nutritionally vulnerable population in Burkina Faso.

Table 3-5. Baseline summary statistics for the study population. These data were collected in July 2018.

BASELINE SUMMARY STATISTICS					
		Control (n=88)	**Partial (n=89)**	**Full (n=83)**	**Total (n=260)**
Egg Consumption	**No**	76 (86%)	82 (92%)	76 (92%)	**234 (90%)**
	Yes	12 (14%)	7 (8%)	7 (8%)	**26 (10%)**
HHDM-F	**Other**	22 (25%)	29 (33%)	33 (40%)	**84 (32%)**
	Self	62 (70%)	58 (65%)	49 (59%)	**169 (65%)**
	No Response	4 (5%)	2 (2%)	1 (1%)	**7 (3%)**
HHDM-B	**Other**	77 (87%)	82 (92%)	76 (92%)	**235 (90%)**
	Self	7 (8%)	5 (6%)	6 (7%)	**18 (7%)**
	No Response	4 (5%)	2 (2%)	1 (1%)	**7 (3%)**
HHDM-P	**Other**	39 (15%)	38 (43%)	46 (55%)	**123 (47%)**
	Self	45 (80%)	49 (55%)	36 (44%)	**130 (50%)**
	No Response	4 (5%)	2 (2%)	1 (1%)	**7 (3%)**
HHDM-E	**Other**	57 (65%)	54 (61%)	58 (70%)	**169 (65%)**
	Self	26 (29%)	33 (37%)	24 (29%)	**83 (32%)**
	No Response	5 (6%)	2 (2%)	1 (1%)	**8 (3%)**

Table 3-6. Endline summary statistics for the study population. These data were collected in April 2019.

ENDLINE SUMMARY STATISTICS					
		Control (n=88)	**Partial (n=89)**	**Full (n=83)**	**Total (n=260)**
Egg Consumption	No	33 (38%)	1 (1%)	0	**34 (13%)**
	Yes	54 (61%)	85 (95%)	79 (95%)	**218 (83.9%)**
	No Survey	1 (1%)	3 (4%)	4 (5%)	**8 (3.1%)**
HHDM-F	Other	0	2 (2%)	0	**2 (0.8%)**
	Self	87 (99%)	83 (93%)	79 (95%)	**249 (95.7%)**
	No Survey	1 (1%)	3 (4%)	4 (5%)	**8 (3.1%)**
	No Response	-	1 (1%)	-	**1 (0.4%)**
HHDM-B	Other	85 (97%)	84 (94%)	76 (92%)	**245 (94.2%)**
	Self	2 (2%)	1 (1%)	3 (3%)	**6 (2.3%)**
	No Survey	1 (1%)	3 (4%)	4 (5%)	**8 (3.1%)**
	No Response	-	1 (1%)	-	**1 (0.4%)**
HHDM-P	Other	7 (8%)	11 (13%)	7 (8%)	**25 (9%)**
	Self	80 (91%)	74 (83%)	72 (87%)	**226 (87%)**
	No Survey	1 (1%)	3 (3%)	4 (5%)	**8 (3%)**
	No Response	-	1 (1%)	-	**1 (0.4%)**
HHDM-E	Other	61	44 (49%)	29 (35%)	**134 (51.6%)**
	Self	26	41 (46%)	50 (60%)	**117 (45%)**
	No Survey	1 (1%)	3 (4%)	4 (5%)	**8 (3%)**
	No Response	-	1 (1%)	-	**1 (0.4%)**
5DE Overall Score Adequacy	Inadequate	50	53	39 (47%)	**142 (55%)**
	Adequate	33	33	40 (48%)	**106 (41%)**
	No Survey	2 (2%)	3	4 (5%)	**9 (4%)**
	No Response	3 (4%)	-	-	**3 (1%)**

Table 3-7. Variables depicting the change in household decision-making from baseline to endline.

Categories of Change in Household Decision-Making			
ΔHHDM	**Baseline HHDM**	→	**Endline HHDM**
Positive Change	Other	→	Self
Positive Sustainment	Self	→	Self
Negative Sustainment	Other	→	Other
Negative Change	Self	→	Other

Table 3-8. Logistic regression results for egg consumption based on HHDM-E at endline

Logistic Regression Predicting Likelihood of Egg Consumption based on HHDM-E at Endline								
Predictor	***B***	**S.E.**	**Wald**	***df***	***p***	**Odds Ratio**	95% CI for Lower	Upper
HHDM-E at Baseline	.678	.486	1.945	1	.163	1.969	.760	5.102
HHDM-E at Endline	1.490	.476	9.809	1	.002	4.439	1.747	11.281
Constant	2.286	.273	70.192	1	.000	9.834		

Note. * denotes significant *p*-value; HHDM-E is for self compared to other.

Table 3-9. Logistic regression results for egg consumption based on change in HHDM-E from baseline to endline

Logistic Regression Predicting Likelihood of Egg Consumption based on Change in HHDM-E from Baseline to Endline								
Predictor		**S.E.**	**Wald**	***df***	***p***	**Odds Ratio**	95% CI for Lower	Upper
Change in HHDM-E (Negative Sustainment)			12.263	3	.007			
Change in HHDM about Household Egg Decisions (Negative Change)	.843	.586	2.074	1	.150	2.324	.738	7.322
Change in HHDM about Household Egg Decisions (Positive Change)	1.341	.490	7.498	1	.006*	3.822	1.464	9.977
Change in HHDM about Household Egg Decisions (Positive Sustainment)	1.896	.763	6.171	1	.013*	6.662	1.492	29.745
Constant	2.192	.256	73.457	1	.000	8.951		

Note. * denotes significant *p*-value; Change in HHDM-E is for Negative Sustainment compared to Negative Change, Positive Change, and Positive Sustainment.

Table 3-10. Logistic regression results for empowerment adequacy based on HHDM-P and HHDM-E at endline.

Logistic Regression Predicting Empowerment Adequacy based on HHDM-P and HHDM-E at Endline								
Predictor	***B***	**S.E.**	**Wald**	***df***	***p***	**Odds Ratio**	95% CI for Lower	Upper
HHDM-P at Endline	1.904	.762	6.247	1	.012*	6.712	1.508	29.871
HHDM-E at Endline	1.056	.275	14.773	1	.000*	2.876	1.678	4.929
Constant	-1.109	.380	8.509	1	.004	.330		

Note. * denotes significant *p*-value; HHDM-P and HHDM-E are for self compared to other.

Table3-11. Logistic regression results for egg consumption based on HHDM-E at endline

Logistic Regression Predicting Likelihood of Egg Consumption based on HHDM-E at Endline								
Predictor		**S.E.**	**Wald**	***df***	***p***	**Odds Ratio**	95% CI for Lower	Upper
HHDM-E at Baseline	.836	.480	3.039	1	.081	2.308	.901	5.911
Empowerment 5DE at Endline	.276	.399	.480	1	.489	1.318	.603	2.878
Constant	2.128	.245	75.347	1	.000	8.397		

Note. HHDM-E at baseline is for self compared to other, and empowerment is for adequate compared to inadequate.

Table 3-12. Logistic regression results for egg consumption at endline based on HHDM-E across research arms

Logistic Regression Predicting Likelihood of Egg Consumption at Endline based on HHDM-E across Research Arms								
Predictor		**S.E.**	**Wald**	***df***	***p***	**Odds Ratio**	95% CI for Lower	Upper
Research Arm (Control)			17.950	2	.000			
Research Arm (Partial)	.782	.319	5.999	1	.014*	2.186	1.169	4.088
Research Arm (Full)	1.398	.331	17.862	1	.000*	4.045	2.116	7.734
Constant	-.126	.132	.916	1	.338	.881		

*Note. ** denotes significant *p*-value; Research Arm is for Control compared to Partial and Full.

CHAPTER 4
THE SUSTAINABILITY AND SCALABILITY OF EGG CONSUMPTION IN BURKINA FASO AS A MEANS TO IMPROVE NUTRITION IN INFANTS AND YOUNG CHILDREN: LESSONS LEARNED FROM THE *UN OEUF* STUDY

Background

Burkina Faso and Childhood Nutrition

Burkina Faso is a low-income country in the Sahel region of Sub-Saharan Africa (SSA). Evaluated against the United Nations Sustainable Development Goals (SDGs), Burkina Faso has multiple areas in significant need of advancement, including maternal and child health (MCH) and mortality rates in children under five (CU5), neonates, and infants—all of which have improved drastically in the past ten years (World Bank, 2018). A significant burden that continues to plague the health of women and children health in Burkina Faso, preventing it from reaching a number of the SDG goals, is childhood malnutrition.

Burkina Faso has high rates of malnutrition, anemia, and stunting in CU5 (INSD, 2012). Much of this is attributable to high levels of food insecurity, inadequate complementary feeding practices, poor dietary diversity, low levels of animal source food (ASF) consumption, and a general lack of food availability (Stewart et al., 2013). Food security and food source resiliency are important facets to consider in a population that is growing rapidly, even as the climate variability increases. Livelihoods in Burkina Faso are heavily reliant on subsistence agriculture and livestock production for food security and wealth, with 85% of all households dependent on livestock for income (Nations, 2019). Burkina Faso also suffers from a high rate of child mortality, a substantial portion of which is associated with malnutrition (UNICEF 2012). Malnutrition

is shown to have significant and lifelong socioeconomic, physical, and cognitive impacts on a child, as well as their future economic potential as an adult (Black et al, 2017).

The First Thousand Days: Critical Window for Child Development

Many studies (Darapheak et al., 2013) have shown the importance of including ASF (milk, meat, dairy, and eggs) in a child's diet, especially during the critical window of child development from conception through two years old—the first one-thousand days (Cusick & Georgieff, 2016; Schwarzenberg & Georgieff, 2018). The regular consumption of ASF has been shown to improve the growth, nutritional status, cognitive development, and overall health of a child (Charlotte G. Neumann et al., 2003).

In Burkina Faso, ASF consumption is low—particularly among women and children (Krasevec, An, Kumapley, Bégin, & Frongillo, 2017; Olney et al., 2015). Barriers to ASF consumption, such as cultural beliefs and stigma surrounding egg consumption by children, may significantly constrain the consumption of ASF and in particular chicken eggs in Burkina Faso (L. L. Iannotti et al., 2017; Rogers, 1996). Many believe that smallholder poultry farms (SHPF) can help alleviate food and nutrition insecurity by increasing the availability of ASF, generating household income, and empowering women (J De Bruyn, 2017; Dolberg, 2001). Despite these findings, ASF consumption among livestock-producing households in Burkina Faso remains low, especially among women and young children.

Mothers play an essential role in improving childhood nutrition; therefore, it is critical to involve and train mothers in livestock production. There is growing evidence that targeting and empowering female caregivers of children through livestock production and programming may improve child nutrition through increased ASF consumption (Jin & Iannotti, 2014). This improvement in a child's nutritional status has

the potential to severely decrease the number of disability adjusted life years (DALYs) a person experiences throughout a lifetime due to the effects of early-life, severe malnutrition (Schwarzenberg & Georgieff, 2018). Within Burkina Faso, livestock is typically produced for income, gifting, and socio-religious practices, as opposed to production for direct, household consumption among household members. Innovative approaches that encourage, facilitate, and ultimately increase ASF consumption among rural livestock holders are needed.

Rationale

Using the success of seminal egg studies from both Ecuador (L. L. Iannotti et al., 2017) and Ethiopia (Omer et al., 2018) as guideposts, a study called, "*Un Enfant, Un Oeuf, Par Jour*," which was funded by USAID's Feed the Future Innovation Lab for Livestock Systems and led by the University of Florida (UF) and *Institut de l'Environnement et Recherches* (INERA), ran from May, 2018 through April 2019 in Burkina Faso. The project title itself translates to, "One Child, One Egg, Each Day," and aimed to increase ASF consumption in infants and young children (IYC; children under the age of two) through an innovative intervention that involved the gifting of chickens by a community champion and a culturally tailored behavior change strategy to improve livestock production and empower women. The *Un Enfant, Un Oeuf, Par Jour* study (henceforth known as " the *Un Oeuf* study") was a cluster randomized controlled trial (cRCT) with three research arms—(1) a full intervention group, whose child participants were gifted chickens by a community champion at the onset of the project and maternal participants received monthly Integrated Nutrition and Agriculture (INA) trainings for 10 months; (2) a partial intervention group, whose participants received the same monthly INA trainings as the full intervention group but no chickens until the end of the study, at

which time they received two chickens; (3) and a control group, whose participants received no trainings, but, like the partial intervention group, received two chickens upon completion of the study. The original study, funded for 12 months, included data from 10 months of behavioral and household monitoring, which operationalized during the time of the intervention. A follow-up study was designed to examine the facilitating factors, barriers, sustainability, and scalability of successful behavior change around egg consumption in IYC in Burkina Faso. To understand if and how the project design could be taken to scale within Burkina Faso, the Enhance Follow-up Study added qualitative data collection to the end of the *Un Oeuf* study (April 2019) and an additional household survey, conducted three months after endline (July 2019) . Using data collected during both the *Un Oeuf* and Enhance Follow-up studies, this paper analyzes qualitative data at endline and longitudinal data across the life and follow-up of the study to examine the sustainability and scalability of the intervention to increase ASF consumption and combat malnutrition in CU5.

Methods

Study Setting

The research was conducted in the Kaya Department of rural Burkina Faso. Eighteen villages were included in the sample (see Stark et al., 2020 for full sampling strategy). Villages were made up of small holder farmers, most of whom practiced a mix of crop and livestock production. Development in the communities was very low, including low levels of literacy, sanitation, and dietary diversity, and high rates of malnutrition (Stark et al., 2020).

Study Design

A mixed-methods approach using both quantitative and qualitative data collection and analysis methods is presented here. This paper examines longitudinal data from baseline, endline, and follow-up surveys conducted with 260 mothers and qualitative data collected at endline in 9 of the 18 participating villages to determine the potential for expanding successful elements of the behavior change strategy within the country.

Quantitative Sample, Data Collection, and Analysis

The *Un Oeuf* study household survey (HHS) was used for quantitative data collection. The HHS was completed by 260 randomly selected mothers of children 4–15 months (see full sampling strategy in Stark et al., 2020). The HHS sections relevant to this paper are those on household demographics; knowledge, attitudes, and practices of household feeding with an emphasis on egg consumption—the behavior change outcome of interest. The demographic factors analyzed include gender, age, age at first live-birth, marital status (including if the husband has other wives), and education level of the respondent. The section on knowledge, attitudes, and practices of child feeding was tailored to describe current and past child feeding practices with an emphasis on egg consumption. A section on household decision-making was created through the adaptation of questions taken from the validated Women's Empowerment in Agriculture Index (WEAI) questionnaire, created by the International Food and Policy Research Institute (IFPRI). Questions in the WE section of the HHS focused on the mother's decision-making ability within the household related to food and aimed to serve as a proxy for her level of empowerment.

Household data were used to examine child egg consumption, poultry production, and household decision-making centered around egg consumption. Egg

consumption was measured by asking if the enrolled child consumed eggs in the "past week" (defined as the seven days prior to data collection). Household decision-making variables were coded as binary categorical variable of "self" or "other" for decision-making. Data were analyzed using IBM Statistical Packaging for the Social Sciences (SPSS). Data were analyzed using summary statistics to examine the observations made at the key timepoints of interest—baseline, endline, and follow-up. Quantitative data results are presented in Table 4-13.

Qualitative Sample, Data Collection, and Analysis

A stratified purposive sampling frame was used to select nine villages for qualitative data collection. Midline (December) average egg consumption data were used to stratify villages into three groups—low, medium, high egg consumption. From within each research arm (full, partial, and control), the villages with lowest, average, and highest egg consumption rates at midline were selected for participation in qualitative data collection.

Qualitative data were collected through focus group discussions, which were conducted at two time periods: May, following the endline HHS of the cRCT, and August, following follow-up HHS, to help explain and understand the overarching project goals, such as shifts in egg consumption, poultry production of households, and the sustainability of behavior change (in egg consumption). The FGDs were facilitated using a set of open-ended questions which aimed to elucidate facilitating factors, barriers, household dynamics, and community-level perceptions relevant to behavior change.[1]

[1] Focus group discussion at endline consisted of seven open-ended questions. At follow-up FGDs consisted of 18 questions. Language in the open-ended questions varied slightly across research arms.

Focus groups were administered using a team of three, in-country researchers, two of whom were heavily involved with project implementation and quantitative data collection and one of whom was a translator. The FGDs were conducted using one researcher to facilitate the FGDs in the native language of Moré, whilst the other two researchers simultaneously took separate notes. Following the collection of data, all notes were compiled and checked against the audio recording to ensure a complete capture of each discussion. Data were then compiled and translated into a master set of FGD transcripts for all nine villages.

The FGD transcripts were independently coded and synthesized by two researchers at UF, using the constant comparative method for content analysis to deduct salient themes. Inter-rater reliability and consensus were established by comparing and discussing the independently derived themes between the two researchers. A comparison of research arm consensuses was presented to establish overarching similarities and fundamental differences reported across research arms. The final list of themes is presented in .

Ethics Statement

All adult study participants received adequate information to make a well-informed decision before consenting to participation in the study. All members of the in-country research team were fluent in the local language of Moré and French. Project documents (participant information sheet and informed consent form) were translated from English into French and copies were provided to the University of Florida Institutional Review Board (IRB) and the Burkina Faso Ethical Review Board (ERB). Approval for the study was granted by both the UF IRB and the Burkina Faso ERB prior to the collection of any data.

Results

The results presented in this analysis consist of quantitative and qualitative data collected during the *Un Oeuf* and Enhance Follow-up studies conducted between July 2018–July 2019. Research-arm-level findings are presented in Appendix A along with tables containing the population-level results (Tables A-1–A-3) presented in this chapter.

Household Survey Data Results

At baseline, 260 participants were surveyed. At endline and follow-up, the number of surveyed individuals decreased to n=252 and n=247, respectively. The results for egg consumption, household chicken ownership, and household decision-making can be found in .

Egg consumption increased significantly between baseline and endline (McKune et al., 2020) and expanded through follow-up. At baseline of the *Un Oeuf* study, only 11 out of 260 children (4%) had consumed chicken eggs in the seven days prior to data collection, with those children having an average egg consumption rate being 0.12 eggs per week. At endline, 171 children, or 67.9% of the surveyed population, had consumed eggs in the past week, with an average egg consumption of 2.99 eggs per week. At follow-up, 223 children, or 90% of the surveyed population, had consumed eggs in the week prior to data collection with an average consumption of 3.70 eggs per week.

Though high to begin with, chicken ownership expanded throughout the study and its follow-up. At the onset of the *Un Oeuf* study, 213 households (81.92%) reported owning one or more chickens with an average chicken ownership of 7.52. By the completion of the *Un Oeuf* study, endline data showed that 248 households (98.4%) of all households owned chickens with an average of 11.16 chickens per chicken-owning

household. At follow-up, all households with survey responses reported owning chickens (100%), and average chicken ownership had dropped slightly to 6.64 (range 2-30) chickens.[2]

Household decision-making

Participants were asked four questions regarding household decision-making (HHDM) centered around egg consumption—*who decides* (1) what foods to feed the children, (2) which foods to purchase, (3) how food is portioned, and (4) what to do with household eggs? Perhaps due to the sensitivity of these questions, some participants chose not to respond to these questions.

At baseline data collection, 169 (66.8%) reported that they make decisions about what foods to feed children.[3] By endline, 249 (99.2%) of all women who were surveyed and responded, reported that they decide what foods are fed to the children and at follow-up data collection, 100% of all surveyed respondents reported that they now make the household decisions on what foods are fed to children.

At baseline data collection, 18 women (6.9%) reported that they make the decisions about what foods are purchased. At endline, 6 women (2.4%) reported making these decisions themselves; by follow-up, the number of women making these purchasing decisions was at its lowest with only 2 women (0.8%) reporting still deciding what foods are purchased.

At baseline, there were seven women who chose not to respond reducing the respondents to 253. Out of the women who responded, 130 (51.4%) reported that they

[2] One participant did not respond to this question, though the participant was surveyed.

[3] At baseline data collection, seven women chose not to respond to any of the household decision-making questions, with one additional choosing not to respond to who decides what to do with household eggs.

decide how foods are portioned. By endline, the number of women who reported deciding how foods are portioned increased to 226 (90% of the surveyed population), and at follow-up, all buy 2 women (99%) of the women surveyed reported still deciding how foods are portioned.

At the beginning of the *Un Oeuf* project, eight women chose not to respond to this question, reducing the number of survey responses to 252 for this question. Out of the women who responded, 83 (33%) reported that they make decisions about what is done with the household eggs. By endline, 117 (47%) of women reported that they were making these decisions. At follow-up data collection, the numbers had almost inverted from those at baseline with 161 women (65%) reporting that they now held decision-making power of what is done with the household eggs.

Focus Group Discussion Data Results

A total of nine villages were used for qualitative data collection. The FGDs were consisted solely of women who had participated in the *Un Oeuf* study. The FGDs were used to explain the quantitative data. For anonymity, quotes will be used but will not be identifiable.

The FGDs yielded six prominent themes—facilitating factors, barriers, motivational factors, livelihood, knowledge-sharing, and sustainability (Table 4-14).

Facilitating Factors

Within the theme of facilitating factors, three subthemes were identified—household chicken ownership, education, and spousal support.

Across all research arms, there was consensus that the increase in the household chicken ownership facilitated the mothers to feed the enrolled child eggs. This increase was either due to the project, whether it be at the onset of the intervention

in the full group or after completion of the intervention in the partial and control groups, or due to the household purchasing chickens so that eggs could be available.

While the delivery of education varied across research arms, there was consensus that increasing knowledge (and awareness) was a key facilitating factor in the behavior change of feeding children eggs. Unintended education for the control group came in the form of the household survey, which brought attention to and started conversations on feeding children eggs (and other foods). For the partial and full groups, the education was much more formalized through the implementation of INA trainings that were attended each month, as well as educational materials (i.e. flipbooks) that were given to mothers. That mothers kept and owned their own flipbook, which facilitated their ability to refer to the flipbooks at any time, was a key component in the education on behavior change toward feeding children eggs.

There was a consensus in all villages that the support of husbands was integral to facilitation of egg consumption. Women reported that their husbands were supportive and encouraging of the women's involvement in the study, and that they helped facilitate egg consumption by giving eggs from their (the husbands') flocks, purchasing chickens so eggs would be available, building hen houses, and helping in the care of the chickens.

Barriers

The theme of barriers consisted of the subthemes of egg production, cultural taboos, and animal health. Importantly, no barriers were reported by the full intervention arm that were not overcome by the study design.

The lack of egg production was a barrier for all research arms. Women reported that, as expected, when hens are sick, they do not lay eggs. Additionally, at the

beginning of the intervention, hens in the full intervention arm were too young to lay eggs; therefore, women in the full group experienced a lack of egg production due to having young hen flocks. Women reported that when hens brood or laid no eggs, it was a burden to need to purchase eggs for the child.

Within this region of Burkina Faso, a cultural taboo was identified surrounding the consumption of eggs by children—particularly young girls. This taboo required training to overcome. However, once women understood that consuming eggs was beneficial to a child's health, this barrier was overcome in the partial and control research arms. It is important to note that there were no reports of cultural taboos within the full research arm.

Another consistent barrier across research arms was the health of the animals. Women expressed that when they lack to food to properly feed their hens, the hens fall ill. Additionally, the inability to construct a hen house left the hens subject to predators and weather. Vaccine availability was also listed as a cause for poor hen health.

Motivational Factors

Child health and time-gain were the two subthemes deduced from the theme of motivational factors.

The health of the child was the overarching and most-reported motivational factor across all groups. Mothers all agreed that the most motivating reason behind their behavior change of feeding the children eggs was the improvement in the children's nutrition, growth, and overall health.

Mothers agreed that with the addition of eggs in the children's diets, the children demanded to suckle less; therefore, reducing the time demand on the mother. Because

of this release, mothers gained time and were able to better care for themselves and their households which was motivational.

Livelihood

Within livelihood, the subtheme of financial independence arose, strictly surrounding the benefits yielded from poultry farming. Mothers reported agreed that there was a newfound sense of financial independence due to the increase that the poultry production brought them. Because of this, particularly in the full group, women reported being able to purchase clothing for her children, pay for school fees, as well as purchase small ruminants and other foods to increase the dietary diversity of the children.

Knowledge-Sharing

Knowledge-sharing was showing within two subthemes—community and household. Knowledge-sharing within the community, both at the village-level and broader department-level, was witnessed across all research arms. Once mothers had knowledge to share, they shared it. Women explained they did this so that other women would have healthier children. This knowledge was shared for the betterment of the greater community.

Knowledge-sharing within the households took place between the mothers who were enrolled in the study and their husband and co-wives. This knowledge was exchanged for the betterment of the entire family unit.

Sustainability

Sustainability in the sense of behavior reinforcement was expressed across all three research arms. Since behavior change is an iterative process, behavior reinforcement is key in sustaining behavior change. Women explained their desire to

always properly care for their chickens to ensure their children always had eggs. Additionally, women stated that they would continue to use and share the information in the flipbooks, provided by the project, as a reminder of what is needed to be done to take care of the children.

Discussion

By and large, a significant behavior change occurred within the study population, where egg consumption increased from 4% of children in the study population having consumed eggs in the past week at baseline to 68% at follow-up, three months after the end of the project. The greatest behavior change was observed in the full intervention group, which is consistent with the facilitating factors of an increase in household chicken ownership, education, and spousal support.[4] Mothers in both the Partial Intervention and Control Groups stated that the project's donation of two hens to their households was instrumental in creating behavior change, as well as freeing up household income previously spent on purchase of eggs that were now produced by the household chickens. This message was amplified from the women in the Full Group who credited the influx of (four) chickens into their household as being lifechanging for their livelihoods, since the poultry production allowed them a sustainable means of livelihood that could be sold in times of need to support the needs of the household—including but not limited to medicines, other types of foods, clothing, and school fees for children. These messages of how livestock was vital to the increase in their livelihoods reverberates messages found by many researchers working in global development

[4] Husbands of women enrolled in both the Partial and Full Intervention Groups were invited and encouraged to attend the INA trainings with their enrolled wives.

(Kristjanson et al., 2014; Pambè, Gnoumou, & Kaboré, 2014; Thornton et al., 2003). Furthermore, the results of the qualitative data revealed that women in the Full did not report any barriers at endline that were not overcome by the intervention design, implying that a simultaneous delivery of model that includes both training and livestock assets via the gifting of chickens to the children is the most effective treatment for behavior change (as discussed in Chapter 2). In addition to the increased observed within livelihood and financial independence, women also stated that they gained *time* due to the results of the project. When a woman gains time, it enables her to do other necessary action items, such as collecting water, caring for her other children, tending to her own fields, or caring for herself (Awumbila & Momsen, 1995; Kevane & Gray, 1999; Kevane & Wydick, 2001; Wodon & Blackden, 2006). These increases in time and livelihood allowed the women to better care for all members of their households, including herself. The results show that by increasing the household livestock and education particular to agriculture and nutrition, women were able to achieve new levels of financial independence and time—both of which are a critical components to increasing a woman's overall empowerment and exemplary of the impact which livestock-related interventions can afford rural women in LMIC (Kristjanson et al., 2014; Malapit et al., 2017; Pambè et al., 2014; Wodon & Blackden, 2006).

Impact of the *Un Oeuf* Study

It is not contrived to say that the *Un Oeuf* project had a profound impact on the lives of its participants by altering the ways in which mothers feed their children, care for their households, and breed chickens. The data show that at the beginning of the study, chicken eggs were sparsely eaten by children, which is not surprising given the widespread poverty and cultural taboo surround egg consumption by young children

within this study population. This makes the results even more profound, because it shows that, at least in some contexts, tailored, targeted education can overcome cultural taboos surrounding the consumption of ASF. The study illustrates the potential of using cultural pathways—as seen in the design of the Full Group by engagement of a Community Champion to gift chickens directly to the children and reinforce and support the messaging of feeding a child an egg a day—to trigger behavior change that challenges cultural norms.

Scalable Pathways to Increasing Egg Consumption in Burkina Faso

Results show that there is already traction for scaling the *Un Oeuf* study further within Burkina Faso, as participants across all three research arms not only have the desire to sustain the behavior of feeding eggs to their children, but also to share what they have learned with other women. This shows a culturally embedded desire for knowledge-sharing that lends itself to scaling the *Un Oeuf* project within the county where a sense of community success is key. The women stated that other women are willing and eager to receive the messaging and implement the teachings; however, the barriers of household chickens and animal health still remain concerns for scaling. Though many households reported owning chickens by endline, only 29% of children within the Control Group were consuming eggs. However, after mothers in the Control Group received one training session and a donation of two chickens to the household, egg consumption changed to 83% of children. While this increase may exhibit what one training session and an influx in chickens can do, more likely, a priming of the control group population a result of treatment contamination (Magill et al., 2018) or exposure to the monthly questionnaire containing dietary diversity and egg consumption. The improvements in child diet (through increased ASF consumption), child and maternal

health, and women's empowerment created by the *Un Oeuf* study intervention align closely with the SDG goals for Burkina Faso and should be seen as an example of a potential pathway for achieving these goals (WCF(UK), 2017). Using the results of the *Un Oeuf* study as a road map, it seems feasible for a nutrition-sensitive, livestock-based intervention to scale within Burkina Faso.

Recommendation

After analyzing the data, it is recommended that further research be conducted to better understand the importance of the use of Community Champions as a trigger for behavior change surrounding the consumption of ASF by children under five. Additionally, it is recommended that future studies be conducted to investigate the threshold for number of eggs required for full child development and growth and the associated number of chickens required to produce enough eggs. Many women in the Control and Partial Groups reported needing to add to the donated number of chickens to have enough eggs to feed their children any eggs, elucidating that two chickens may not overcome the barrier of egg production—a point that may be illustrated in Table 4-1 with the modes of egg consumption. While it is both expected and observable that the Full Group is skewing the mode at endline with its targeted consumption of seven eggs in a week, the second mode was 2 eggs at Endline. However, after the Partial and Control received two chickens for their households, the mode of egg consumption at follow-up was only 2 eggs at follow-up. Furthermore, it is recommended that the attitudinal shift in the Control Group prior to their receipt of a training session or chickens be taken into account for future strategies. This shift in attitude implies that prior messaging (i.e. text messages, radio announcements, or trusted community members) to prime the population may be key in catalyzing behavior change once

assets and/or training are provided. Lastly, an economic analysis comparing the cost of supplying each child under 5 an appropriate number of chickens (with vaccinations) to afford them an egg a day against the cost of malnutrition-related morbidity and mortality of children under five may inform how the government of Burkina Faso allocates funds.

Strengths and Limitations

This study is strengthened by data collected over the course of 15 months and in its mixed-methods approach, allowing for observation over time and triangulation from various data collection methodologies. One limitation of this study is the relatively limited nature of FGDs. Despite training and appropriate role play by data collectors, transcripts and field notes indicate that women engaged in the FGCs more like a group interview, where not all women engaged in discussion, despite facilitated efforts.

Conclusion

It has been shown that a nutrition-sensitive, livestock-based intervention changed the behavior surrounding feeding eggs to CU5 in the Kaya Department of rural Burkina Faso. Furthermore, it can be concluded that, by simultaneously increasing a household's number of chickens and providing training on how to care for those chickens and incorporate the eggs into the diets of CU5, it stimulated livelihoods and created time-gain for women, resulting in greater impacts on the overall health of that household.

Table 4-13. Study population summary statistics

Total Population Summary Statistics			
	Baseline n=260	**Endline** n=252	**Follow-up** n=247
Egg consumption*	11 (4%)	171 (67.9%)	223 (90%)
Mean (SD)	0.12 (0.69)	2.99 (2.74)	3.70 (2.19)
Mode	0	2, 7	2
Range	7	7	10
HH chicken ownership†	213 (81.9%)	248 (98.4%)	246 (100%)
Mean (SD)	7.52 (13.48)	11.29 (8.70)	6.64 (3.31)
Mode	0	10	6
Range	100	40	28
HHDM-F‡			
Self	169 (65%)	249 (99.2%)	247 (100%)
Other	84 (23%)	2 (0.8%)	0 (0%)
HHDM-B‡			
Self	18 (7.1%)	6 (2.4%)	2 (0.8%)
Other	235 (92.9%)	245 (97.6%)	245 (99.2%)
HHDM-P‡			
Self	130 (51.4%)	226 (90%)	245 (99.2%)
Other	123 (48.6%)	25 (10%)	2 (0.8%)
HHDM-E‡			
Self	83 (32.9%)	117 (46.6%)	161 (65.2%)
Other	169 (67.1%)	134 (53.4%)	86 (34.8%)

Note. *SD is the standard deviation. Household decision-making is represented as follows: HHDM-F for foods fed to the children is represented by; HHMD-B for foods bought; HHDM-P for how foods are portioned; HHDM-E for what is done with household eggs.

†Household chicken ownership shows the count of households which own one or more chickens, then it shows the mean, mode, and range of the number of chickens owned.

‡Some respondents chose not to respond to these sensitive questions concerning household decision-making

Table 4-14. Content analysis results for FGDs.

Theme	Subtheme	Content by Research Arm		
		Control	Partial Intervention	Full Intervention
Facilitating Factors *A facilitating factor is anything that helped facilitate feeding eggs to the enrolled child.*	Household Chicken Ownership	"[The project] increasing the hens." "We received chickens and now we are able to feed our children eggs."	"[U]sing our hens' eggs for our children. What would have helped us [more] is the donation of hens at the beginning of training." "The increase [to] our bird stock [from the project]." "We [bought] hens for our children.	"Chicken donations help women to feed their children eggs."
	Education	"…[A]sking questions each month changed our behavior toward feeding our child eggs (or other foods)."	"The messages from the trainings that will stay with us are: a child an egg daily; handwashing prevents the spread of diseases."	"…[A] child an egg daily, we must clean very well our house and henhouse." "We learned how to take care of our hens, household, and child."

Table 4-2. Continued

Facilitating Factors *A facilitating factor is anything that helped facilitate feeding eggs to the enrolled child.*	Spousal Support	"[The spouses support us] by giving us permission to participate in the survey." "My husband built a hen house for the hens [donated by the project] and paid [for] a rooster to add to the hens…"	"Our spouse's hen donation [help feed our children]." "My husband has built a chicken house for my chickens." "My husband often call[s] the vet to vaccinate our chickens."	"[Our husbands] encourage us to participate in the training." "Our husbands often help us in breeding chickens."
Barriers *A barrier is anything that prevented the feeding of eggs to the enrolled child.*	Egg production	"The low number of [egg] laying hens." "If our hens don't eat well they cannot lay eggs."	"When hens brood and we do not have money to buy eggs." "We [do] not have many hens." "The [two] hens do not lay enough eggs."	"If the hens are sick and do not lay." "If the hens are not well fed, they will not lay [eggs]." "…[A]t the beginning the hens were [too] young."
	Cultural Taboos[5]	"Barriers keep us from feeding our child an egg daily, the social and cultural barrier [that] a child must not eat eggs."	"At the beginning we did not feed children eggs because of traditional barriers, but since we received the training we feeding our children eggs."	

5 There were no reports of cultural taboos being a barrier within the Full Research Arm.

Table 4-2. Continued

Barriers *A barrier is anything that prevented the feeding of eggs to the enrolled child.*	Animal Health	"When hens do not have a hen house; they lay eggs where they want." "[H]ens lack food." "The non-existence of a hen house for hens…if it rains, I am obliged to put my hens and their chicks in our house…" "Avian pathologies can decimate hens." "[M]aintenance and follow-up of the hens."	"Unfortunately, I only have one hen now, the other hens are dead, so I can't get eggs for the child. I have to buy eggs for my child." "When there is no local veterinarian to vaccinate our hens… they will become sick."	"If we don't have medicines to give to the hens when they are sick." "If we don't have hen houses." "[I]f you do not have hen houses, it will be difficult to take care of poultry." "How are we going to take care of our poultry without you?"
Motivational Factors *A motivational factor is anything that motivated and inspired the mothers to start or continue feeding eggs to the enrolled child.*	Health of Child	"Our child is very healthy, compared to other children, his weight is normal."[6] "…[C]hicken eggs improve his growth and intelligence."	"All my children were malnourished and since I started giving eggs to this child, he is doing well. [H]e is not malnourished [like] his other siblings."	"[I] can see an impact of the project on our child. [He is] very healthy, are in top form. [He is] are growing well compared to other children his age who are not enrolled."

[6] It is important to note that mothers in the Control Group mentioned the health of their children in relativity to no other children that were enrolled in the study. This shows the skewed perspective of health that can occur when a village has low dietary diversity and faces food insecurity.

Table 4-2. Continued

Motivational Factors *A motivational factor is anything that motivated and inspired the mothers to start or continue feeding eggs to the enrolled child.*	Health of Child	"…[E]ating eggs helps children to avoid some diseases.	"The face that we see our children are healthy motivates [us]."	"…We have more respect for our community leader, to know they turned [our] attention to our children's nutrition shows we must take care very well of children's hens."
	Time	"There is the decrease of breastfeeding of children thanks to the eggs." "There is partial release of mothers and increase mothers' household time." "There is the saving of time (and money) by mothers thanks to the good health of the children."	"There was a change, the children suckle less and are healthy. [W]e are also healthy."	"As a mother, [I am] satisfied there is a decrease in child breastfeeding through egg consumption." "When a child eats an egg, he suckles less and gives a lot of free time to the mother to do her activities."

Table 4-2. Continued

Motivational Factors *A motivational factor is anything that motivated and inspired the mothers to start or continue feeding eggs to the enrolled child.*	Financial Independence	"We will have profits because we [now] have chicks [from the project donation] and they will become chickens we will sell some of them to support certain needs."	"As mothers, we are happy. It will benefit [us] if we have many chickens we can sometimes sell some chickens to support our child's needs or our needs."	"I am happy to have chickens. I can often sell some chickens to pay [for] my child's clothes." "We learned a lot about poultry breeding … now we can take care [of] or breed poultry ourselves." "I sold some chickens to pay for a small ruminant for my child." "As a mother, we see a difference [between] other mothers who did not receive the chickens. The mother who received the chickens is financially independent…"

Table 4-2. Continued

Knowledge-Sharing *Mothers within the full and partial intervention arms were sharing their knowledge, whilst mothers in the control were eagerly accepting of it when shared.*	Community	"We heard about the program from one of our family members." "…[T]he project has changed how we interact within our household and our community, because we tell other women in our community what we learned about children's nutrition during the survey." "…[O]ther women in the village put into practice the advice and some would like to participate in the program."	"[We shared] the benefits of egg consumption, child hygiene, and sanitation." "When we go home after training sessions, we share what we learned with our neighbors." "[We shared this information] because it will help other women to take care of their children."	"…[W]e use the flipbooks to share information with women outside our community." "We share this information with women outside in our community (village) who are participating in this project." "[This] benefited us, so we want the same thing for [other mothers]".
	Household	"I shared this with my husband's second wife." "In our household, the project has changed our behaviors around health and hygiene of [our] children."	"There is the involvement of household members in poultry monitoring." [We share information] with our husband's second wife."	"Behaviors [that] have changed in our household are our children's hygiene and nutrition, [and] poultry's hygiene."

Table 4-2. Continued

Sustainability *Sustainability within the population is what the participants planned to do to maintain egg consumption within their households.*	Behavior Reinforcement	"We will take care of the chickens to always have eggs." "We will remind each other what we must do." "We will take care of the chickens to have eggs at all times."	"We will use our flipbooks. Our flipbooks contain information that help us to put into practice what we learned during training sessions." "We have our flipbooks that will help us to continue [to] remember everything we learned during our training and put it into practice.	"We will use our flipbooks to remember." "We will vaccinate our chickens. [T]here are people who are in the villages who can vaccinate our chickens." "[I] will always apply the creed: 'a child an egg a day,' even if [I] give birth to another child."

CHAPTER 5
CLOSING REMARKS

Discussion

Chapter Reviews

Chapter Two, “Assessing the Effectiveness of Timing Models for Livestock Asset Delivery to Increase Egg Consumption: Findings from Follow-Up to the *Un Oeuf* Study,” showed that a synchronous timing model of both increasing livestock assets through ownership and INA trainings yielded the most significant and sustained behavior change of feeding eggs to CU5. Egg consumption was significantly higher among participants in the synchronous timing model compared to children in the asynchronous timing model—and this result held for all analyzed time points. While this model requires more money and manpower to execute, it appears to have created significant change that can be sustained within the population. This behavior change is the result of a well-developed BCC package that was culturally-centered and used an appropriate diffusion of innovation through the use of the Community Champions to catalyze behavior change. Chapter 3 served as confirmation to antecedent studies, which showed that livestock ownership and education on livestock, agriculture, and nutrition correlate to an increase in ASF consumption (Azzarri et al., 2015; Hetherington et al., 2017; Jin & Iannotti, 2014; Kariuki et al., 2013; Mosites et al., 2015).

These results can serve as a potential road map for the successful convergence and use of best practices from international development, human capacity building, and behavior change to effect positive change in the nutritional states of CU5 (McKune et al., 2020). While it was also shown that behavior change did occur in the asynchronous timing model and the delivery of livestock assets only, neither of these groups served to

break the threshold set by Omer (2018) of consuming a minimum of 4 eggs per week. However, the knowledge that a synchronous delivery model created significant and sustainable behavior change should be of importance to actors in the international development and research arenas as they develop projects and allocate resources hoping for similar results.

Chapter Three

In Chapter 3, Household Decision-Making, Women's Empowerment, and Egg Consumption in Children Under Five in Rural Burkina Faso," the researcher examined the relationship between women's household decision-making and women's empowerment on the ASF consumption of their enrolled children. The results showed that there was no significant relationship between the data yielded from the 5DE and egg consumption; however, significant relationships between various household decisions and egg consumption were found. In particular, there were significant and positive relationships between egg consumption by CU5 and a woman's level of household decision-making on (1) what is done with the household eggs and (2) who decides how foods are portioned amongst the household members. These results are consistent with existing literature that shows a woman's level of HHDM surround nutrition and that a woman's level of empowerment impacts the nutritional intake of her children—in particular the ASF consumption, of her children (Ayele & Peacock, 2003; Jin & Iannotti, 2014; Lépine & Strobl, 2013; Richards et al., 2013; Tolhurst et al., 2008).

While it is true for this study that no significant relationship was observed between egg consumption and a woman's 5DE score (adequate v. inadequate), this does not mean that a woman's level of empowerment does not have a relationship with the egg consumption of her child(ren). This is because, regardless of the extreme care

used to create the A-WEAI questionnaire and tailor it to the study population, not all empowerment can be captured from a questionnaire. Additionally, Chapter 3 exposed HHDM centered around nutrition were the key relationships with egg consumption, which is very logical; however, those decisions are not factored into the A-WEAI at such a minute level. This serves to show that even though a woman may be "disempowered" at a macro-level according to 5DE data, she may be empowered enough within her home at a more micro-level, which still yields significant behavior change consistent with existing literature (Agarwal, 1997; Ahmed, 2006; Seebens, 2011).

Chapter Four

In Chapter 4, "The Sustainability and Scalability of Increasing Household Livestock Assets as a Means to Improve Nutrition in Infants and Young Children: Lessons Learned from Rural Burkina Faso," the researcher inspected the overall project metrics and potential for sustainment and scale. The quantitative results revealed that egg consumption within the total study population increased from just 4% at baseline to 68% by follow-up. The greatest behavior change was observed in the full intervention group, which received the synchronous timing model discussed in Chapter 2. The mothers of the Full explained their facilitating factors during the FGDs—an increase in household chicken ownership, education, and spousal support, consistent with literature for increasing ASF consumption (Ayele & Peacock, 2003; Campbell et al., 1994; Girard, Self, McAuliffe, & Olude, 2012). Furthermore, qualitative results disclosed that women in Full reported no barriers that were not overcome by the BCC package, highlighting the importance of a simultaneous timing model *and* the impact of a Community Champion, as presented by Omer (2018).

Perhaps the more unexpected results of the *Un Oeuf* study were the time-gain of mothers due to egg consumption by the children and the livelihood stimulated by the poultry production, both of which occurred in the Full Group. The concept of time-gain is extremely important for women in LMIC, as many studies have already shown (Awumbila & Momsen, 1995; Kevane & Wydick, 2001; Wodon & Blackden, 2006). Mothers in the full and partial intervention groups voiced an increase in their time availability due to the enrolled child suckling less and being sick less often. This time-gain allowed mothers to tend to other necessary activities, which according to the women, ultimately increased their quality of life and happiness. Furthermore, many studies have shown that increasing a woman's livelihood is a pathway to improving the nutrition and health of her children, empowering her, and increasing her own health (Kristjanson et al., 2014; Malapit et al., 2017; Pambè et al., 2014; Wodon & Blackden, 2006). To this end, mothers in the Full Group reported increases in livelihood that created a newfound capacity to afford unexpected medical expenses, diversify the household diets through the purchase of other livestock and food types, and pay for children's school fees—all of which can be life-changing and lifesaving for people living in LMIC.

Recommendations

As a result of knowledge gained throughout the process and construction of this dissertation, the researcher recommends that efforts moving forward be more holistic and precise in their strategies. Eggs have become the potential "silver bullet" for increasing macro- and micro-nutrients in an effort to improve health outcomes, particularly within vulnerable populations in LMIC; however, this is problematic for a few reasons, which should be considered when taking an intervention such as the *Un Oeuf*

study to scale. First, there is the need to properly monitor the anthropometry of enrollees throughout any nutrition study to ensure that a stop-trial is never needed.[7] Additionally, there are risk factors that must be discussed when increasing livestock production within a household. Many studies have shown the adverse health outcomes due to children being in close quarters or contact with poultry (Crane, Jones, & Berkley, 2015; Headey & Hirvonen, 2016; Johnson & Brown, 2014). Any project, program, or initiative seeking to increase ASF consumption through an increase in livestock, particularly poultry, should take appropriate measures to mitigate the spread of disease to the population, and in particular to CU5. Lastly, the researcher recommends that more studies be conducted surrounding the nutritional benefit of egg consumption by CU5 to better understand the difference between its efficacy in a more clinical setting versus its effectiveness in LMIC, where climate variability is affecting natural resources. Regardless of the livestock or ASF that a project, program, or initiative is centering its efforts around, it is imperative to always include nutrition education (including safe food handling practices) to facilitate the most change possible in a safe and sustainable manner.

So, what now?

Currently, there are policies and programs in place in Burkina Faso which emphasize the commitment of the Burkina Faso government, governmental organizations, and the greater international development community to improve food

[7] A stop-trial occurs when the treatment is so significant that it is unethical to withhold it from the non-treatment group(s). While a stop trial is particular to clinical trials but should be taken into consideration anytime the health outcome can be life-changing or lifesaving, as is the case with nutrition in CU5.

and nutritional security within the country.[8] While this constellation of efforts aims to create an enabling environment whereby livestock can generate both income and ASF to improve human nutrition, there remains a disconnect—most visibly at the household level—between efforts that promote consumption of high value foods and livestock programs that foster increased production (Kauffmann & Dominguez-Salas, 2015). Many programs, efforts, and initiatives are found to be slightly wanting, with nutrition programs either stopping short of promoting ASF consumption through a sustainable means or failing to address how resource-poor households might operationally do so after a project's departure.

The *Un Oeuf* study took into account the risk factors for increasing household poultry by teaching safe poultry husbandry practices during the INA trainings—including the importance of housing hens and separating the household poultry from children. Additionally, the *Un Oeuf* study created culturally-centered educational materials that the mothers were able to keep and reference, helping to reinforce behavior change, as well as teaching safe food handling and hygiene practices. Furthermore, the husbands of enrolled women were invited to partake in the INA trainings and home visits for further knowledge-sharing and community engagement. The *Un Oeuf* study exhibits how implementing best practices in all facets of a study can yield impactful, sustainable, and scalable results to further the global effort to better childhood nutrition and mitigate CU5 mortality.

[8] Efforts are being spearheaded by such agencies and organizations as Feed the Future, Oxfam International, World Food Program, and the Hunger Project.

APPENDIX A
SUPPLEMENTAL CHAPTER 4 MATERIALS

Control Group Results

The Control Group ("Control") consisted of 88 mother-child dyads. At baseline, all 88 mothers were surveyed; however, at endline and follow-up a lesser number were surveyed (87 and 84, respectively). All Control Group summary statistics can be seen in Table A-1 at the bottom of this section.

Egg Consumption

At the beginning of the Un Oeuf study, baseline data showed that 6 (7%) children in the Control Group had consumed chicken eggs in the past seven days with a consumption range of 1–5 eggs. By endline the egg consumption within the Control Group had increased to 22 children (25.3%) with a range of 1–5 eggs being reported as consumed in the past week. Focus group discussions at endline revealed that the survey, itself, had been enough to alter attitudes about feeding children eggs within the women of the control group. Additionally, these women reported that other women who were participating in the project and receiving training in other villages (partial and full intervention groups) shared knowledge gained from trainings with them.1 Despite this shift in attitude and gain in knowledge, the focus groups in the control group shared that most women still lacked the necessary resources to feed their children eggs.

By follow-up, reported egg consumption in the past week had increased from 22 children to 70 children (83.3%), with a range of 1–7 eggs with a mode of 3 eggs being consumed. Women reported that due to the donation of chickens from the project after

1 The sharing of information from either of the intervention groups to the control group is known as "treatment contamination" and shows the importance that word-of-mouth transmission can have within the study population (Magill et al., 2018).

endline, they were now able to feed their enrolled child eggs. However, the women also stated there was still a barrier of egg availability to feed their enrolled child an egg a day because two chickens were not able to produce enough eggs, but also because some chickens preferred to brood which resulted in fewer eggs. Women shared that some of the facilitating and motivating factors that helped them sustain their behavior change included the knowledge the women gained about feeding eggs to their children, as well as seeing the growth and health of the children after they had been eating eggs.

Poultry Production

At baseline, 70 of the 88 households (79.5%) in the Control Group reported owning chickens. Within the Control, 70% of all households owned 4 or fewer chickens. By endline only 1 household reported not owning any chickens with an average of 6.16 chickens per household; however, the most commonly owned number of chickens was only two. There were not results within the qualitative data showing that the project had any direct impact on the increase in household chickens by endline. However, by follow-up data collection, all households had received two chickens as gratitude for their participation in the project. By follow-up, all households reported owning chickens with the average chicken ownership was 5.12 chickens per household with 48% of households (48:83 survey responses) reporting chicken ownership of either 4 or 5 chickens—no households with survey responses reported not owning chickens. At follow-up, the women stated that when they keep their chickens healthy and well-fed that they lay more eggs and produce successful offspring. Factors that were facilitating the women properly caring for their chickens included the fact that their household was happier and healthier and as a result, their husbands were willing to either purchase

more chickens to aid in poultry production and/or build hen houses to help safeguard the chickens and their eggs.

Household Decision-making

Whilst the Control did not receive any trainings prior to the FGDs at endline, they stated feeling a sense of empowerment from the knowledge they gained from the survey and from participants in other villages. They stated that they now had a better idea of how to care for their household—nutrition and hygiene—and could start breeding poultry when they acquired [more] chickens. Additionally, women reported that their husbands were supportive of their involvement in the project and were now helping to better ensure the health of the children and poultry. Within household decision-making, baseline metrics for women who responded to the survey questions showed that 74% of women reported making decisions about what foods children are fed; however, at both endline and follow-up 100% of women surveyed reported making decisions on what foods are fed to the children.[2] Regarding food portioning within the household, baseline results showed that 54% of women reported making these decisions. At endline, 92% of women reported that they now made these decisions and by follow-up, 100% of women reported their household decision-making power over food portioning. Additionally, when participants were asked at baseline who decides what to do with the household eggs, only 31% of women reported that they made these decisions. At endline, a minimal decrease in this decision-making was observed with only 30% of women reporting making this decisions; however, after receiving household

[2] Within the Control Group, four women chose not to respond to questions regarding household decision-making at baseline.

chickens after the project completion and by follow-up, 66% of women who were surveyed reported that they now had household decision-making power over what is done with the household eggs. Conversely to the previously discussed areas of household decision-making, the reported level of women's decision-making power decreased over time in the realm of who makes decisions about which foods are purchased. At baseline, only 8% of women reported making these decisions and by endline, only 2% of women reported making these decisions. By follow-up, no Control Group women reported making decisions regarding which foods are purchased.

At follow-up FGDs, women reported that the project was very impactful, and they plan to continue to breed chickens to ensure there are always enough eggs to feed to their children for secured health. Overall, women in the Control Group reported having a higher level of happiness and self-satisfaction as mothers due to their gained knowledge on how to better care for their children and contribute to their households.

Table A-1. Control group summary statistics for baseline, endline, and follow-up.

Control Group Summary Statistics

		Baseline n=88	**Endline** n=87	**Follow-up** n=84
Egg consumption*		6 (7.5%)	22 (25.3%)	70 (83.3%)
	Mean	0.19	0.66	2.9
	Mode	0	0	3
	Range	5	5	7
HH chicken ownership†		70 (79.5%)	86 (98.9%)	84 (100%)
	Mean	5.45	6.16	5.12
	Mode	0	2	4
	Range	60	30	13
HHDM‡				
Foods for children				
	Self	62 (74%)	87 (100%)	84 (100%)
	Other	22 (26%)	-	-

Foods purchased				
	Self	7 (8%)	85 (978%)	-
	Other	235 (92.9%)	2 (2%)	84 (100%)
Food portions				
	Self	45 (54%)	80 (92%)	84 (100%)
	Other	39 (46%)	7 (8%)	-
Household eggs				
	Self	26 (31%)	26 (30%)	55 (65.5%)
	Other	57 (69%)	61 (70%)	29 (34.5%)

Note. *Egg Consumption is shown first as a count by the number of children (percentage of population) confirmed to have eaten eggs in the past week.
†Household chicken ownership shows the count of households which own one or more chickens, then it shows the mean, mode, and range of the number of chickens owned.
‡Some respondents chose not to respond to these sensitive questions concerning household decision-making

Partial Intervention Group

The Partial Intervention Group ("Partial") consisted of 89 mother-child dyads, all of whom were surveyed at baseline. By endline and follow-up the Partial participants had reduced to 86 and 85, respectively. Summary statistics for the Partial Intervention Group can be seen in Table A-2.

Egg Consumption

At baseline, only one child in the Partial Intervention Group was reported to have eaten eggs the week prior, and the child ate 2 eggs. In FGDs, women explained that there was historically a cultural taboo surrounding egg consumption by children, especially young girls, that needed to be overcome in order for behavior change to occur. This barrier was overcome by endline due to the nutritional training provided to the women. In fact, most women in the Partial reported no hesitance to adopting the behavior of feeding their children eggs after learning the benefits of egg consumption at the INA trainings. The women reported another major barrier that was a constant throughout the project—a lack of egg availability within the household. To overcome this barrier, many women admitted their need to purchase eggs in order to feed their

enrolled children eggs, but only when it was financially feasible. Facilitating factors for the women's behavior change included the instructional flipbooks (provided as part of the behavior change package for the partial intervention group), which helped to stimulate and sustain their behavior change. Women stated that the flipbooks were referred to regularly to remind themselves what is necessary to keep their children healthy. An additional facilitating factor that many women shared during FGDs was that their spouses allowed them to use the spouse's chickens to feed the children eggs. After intervention completion, endline data collection showed that 67 children (78%) were reported as eating eggs in the past week, with a range of egg consumption at endline was 7 and a mode of 2 eggs being consumed in a week.

At follow-up, all but 10 children were reported eating eggs, for an increased total of 88% of the research arm. The range was slightly less than endline, with a range in egg consumption from 1–6 eggs and a sustained mode of 2 eggs being consumed in the past week. At follow-up FGDs, women said that the trainings were essential in learning how they could change their behaviors; however, they stated the most important facilitating factor came when the project donated chickens to the households because it reduced or removed the need for the women to purchase eggs. At follow-up, women in the Partial reported that they were (now) feeding as many of their children, including those not enrolled, as many eggs as possible. Women shared that throughout the project, getting to have their children measured and seeing the positive results in their growth as a result of including eggs into their diets provided extra motivation for sustaining their behavior.

Poultry Production

Prior to receiving any INA trainings and at the baseline data collection point, 69 households (77.5%) reported owning chickens with only 20 households in this research arm reported no chicken ownership. At the onset of the project, 4 households reported owning more than 50 chickens (50, 65, 73, and 100), which skewed the average household chicken ownership of 8.53 chickens. Out of those who owned chickens, the modal number of chickens owned was 2, as reported by 15 households. Within this research arm, 60% of all households owned 3 or fewer chickens with 81% owning 10 or fewer chickens. At the endline FGDs, women in the Partial Group said that the trainings gave them the knowledge they needed to better care for their poultry. They reported that when they implemented what they learned at the trainings that their chickens became more successful—producing numerous offspring and eggs. Resultingly, after intervention completion data showed that 98% of all households reported owning chickens with only 2 households in Partial reported not owning chickens. At this timepoint, no households reported owning more than 40 chickens. Additionally, at endline, only 17.4% of the households owned 3 or fewer chickens, whilst 91% of households owned 15 or fewer chickens with a modal ownership of 10 chickens.

During the follow-up FGDs, many women in the partial shared that, catalyzed by the donation of chickens from the project, they (or their husbands) had purchased more chickens to increase “the child’s flock”.[3] At follow-up, household chicken ownership was at an all-project high within the Control Group with 100% of households owning two or

[3] Within the Partial Intervention Group, women in the FGDs often referred to the donation of chickens as “the child’s flock”, which was not a prompt from the data collection instrument.

more chickens with a mean ownership of 6.18 chickens and a modal ownership of 6 chickens.[4] The women stated a desire to take good care of the chickens, so they their children will always have eggs available for consumption. However, the women's barriers to being able to care for the household chickens included concerns for medical checks and vaccinations for chickens after the project's departure. Facilitating factors for Partial women included the enthusiasm and support of their spouses for the women's involvement in the project, as well as the positive impact the trainings and donated chickens had on the overall health household.

Household Decision-making

At baseline data collection and prior to receiving any training meant to increase women's empowerment through an increase in knowledge and capabilities via the INA trainings, baseline data showed that 67% of women reported deciding what foods to give the children and 56% of women decided how foods were portioned.[5] Alternately, less than half (38%) of women reported deciding what is done with household eggs, whilst only 6% of women decided which foods were purchased. After completing the training program, household decision-making had increased in three areas amongst women who responded to the survey—98% reported deciding what foods are given to the children, 87% reported deciding how foods are portioned, and 48% reported now deciding what to do with the household eggs. There was an observed decrease in decision-making at endline over which foods are purchased, with only 1% of women

[4] In one of the Partial villages sampled for FGDs, it was confirmed that New Castle had struck and killed many of the participants' chickens, including some that were donated from the project.

[5] There were non-responses for HHDM questions in the household survey at baseline and endline. Two women chose not to respond to baseline HHDM questions and one woman chose not to respond at endline.

reported making these decisions. These results echoed the statements from women's statements during endline FGDs, where reported being very happy about attending the trainings and that they had not been a burden on the women or caused issues within their households. They stated feeling a sense of empowerment from the project, because they had learned how to take better care of their children through nutrition, households through sanitation and hygiene, and poultry through proper husbandry techniques. They reported that their children had a reduction in illness after they learned the importance of handwashing prior to feeding, introducing egg into the diet, and caring for their chickens—with this reduction in illness came more time for the mother to tend to other matters. Women reported that due to egg consumption, their children suckled less, and this had resulted in an additional increase in their (the mothers') available time and bettered their own health. Women said that because of their increased feelings of empowerment, happiness, and satisfaction that they wanted to share their knowledge with others, so they had been sharing the information taught to them at trainings to their husbands and other women—inside and outside of their villages. Specifically, women in the Partial Group confirmed sharing information with women who were enrolled in the project but did not receive trainings (Control). By follow-up, with the exception of decisions regarding what foods are purchased for the household, which no women reported making themselves, all other HHDM metrics had continued to increase. By follow-up, 100% of women reported making decisions on what food are fed to the child and which foods are purchased, while 99% of women reported deciding how foods are portioned and 65% now had decision-making power over what is done with the household eggs.

Table A-2. Summary statistics for the partial intervention group at baseline, endline, and follow-up.

Partial Intervention Group Summary Statistics

		Baseline	Endline	Follow-up
		n=89	n=86	n=85
Egg consumption*		1 (1.1%)	67 (77.9%)	75 (88.2%)
	Mean	0.02	2.35	2.6
	Mode	0	2	2
	Range	2	7	6
HH chicken ownership†		69 (77.5%)	84 (97.7%)	85 (100%)
	Mean	8.53	9.4	6.18
	Mode	0	10	6
	Range	100	40	11
HHDM‡				
Foods for children				
	Self	58 (67%)	83 (97.6%)	85 (100%)
	Other	29 (33%)	2 (2.4%)	-
Foods purchased				
	Self	5 (5.7%)	1 (1.2%)	-
	Other	82 (94.3%)	84 (98.8%)	85 (100%)
Food portions				
	Self	49 (56.3%)	74 (87.1%)	84 (98.8%)
	Other	38 (43.7%)	11 (12.9%)	1 (1.2%)
Household eggs				
	Self	41 (48.2%)	26 (30%)	55 (64.7%)
	Other	44 (41.8%)	61 (70%)	30 (35.3%)

Note. *Egg Consumption is shown first as a count by the number of children (percentage of population) confirmed to have eaten eggs in the past week.
†Household chicken ownership shows the count of households which own one or more chickens, then it shows the mean, mode, and range of the number of chickens owned.
‡Some respondents chose not to respond to these sensitive questions concerning household decision-making.

Full Intervention Group

The Full Intervention Group ("Full") consisted of 83 mother-child dyads, all of whom participated in baseline data collection. This research arm population also decreased between baseline to follow-up, having 79 and 78 participants at both endline and follow-up, respectively. All summary statistics can be seen in Table A-3.

Egg Consumption

Prior to the start of intervention, baseline data collection, 95% of children in the Full Intervention Group had not consumed eggs in the week prior. Out of the 4 children (5%) who had consumed eggs, the consumption range was from 1–7 with two children consuming 1 egg in the past week, while two other children separately consumed 3 and 7 eggs. Women in the Full Group reported that it was important for them to change their behavior at the immediate onset of the project, because their Community Champion had shined a light on the nutrition of their children. This made the women feel it was necessary to take special care of the enrolled child's hens and ensure the child ate an egg a day. The women also noted that the support of their spouses for the child to eat eggs was very helpful in adopting this new behavior. Other facilitating factors for their behavior change included the flipbooks, that the child now had chickens and available eggs for consumption, and that the women were receiving training on how to better care for their children and poultry.

After the intervention completion, women in the Full Intervention Group reported that 100% of the children were consuming eggs at endline data collection. The egg consumption range was 4, having a minimum egg consumption of 3 and a maximum of 7. The intervention messaging centered around a child eating one egg a day for a target goal of seven within a week—60% of children in the Full Intervention Group were reported to have eating 7 eggs within the past week at endline. Regarding the sustainment of their behavior change to feed their children eggs, women said it was very motivational to see the improvement in their children's health and how their children were healthier and growing more than children who were not enrolled in the project. The women reported that they self-organize to meet amongst themselves and

reinforce the messaging from the project trainings, as well as help anyone who may be having issues with feeding her child an egg a day.

At the project follow-up data collection, the egg consumption range had broadened to 9 (minimum of 1, maximum of 10); however, there was observable sustainment in behavior change as 100% of children were still eating eggs. A sustainment of 7 eggs within the past week was observed within 40% of the population, and 80% of the Full Group reported eating four or more eggs in the past week. The women credited the flipbooks with being instrumental in helping them sustain good practices by reminding them of what should be done and how—they will keep the flipbooks indefinitely to help retain and spread its messages.

Poultry Production

Prior to children in the Full Intervention Group receiving 4 chickens for their flock, as part of the intervention, baseline data was collected and showed that 89% of all households owned chickens with a range of 100, an average of 8.63 chickens per household and a mode of 4 chickens.[6] After intervention completion, endline data showed that 100% of all households owned five or more chickens, with a mean chicken ownership of 18.51 and a modal ownership of 20 household chickens. Women in Full reported that poultry production had changed their households for the better, thanks to the project. Overall, the women were in resounding agreement that the trainings had taught them how to breed chickens to a point where it created livelihood for them and their households. They stated that they shared the information they learned with their

[6] At baseline, one household owned 100 chickens; however, this was not a sustained number throughout the project and served to skew the average and median household number of chickens.

husbands, who were very thankful for the increase in livelihood and became involved with caring for the chickens. During the endline FGDs, many women shared chickens began reproducing to a point where women were able to sell chickens to help meet other needs for all of their household—other types of foods to round out the diet, medicine, clothes, and school fees. Additionally, some women stated that they even sold some chickens to finance a small ruminant for the improvement of the enrolled child's diet and health.

By follow-up 100% of households still reported owning chickens, with no household owning less than 3 chickens. The average chicken ownership at follow-up was 8.77 chickens with a modal ownership of 8 chickens. Women in the Full Intervention Group reiterated many times that they were very happy for the improvement that the poultry breeding had afforded their households and that they would continue to breed poultry for these benefits.

Women's Empowerment through HHDM

Baseline data showed that 60% of women reported making decisions over what foods are fed to the children; however, only 4% reported deciding which foods are purchased. Less than half of the women reported making decisions on how foods are portioned (44%) and about what is done with household eggs (29%). After completing the INA training program, 100% of women reported making decisions on what foods are fed to the children, followed closely by deciding how foods are portioned (91%). Food purchasing remained largely within the decision-making of other household members, with only 4% of women reporting making these decisions at endline; however, 63% of women reported now deciding what is done with household eggs. Women who participated in the Full Group stated feeling very empowered by the project. They felt

the increase in their livelihood from the poultry production afforded many of them some financial independence that allowed them to handle the needs of her children or herself, autonomously. They also reported an increase in their availability of time due to the child suckling less and not falling ill as often. The newfound increase in time allowed the mothers to handle other household matters, work more outside of the home, and take better care of themselves.

By follow-up, 100% of women were still deciding what food are fed to the children and 99% were deciding how foods are portioned. Decision-making over food purchasing decreased to only 3% of women reporting having this decision-making power. However, a slight increase in decision-making over what is done with the household eggs with 65% of women reporting making this decision at follow-up. They reported an increase in their self-satisfaction and happiness as mothers and women, and that this made them want to share the knowledge they had gained so other women could feel this way and better care for their children. Women in the Full Group reported sharing the information they learned on poultry practices, sanitation and hygiene, and the nutritional benefits of eggs with women in and out of their villages. They confirmed sharing information with women who were participating in the project in different villages. Women reported sharing the information with their husband's other wives and that they witnessed the women put it into practice with no hesitation. The women in the Full Group said they plan to always feed their children eggs and continue to share this knowledge so that its message never dies.

Table A-3. Summary statistics for the full intervention group at baseline, endline, and follow-up.

Full Intervention Group Summary Statistics

		Baseline n=83	Endline n=79	Follow-up n=78
Egg consumption*		4 (4.8%)	79 (100%)	78 (100%)
	Mean	0.14	6.25	5.74
	Mode	0	7	7
	Range	7	4	9
HH chicken ownership†		74 (89.2%)	79 (100%)	78 (100%)
	Mean	8.63	18.51	8.77
	Mode	4	20	6
	Range	100	36	27
HHDM‡				
Foods for children				
	Self	49 (59.8%)	79 (100%)	78 (100%)
	Other	33 (40.2%)	-	-
Foods purchased				
	Self	6 (7.3%)	3 (3.8%)	2 (2.6%)
	Other	76 (92.7%)	76 (986.3%)	76 (97.4%)
Food portions				
	Self	36 (43.9%)	72 (91.1%)	79 (100%)
	Other	46 (56.1%)	7 (8.9%)	-
Household eggs				
	Self	24 (29.3%)	50 (63.3%)	51 (65.4%)
	Other	58 (70.7%)	29 (36.7%)	27 (34.6%)

*Egg Consumption is shown first as a count by the number of children (percentage of population) confirmed to have eaten eggs in the past week.
†Household chicken ownership shows the count of households which own one or more chickens, then it shows the mean, mode, and range of the number of chickens owned.
‡Some respondents chose not to respond to these sensitive questions concerning household decision-making.

APPENDIX B
DATA

In accordance with Feed the Future's data curation requirements for this grant-funded research, the quantitative data and respective instruments from this project will be available through Harvard Dataverse after October 1, 2020. The data and instruments can be found in Dataverse by searching, "Improving Nutrition in Children Under 2 through Increased Egg Consumption".

APPENDIX C
FOCUS GROUP DISCUSSION INSTRUMENTS

This appendix contains the Focus Group Discussion Instruments for FGDs held at endline and follow-up.

Endline FGD Instrument

Control Arm

1. I'd like to start by understanding your overall sense of how the project went. What was the impact of our asking you questions every month? Why do you think we were doing that?
   - *Did our coming to ask questions monthly cause any problems for you, in the community or your household? Can you describe that experience?*
   - *Was your spouse supportive of your participation? How so/why not?*
2. Do you feed your child eggs?
   - *What facilitating factors lead to feed your child an egg daily?*
   - *What barriers keep you from feeding your child an egg daily?*
   - *Has our asking you questions each month changed your behavior toward feeding your child eggs or other foods?*
3. We have been asking you questions over the past 10 months as part of a study on egg consumption. In other communities nearby, we have been testing an intervention that aims to increase egg consumption among children. We did not run the intervention here. Were you aware of the intervention/program, besides what we have told you about it?
   - *How did you hear about the program? What part?*
   - *Did you hear from others that feeding your child eggs was a good idea?*
   - *Do you think your behavior around egg consumption has changed because of anything you heard from others over the past 10 months?*
4. How does your child compare to other children his/her age in terms of growth, health, and development?
5. What about you? Do you feel the project has changed you?
   - *Has the project changed how you interact within your household? Your community?*
   - *Do you feel the project has empowered you or disempowered you in anyway?*
6. What about your household? How has the project changed your household?
7. Do you have any other comments, questions, or concerns that we should know about?

Partial Intervention Groups

1. I'd like to start by understanding your overall sense of how the project went. What worked and what didn't?
    - *Did it cause any problems in the community or your household? Can you describe that experience?*
    - *Was your spouse supportive of your participation? How so/why not?*
2. As you know, our goal was to improve egg consumption among your children in the study. Did it work? Why or why not?
    - *What helped you provide the egg and day?*
    - *What barriers remained that kept you from feeding your child an egg daily?*
    - *Were you able to overcome any of these barriers? How? What would have helped?*
    - *If/when you fed the child, how did she/he respond to the introducing of an egg into their diet?*
        - *Will you continue to try feed your child an egg a day?*
3. Can you see an impact of the project on your child? How does he or she compare to other children his/her age who are not enrolled?
4. What about you? Do you feel the project has changed you?
    - *Has the project changed how you interact within your household? Your community?*
    - *Do you feel the project has empowered you or disempowered you in anyway?*
5. What about your household? How has the project changed your household?
    - *Feeding practices of other children?*
    - *Food security in general?*
6. I'd like to understand more about how the trainings went. Can you describe what you liked and didn't like about the monthly INA trainings?
    - *Did you enjoy the trainings? Why/why not?*
    - *Was attending the trainings a burden for you? What were the barrier to attending?*
    - *What messages from the trainings will stay with you?*
    - *What behaviors or norms have changed in your household? Give example?*
    - *Did you find the flipbooks to be helpful?*
    - *Did you share this information with women outside of the women in your community who are participating in this project?*
7. Do you have any other comments, questions, or concerns that we should know about?

Full Intervention Groups

1. I'd like to start by understanding your overall sense of how the project went. What worked and what didn't?
   - *Did it cause any problems in the community or your household? Can you describe that experience?*
   - *Was your spouse supportive of your participation? How so/why not?*
2. As you know, our goal was to improve egg consumption among your children in the study. Did it work? Why or why not?
   - *What helped you provide the egg and day, and what barriers remained?*
   - *How did your child respond to the introducing of an egg into their diet?*
   - *In the design of the project, the children received the chickens directly as gifts. Was this important to you?*
   - *In the design of the project, the child received the chickens from a community leader; did this matter to you? How would your behavior have been different if an NGO had given the chickens?*
   - *Will you continue to feed your child an egg a day?*
3. Can you see an impact of the project on your child? How does he or she compare to other children his/her age who are not enrolled?
4. What about you? Do you feel the project has changed you?
   - *Has the project changed how you interact within your household? Your community?*
   - *Do you feel the project has empowered you or disempowered you in anyway?*
5. What about your household? How has the project changed your household?
   - *Feeding practices of other children?*
   - *Food security in general?*
6. I'd like to understand more about how the trainings went. Can you describe what you liked and didn't like about the monthly INA trainings?
   - *Did you enjoy the trainings? Why/why not?*
   - *Was attending the trainings a burden for you? What were the barrier to attending?*
   - *What messages from the trainings will stay with you?*
   - *What behaviors or norms have changed in your household? Give example?*
   - *Did you find the flipbooks to be helpful?*
   - *Did you share this information with women outside of the women in your community who are participating in this project?*
7. Do you have any other comments, questions, or concerns that we should know about?

Follow-up FGD Instrument

Control Group

I would like to understand how receiving chickens from the project has affected your household, and how you all think the project can address more women and mothers.

Receipt of livestock assets (chickens)

1. Ownership:
    a. Who owns the chickens received from the project?
    b. Who makes decisions about the chickens and the eggs produced from the chickens given by the project?
2. Consumption:
    a. Does your child enrolled in the project eat chicken eggs after receiving chickens from the project?
        i. Why?
        ii. Why not?
    b. Do your other children in the household eat chicken eggs after receiving chickens from the project?
        i. Why?
        ii. Why not?
    c. Do your children eat chicken eggs as a result of you attending the project ceremony?
        i. Why?
        ii. Why not?
    d. What factors facilitate you feeding your child/children chicken eggs?
    e. What barriers keep you from feeding your child/children chicken eggs?
3. Did receiving chickens from the project affect your household in any way?

Sustainability of eating chicken eggs

4. Do you think it is important to feed your children chicken eggs?
5. How often can you afford to feed your children chicken eggs?
6. What would make it possible for you to feed your children chicken eggs every day or multiple times a week?
7. Is it important that husbands and fathers be part of the discussion concerning the importance of feeding children chicken eggs?
    a. Why?
    b. Why not?

Scalability of eating chicken eggs

8. Do you think it is important for other Burkinabe women to feed their children chicken eggs?
9. Do you think other Burkinabe women DO feed their children chicken eggs?
    a. Why?
    b. Why not?
10. Do you think other Burkinabe women WOULD feed their children chicken eggs if they knew the benefits of feeding their children chicken eggs?
    a. Why?
    b. Why not?
11. Are there any taboos surrounding chicken egg consumption by children that you are aware of that would prevent other Burkinabe women from feeding their children chicken eggs?
12. Is it important that husbands and fathers know the importance of feeding children chicken eggs?
    a. Why?
    b. Why not?
13. Do you think it is important for other African women to feed their children chicken eggs?
14. Do you think other African women DO feed their children chicken eggs?
15. Do you think other African women WOULD feed their children chicken eggs if they knew the benefits?
16. Did receiving the project findings at the ceremony change make you want to feed your child an egg a day?
    a. Why?
    b. Why not?
17. Did receiving the project findings at the ceremony change your behavior in feeding your children chicken eggs?
18. Do you have any advice to the project on how to encourage or support women to feed their children chicken eggs?

Partial Intervention Group

I would like to understand how receiving chickens from the project has affected your household, and how you all think the project can address more women and mothers.

Receipt of livestock assets (chickens)

1. Ownership:
    a. Who owns the chickens received from the project?
    b. Who makes decisions about the chickens and the eggs produced from the chickens given by the project?
2. Consumption:
    a. Does your child enrolled in the project eat more chicken eggs after receiving chickens from the project?
        i. Why?
        ii. Why not?
    b. Do your other children in the household eat chicken eggs after receiving chickens from the project?
        i. Why?
        ii. Why not?
    c. Do your children eat chicken eggs as a result of you attending the project ceremony?
        i. Why?
        ii. Why not?
    d. What factors facilitate you feeding your child/children chicken eggs?
    e. What barriers keep you from feeding your child/children chicken eggs?
3. Did receiving chickens from the project affect your household in any way?

Sustainability of eating chicken eggs

4. Do you think it is important to feed your children chicken eggs?
5. How often can you afford to feed your children chicken eggs?
6. What would make it possible for you to feed your children chicken eggs every day or multiple times a week?
7. Is it important that husbands and fathers be part of the discussion concerning the importance of feeding children chicken eggs?
    a. Why?
    b. Why not?

Scalability of eating chicken eggs

8. Do you think it is important for other Burkinabe women to feed their children chicken eggs?
9. Do you think other Burkinabe women DO feed their children chicken eggs?
    a. Why?
    b. Why not?
10. Do you think other Burkinabe women WOULD feed their children chicken eggs if they knew the benefits of feeding their children chicken eggs?
    a. Why?
    b. Why not?
11. Are there any taboos surrounding chicken egg consumption by children that you are aware of that would prevent other Burkinabe women from feeding their children chicken eggs?
12. Is it important that husbands and fathers know the importance of feeding children chicken eggs?
    a. Why?
    b. Why not?
13. Do you think it is important for other African women to feed their children chicken eggs?
14. Do you think other African women DO feed their children chicken eggs?
15. Do you think other African women WOULD feed their children chicken eggs if they knew the benefits?
16. What part(s) of this project do you think are most important to helping and getting women to feed their children chicken eggs? (Trainings? Receiving chickens? Receiving the project findings?)
17. How many trainings did you attend before the importance of feeding your child chicken eggs changed your behavior to feeding your child chicken eggs?
18. Do you have any advice to the project on how to get other women to feed their children chicken eggs?

Full Intervention Group

I would like to understand how you have been maintaining the feeding practice of feeding your child a chicken egg each day.

Receipt of livestock assets (chickens)

1. Ownership:
    a. Who owns the offspring of the chickens received from the project?
    b. Who makes decisions about the offspring of the chickens given by the project?
2. Consumption:
    a. Does your child enrolled in the project eat continue to eat chicken eggs, daily?
        i. Why?
        ii. Why not?
    b. Do your other children in the household eat chicken eggs after attending the project ceremony?
        i. Why?
        ii. Why not?
    c. What factors facilitate you feeding your child/children chicken eggs?
    d. What barriers keep you from feeding your child/children chicken eggs?
3. Did receiving chickens from the project affect your household in any way?

Sustainability of eating chicken eggs

4. Do you think it is important to feed your children chicken eggs?
5. How often can you afford to feed your children chicken eggs?
6. What would make it possible for you to feed your children chicken eggs every day or multiple times a week?
7. Is it important that husbands and fathers be part of the discussion concerning the importance of feeding children chicken eggs?
    a. Why?
    b. Why not?

Scalability of eating chicken eggs

8. Do you think it is important for other Burkinabe women to feed their children chicken eggs?
9. Do you think other Burkinabe women DO feed their children chicken eggs?
    a. Why?
    b. Why not?

10. Do you think other Burkinabe women WOULD feed their children chicken eggs if they knew the benefits of feeding their children chicken eggs?
    a. Why?
    b. Why not?
11. Are there any taboos surrounding chicken egg consumption by children that you are aware of that would prevent other Burkinabe women from feeding their children chicken eggs?
12. Is it important that husbands and fathers know the importance of feeding children chicken eggs?
    a. Why?
    b. Why not?
13. Do you think it is important for other African women to feed their children chicken eggs?
14. Do you think other African women DO feed their children chicken eggs?
15. Do you think other African women WOULD feed their children chicken eggs if they knew the benefits?
16. What part(s) of this project do you think are most important to helping and getting women to feed their children chicken eggs? (Trainings? Receiving chickens? Receiving the project findings?)
17. How many trainings did you attend before the importance of feeding your child chicken eggs changed your behavior to feeding your child chicken eggs?
18. Do you have any advice to the project on how to get other women to feed their children chicken eggs?

LIST OF REFERENCES

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BIOGRAPHICAL SKETCH

Emily Moore was born and raised in Oklahoma and attended both primary and secondary schools in Midwest City, Oklahoma. She graduated high school from Carl Albert Senior High School in 2004 as a Valedictorian and member of the National Honors Society. She began her collegiate career at the State University of New York-Buffalo on an ice hockey scholarship; however, injuries and logistics led her to transfer to the University of Oklahoma (OU) after her Freshman year. During her time at OU, she was a student-athlete on the cross-country team, a member of the Reserve Officer Training Corps, and was inducted into the National Honorary Society for Classical Studies. She was chosen to participate in the Oklahoma Scholar-Leadership Enrichment Program and completed her capstone research on Etruscan Archaeology in Orvieto, Italy during the Summer of 2008. She joined the Oklahoma Army National Guard as an Air Traffic Controller in July of 2008 and took a military leave of absence for the Academic Year of 2008–2009 to attend military training. She graduated from OU in Spring 2010 with a Bachelor of Arts in letters.

Immediately following graduation, Ms. Moore began military deployment to Afghanistan in support of Operation Enduring Freedom. During her deployment, Moore served in additional duties to her primary position as an Air Traffic Controller which opened her eyes to international aid, development, and global health disparities. Whilst finishing her last year of service, she returned to school at the University of North Florida (UNF). During her time at UNF, she was inducted into the National Society for Leadership and Success and conducted undergraduate honors research with Dr. Keith Ashley. She graduated from UNF with a Bachelor of Arts in anthropology in 2014 with the distinctions of *summa cum laude* and Honors in the Major.

Ms. Moore received her Master of Health Science from The University of Florida in 2017. During this time, she served as a Graduate Teaching Assistant for the UF Broward Teaching Center, working with student-athletes. In addition to her work at UF, she was accepted to the United States Department of Agriculture Pathways Program, where she worked and conducted graduate-level research in Dr. Ken Linthicum's lab. She continued at UF and gained her Doctor of Philosophy in public health with a concentration in one health and a certificate in African studies in Summer 2020. During her PhD, she worked on several international projects in Sub-Saharan Africa.