Linking Measures of Women's Empowerment and Intra-Household Gender Dynamics with Women's Nutritional Outcomes and Household Food Security in Rural Ghana

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Abstract

Ghanaian women farmers play a significant role in the agriculture sector, participating as different actors in the value chain. Yet, the prevalence of poor nutrition in the form of overweight and obesity among women in Ghana is rising and micronutrient deficiencies and food insecurity are still prevalent. Nutrition-sensitive agricultural (NSA) interventions that improve women's empowerment and gender equality have the potential to affect the underlying and immediate determinants of women's nutrition and household food security outcomes. Nevertheless, assessing the relationship between empowerment, gender equality, and these outcomes along the agriculture-nutrition pathway has been limited due to issues with (1) operationalization of the constructs, and (2) empirical evidence on the linkages between women's empowerment and gender equality, and consequently nutritional and food security outcomes.

The Scaling Up Women's Agripreneurship through Public-Private Linkages to Improve Rural Women's Income, Nutrition, and the Effectiveness of Institutions in Rural Ghana (*LinkINg Up*; ClinicalTrials.gov NCT03869853) project was implemented as a multisectoral NSA intervention to scale up activities and services to women farmers/agricultural entrepreneurs and their households. The *LinkINg Up* project was a quasi-experimental study with the primary outcomes of empowering women, strengthening the capacity of local institutions, and improving women's diets. The project partnered with local institutions in different sectors (e.g., financial, food and agriculture, health, and education) in three sub-districts of the Eastern Region of Ghana to provide in-kind agricultural loans (i.e., poultry or vegetable loan input package), and agriculture and nutrition education to female members of existing farmer-based organizations (FBO). Over a

2-year period, the project recruited 330 households from eight communities; 166 women farmers were FBO members, and 164 women were farmers but not FBO members. Adult male family members (n=205) were also enrolled to participate. This dissertation was embedded within the *LinkINg Up* project to investigate the following objectives: (i) explore local meanings and perceptions of WE among women farmers and their male family members, (ii) investigate the relationship of empowerment and household gender equality with women's participation in FBO, women's and men's nutritional status, and household food security, (iii) examine the association between the *LinkINg Up* intervention and endline women's and men's empowerment and household gender equality, and (iv) investigate if a change in empowerment and household gender equality mediated the association between the *LinkINg Up* intervention and women's diet quality and household food security.

The first study employed a qualitative approach with participants of the *LinkINg Up* project. During the first three months of the project, participants (53 females and 45 males) were selected purposefully to participate in eight focus group discussions (FGD) with women and seven FGD with men to probe into local understandings of empowerment and women's empowerment. The FGD were translated to English from the local language and transcripts were coded using an inductive approach (i.e., open, axial, selective coding) with MAXQDA 2022. *Emic* understandings of women's empowerment were often related to women's relationships with others and their roles (reproductive, productive, and community) in society. The local descriptions of an empowered woman were categorized as someone who: (i) exhibits qualities that are perceived to help one achieve goals, (ii) takes actions to achieve goals, and (iii) works with others to achieve their own goals or common goals. In summary, the results suggested that,

when assessing women's empowerment in the study area, it would be important to incorporate measures for women's goal-setting capacity in relation to farming and business activities, and their ability to implement their goals, while taking into account relational aspects.

The second study was a secondary analysis of the baseline data from the *LinkINg Up* project. Participants provided data on individual and household characteristics; the Project-level Women's Empowerment in Agriculture Index (pro-WEAI) was used to assess empowerment and household gender equality across 11 equally weighted indicators. Food insecurity was assessed with the 15-item Latin American and Caribbean Food Security Scale. Generalized linear mixed models tested the associations between empowerment and household gender equality with women's FBO membership, adult body mass index, and household food security. Women's FBO membership was associated with an increased likelihood of women's empowerment (aOR =3.25; 95% CI [1.97, 5.33]) and household gender equality (aOR= 2.82; 95% CI [1.39, 5.84]) but not men's empowerment. Household food insecurity, but not nutritional status, was positively associated with women's FBO participation and the individual empowerment indicator related to access and decisions on financial services. However, household food insecurity was negatively associated with the women's empowerment indicator related to attitudes about domestic violence (aβ = -0.78; 95% CI [-1.35, -0.21]) and men's overall empowerment (aβ = -0.79; 95% CI [-1.58, -0.01]). The findings provide supporting evidence on the pathway linking agriculture to household food security but highlight the complexity of these linkages.

The final study used baseline and endline data of participants in the *LinkINg Up* quasi-experimental study. The intervention group included women who were FBO members, while the comparison group included women farmers who were not FBO members. Women's

empowerment, household gender equality, and household food security were assessed as previously described. Women's diet was assessed using three 24-hr dietary recalls. The Food and Agriculture Organization's indicator of minimum dietary diversity for women of reproductive age as well as energy, macronutrient, and micronutrient intakes were estimated. Regression-based mediation analyses adjusting for covariates, baseline values, and clusters were used to test empowerment and household gender equality as potential mediators for the study outcomes. The intervention had an indirect negative association ($a\beta$ = -0.22 (95% CI [-0.51, -0.05]) with household food insecurity mediated by its positive association with women's empowerment. The intervention was not significantly associated with other potential mediators (endline men's empowerment and household gender equality). Women's empowerment did not mediate the association with diet outcomes. However, the intervention had a direct positive association ($a\beta$ = 0.58 (95% CI [0.01, 1.15]) with women's egg consumption at endline.

The thesis demonstrates that local meanings of women's empowerment were focused more on interdependence rather than independence. Furthermore, the study provides evidence that NSA interventions that leverage existing groups with some level of empowerment and interdependence as well as strengthen existing resources have the potential to improve WE outcomes. In addition, the findings show empirical evidence of the potential effect of NSA on household food security outcomes through increasing women's empowerment. Future NSA interventions would benefit by considering all these factors in the design and implementation of projects aiming to strengthen the agriculture-nutrition pathway.

Résumé

Les agricultrices ghanéennes ont un rôle important à jouer dans le secteur agricole, en tant que nouvelles actrices de la chaîne de valeur. Pourtant, la prévalence d'une mauvaise nutrition sous forme de surpoids et d'obésité chez les femmes ghanéennes est en hausse, en parallèle aux carences en micronutriments et l'insécurité alimentaire toujours présentes. Les programmes agricoles sensibles à la nutrition qui améliorent l'autonomisation des femmes et l'égalité entre les hommes et les femmes peuvent influer sur les déterminants sous-jacents et immédiats de la nutrition des femmes et de la sécurité alimentaire des ménages. Néanmoins, l'évaluation de la relation entre l'autonomisation, l'égalité des sexes et les résultats en lien avec les concepts d'agriculture-nutrition a été limitée en raison de problèmes liés (1) à l'opérationnalisation des concepts et (2) aux preuves empiriques des liens entre l'autonomisation et l'égalité des sexes et, par conséquent, les résultats en matière de nutrition et de sécurité alimentaire.

Le projet « Scaling Up Women's Agripreneurship through Public-Private Linkages to Improve Rural Women's Income, Nutrition, and the Effectiveness of Institutions in Rural Ghana » (*LinkINg Up* ; ClinicalTrials.gov NCT03869853) a été mis en œuvre en tant qu'intervention multisectorielle de l'ANE pour développer les activités et les services destinés aux femmes entrepreneurs agricoles et à leurs ménages. Le projet *LinkINg Up* était une étude quasi-expérimentale dont les principaux objectifs étaient l'autonomisation des femmes, le renforcement des capacités des institutions locales et l'amélioration de l'alimentation des femmes. Le projet s'est associé à des institutions locales de différents secteurs (finances, alimentation et agriculture, santé et éducation) dans trois sous-districts de la région orientale du Ghana pour fournir des prêts agricoles en nature (c'est-à-dire un ensemble de prêts pour la production de volailles ou de

légumes) et de l'éducation en lien avec l'agriculture et la nutrition pour les femmes membres d'organisations paysannes (FBO) existantes. Sur une période de deux ans, le projet a étudié 330 ménages dans huit communautés ; 166 agricultrices étaient membres d'organisations paysannes, et 164 femmes étaient agricultrices, mais non-membres d'organisations paysannes. Les membres masculins adultes de la famille (n=205) ont également été inclus dans le projet. Cette thèse a été intégrée au projet *LinkINg Up* afin d'étudier les objectifs suivants : (i) explorer la perception locale et la relation entre L'AF et les membres masculins de leur famille, (ii) étudier la relation entre l'autonomisation et l'égalité des sexes au sein du ménage et la participation des femmes aux organisations paysannes, l'état nutritionnel des hommes, des femmes et la sécurité alimentaire du ménage, (iii) examiner l'association entre l'intervention *LinkINg Up* et l'autonomisation des femmes et des hommes et l'égalité des sexes au sein du ménage à la fin de l'étude, et (iv) examiner si un changement dans l'autonomisation et l'égalité des sexes au sein du ménage a servi de médiateur à l'association entre l'intervention *LinkINg Up* et la qualité du régime alimentaire des femmes et la sécurité alimentaire au sein du ménage.

La première étude a utilisé une approche qualitative avec les participants du projet *LinkINg Up*. Au cours des trois premiers mois du projet, les participants (53 femmes et 45 hommes) ont été sélectionnés pour participer à huit discussions de groupe avec des femmes et à sept discussions de groupe avec des hommes afin d'approfondir la compréhension locale de l'autonomisation et de l'émancipation des femmes. Les discussions de groupe ont été traduites en anglais à partir de la langue locale et les transcriptions ont été codées à l'aide d'une approche inductive (c'est-à-dire un codage ouvert, axé et sélectif) avec MAXQDA 2022. Les conceptions émiques de la condition féminine sont souvent liées aux relations des femmes avec les autres et à leurs rôles (reproductif,

productif et communautaire) dans la société. Les descriptions locales d'une femme autonome sont catégorisées comme quelqu'un qui : (i) présente des qualités perçues comme aidant à atteindre des objectifs, (ii) prend des mesures pour atteindre des objectifs, et (iii) travaille avec d'autres pour atteindre leurs propres objectifs ou des objectifs communs. En résumé, les résultats suggèrent qu'il serait important d'intégrer, dans la zone d'étude de AF, des mesures de la capacité des femmes à se fixer des objectifs en rapport avec les activités agricoles et commerciales, et de leur capacité à mettre en œuvre leurs objectifs, tout en tenant compte des aspects relationnels.

La seconde étude était une analyse secondaire des données recueillies avec le projet *LinkINg Up*. Les participants ont fourni des détails sur leurs caractéristiques sociodémographiques et des informations sur leur ménage. L'indice d'autonomisation des femmes dans l'agriculture au niveau du projet (pro-WEAI) a été utilisé pour évaluer l'autonomisation et l'égalité des sexes dans les ménages à l'aide de 11 indicateurs également pondérés. L'insécurité alimentaire a été évaluée à l'aide de l'échelle de sécurité alimentaire de l'Amérique Latine et des Caraïbes, qui comporte 15 éléments. Des modèles linéaires mixtes généralisés ont testé les associations entre l'autonomisation et l'égalité des sexes au sein des ménages entre l'appartenance des femmes membres à des organisations paysannes, l'indice de masse corporelle des adultes et la sécurité alimentaire des ménages. La participation des femmes aux organisations confessionnelles a été associée à une probabilité accrue d'autonomisation des femmes (aOR = 3,25 ; IC à 95 % [1,97, 5,33]) et d'égalité des sexes au sein du ménage (aOR = 2,82 ; IC à 95 % [1,39, 5,84]), mais pas à l'autonomisation des hommes. L'insécurité alimentaire des ménages, mais pas l'état nutritionnel, était positivement associée à la participation des femmes membres d'organisations paysannes et à

l'indicateur d'autonomisation individuelle lié à l'accès aux services financiers et aux décisions en la matière. Cependant, l'insécurité alimentaire des ménages était négativement associée à l'indicateur d'autonomisation des femmes lié aux attitudes face à la violence domestique (aβ = -0,78 ; IC à 95 % [-1,35, -0,21]) et à l'autonomisation globale des hommes (aβ = -0,79 ; IC à 95 % [-1,58, -0,01]). Les résultats fournissent des preuves de l'existence d'un lien entre l'agriculture et la sécurité alimentaire des ménages, mais soulignent la complexité de ces liens.

L'étude finale a utilisé les données initiales et finales des participants à l'étude quasi-expérimentale *LinkINg Up*. Le groupe participant à l'intervention comprenait des femmes membres d'organisations paysannes, tandis que le groupe de comparaison comprenait des agricultrices non-membres d'organisations paysannes. L'autonomisation des femmes, l'égalité des sexes au sein des ménages et la sécurité alimentaire des ménages ont été évaluées comme d'écrit précédemment. Le régime alimentaire des femmes a été évalué à l'aide de trois périodes de 24 heures de rappel alimentaire. L'indicateur de l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) pour la diversité alimentaire minimale pour les femmes en âge de procréer, ainsi que les apports en énergie, en macronutriments et en micronutriments ont été estimés. Des analyses de médiation basées sur la régression et ajustées pour les covariables, les valeurs de base et les groupes ont été utilisées pour tester l'autonomisation et l'égalité des sexes au sein des ménages en tant que médiateurs potentiels des résultats de l'étude. L'intervention avait une association négative indirecte (aβ = -0,22 (IC 95 % [-0,51, -0,05]) avec l'insécurité alimentaire des ménages. Cette association est modérée par l'association positive avec l'autonomisation des femmes. L'intervention n'était pas associée de manière significative à d'autres variables modératrices potentielles (tel que l'autonomisation des hommes et l'égalité des sexes dans les

ménages). L'autonomisation des femmes n'a pas joué de rôle modérateur dans l'association avec les résultats lié à l'alimentation. Cependant, l'intervention avait une association directe ($a\beta = 0,58$ (IC 95 % [0,01, 1,15]) avec la consommation d'œufs des femmes à la fin de l'étude.

La thèse démontre que les significations locales l'autonomisation étaient davantage axées sur l'interdépendance que sur l'indépendance. Entre autres, l'étude démontre que les interventions des ANE qui s'appuient sur des groupes existants ayant un certain niveau d'autonomisation et d'interdépendance et qui contribuent à renforcer les ressources existantes ont le potentiel d'améliorer les résultats en matière l'autonomisation des femmes. De plus, les résultats démontrent empiriquement, l'effet potentiel des ANE sur la sécurité alimentaire des ménages avec l'amélioration l'autonomisation des femmes. Les interventions futures des ANE gagneraient à prendre en compte tous ces facteurs dans la conception et la mise en œuvre de projets visant à renforcer la filière agriculture-nutrition.

Contribution to knowledge

The doctoral thesis makes a meaningful contribution to the literature on women's empowerment and intra-household gender dynamics and how they may influence household food security outcomes by providing empirical evidence from rural Ghana. The thesis did not confirm the hypothesis that women's empowerment or intra-household gender dynamics were linked with women's nutritional status and diet quality. Nevertheless, the thesis adds evidence to the literature that other factors in the environment may be more important than women's empowerment in influencing these outcomes for women.

The first manuscript published in the *African Journal of Food, Agriculture, Nutrition and Development* adds to the evidence of limited qualitative studies conducted within the Sub-Saharan African region to understand the meanings of women's empowerment. It provided evidence that local understandings of women's empowerment among rural farming communities were relational. Women's social ties, relationships, and participation in groups were key to their empowerment. The thesis evidence does not align with Western understandings of empowerment that emphasize individualism, rather than collectivism.

In Ghana, the primary mechanism of government-farmer interaction is through farmer-based organizations. Through analysis of the participation of women in these groups, manuscript 2, published in *Current Developments in Nutrition,* provided empirical support for the role of these farmer organizations on women's empowerment and gender equality. Manuscript 3 empirically demonstrated that the strengthening of existing government services and the provision of loans to women through farmer groups positively influence their empowerment which in turn influenced

household food security. The finding is an important contribution to the literature as it provides empirical evidence to support the theorized women's empowerment in the linkage between agriculture and nutrition. The supporting evidence from both studies is useful to municipal assemblies and the Ghana government to consider in their efforts to close the gender gap in agriculture to achieve women's empowerment and food security.

To measure empowerment, the studies used the novel project-level Women's Empowerment in Agriculture Index (pro-WEAI), a multidimensional tool that provided rich information on different dimensions of empowerment in agriculture, sex-disaggregated information on women's and men's empowerment, and women's empowerment relative to that of men from the same households. Thus, the thesis provides evidence that aligns with the goals of the Ghanaian government to track their gender mainstreaming efforts using gender-based indicators.

Finally, the thesis adds to the literature that farmer-based organizations and women's empowerment alone do not influence household food security outcomes. The thesis makes the contribution that men's empowerment and intra-household relationships are strongly related to household food security. Together, the thesis provides empirical evidence to support the design of future interventions and policy.

Contribution of authors

The present thesis is embedded within the *Scaling Up Women's Agripreneurship through Public-Private Linkages to Improve Rural Women's Income, Nutrition, and the Effectiveness of Institutions project in rural Ghana* (referred to as *LINkINg Up;* ClinicalTrials.gov [NCT03869853]). The principal investigators of the *LinkINg Up* project were Drs. Esi K Colecraft, Grace S Marquis, Naa D Dodoo, and Nii A. Addy. They were involved in the conceptualization and design as well as obtaining ethics approval, implementation, and data collection of the project.

For the first manuscript, the candidate in consultation with Dr. Marquis designed the protocol and the research tools, coordinated, and managed all field data collection activities, and oversaw transcription in Ghana. Support and supervision for the field data collection in Ghana were provided by Drs. Colecraft and Dodoo. The candidate performed all data cleaning and analysis and drafted the manuscript and subsequent revisions. Dr. Marquis provided input with the interpretation and presentation of the qualitative findings. Manuscript 1 has been published in the *African Journal of Food, Agriculture, Nutrition and Development* (January 2023). The candidate was the first author. All co-authors (Drs. Marquis and Colecraft) contributed to and approved the final manuscript.

For the second manuscript, the candidate developed the protocol around women's empowerment assessment. The candidate developed the research instruments with assistance from Drs. Marquis, Colecraft, and Dodoo. The candidate analyzed the data and drafted the manuscript and subsequent revisions. Drs. Franque Grimard and Grace Marquis supported the analysis and

provided critical input with the interpretation and presentation of the findings. Manuscript 2 has been published in *Current Developments in Nutrition* (July 2022). The candidate was the first author. All co-authors (Drs. Marquis, Colecraft, Dodoo, and Grimard) contributed to and approved the final manuscript.

For the third manuscript, the candidate developed the research protocol. Drs. Marquis and Colecraft along with the candidate developed the research instruments. The candidate and Ana Maria Maldonado cleaned and performed the nutrient analysis with the dietary data. The candidate conducted data analysis and drafted the manuscript as well as the subsequent revisions. Drs. Marquis and Colecraft provided significant input with the interpretation and presentation of the results and revised the manuscript. All authors approved the final manuscript.

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Dedication

This doctoral thesis is dedicated to my parents, Ambassador Abdussamadu Zango Abdu and Hajiya Asiya Zango Abdu.

Allah ya sa ka maku da alheri

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List of abbreviations

aβ	Adjusted beta coefficient
AEA	Agriculture extension agents
aOR	Adjusted odds ratio
AR	Average requirement
AMDR	Acceptable Macronutrient Distribution Ranges
β	Beta coefficient
BCC	Behavior change communication
BMI	Body Mass Index
CFC	Community Foundations of Canada
COVID-19	Coronavirus disease 2019
CI	Confidence intervals
d	Day
DD	Dietary diversity
DID	Difference in differences
EFSA	European Food Safety Authority
FAO	Food and Agriculture Organization
FASDEP	Food and Agriculture Sector Development Policy
FBO	Farmer-based organization
FGD	Focus group discussion
g	Gram
GAD	Gender and Agriculture Strategy

GDP	Gross domestic product
GH₵	Ghana cedis
GSGDA	Ghana Shared Growth and Development Agenda
H-AR	Harmonized average requirements
IDRC	International Development Research Center
IQR	Interquartile range
kg	Kilograms
kcal	Kilocalories
kJ	Kilojoules
LMKM	Lower Manya Krobo Municipality
m	Meters
MDD-W	Women's minimum dietary diversity
METASIP	Medium Term Agriculture Sector Investment Plan
mg	Milligram
MSM	Multiple Source Method
NCD	Noncommunicable disease
NL	Nutrition Links
NSA	Nutrition-sensitive agriculture
OB	Obesity
OW	Overweight
PI	Principal investigator
pp	Percentage point
pro-WEAI	Project-level Women's Empowerment in Agriculture Index

QES	The Canadian Queen Elizabeth II Diamond Jubilee Scholarships
QES-AS	The Queen Elizabeth Scholarship-Advanced Scholars
RHF	Rideau Hall Foundation
RR	Relative risk
SD	Standard deviation
SDG	Sustainable Development Goals
SHG	Self-help groups
SSA	Sub-Saharan Africa
SSHRC	Social Sciences and Humanities Research Council
UMKD	Upper Manya Krobo District
UNICEF	United Nations International Children's Emergency Fund
USD	United States dollar
VIF	Variance inflation factor
WE	Women's empowerment
WEAI	Women's Empowerment in Agriculture Index
WIAD	Women in Agriculture Development Directorate
WRA	Women of reproductive age
y	Years
YLKM	Yilo Krobo Municipality

List of appendices

Chapter 1. Introduction

1.1 Background and rationale

Agriculture plays an important role in Ghana's economy contributing about 20% of the gross domestic product (GDP) and employing nearly 30% (3.8 million people) of the labour force (Nyamekye et al., 2021; Roser, 2022; World Bank, 2021). Those employed are mostly in the rural areas (61%) as smallholder farmers engaging in subsistence farming as their main source of livelihood (Ghana Statistical Service et al., 2015). Women account for almost 50% of the agriculture labour force participating in different aspects of the value chain (CGIAR Research Program on Climate Change, Agriculture and Food Security, 2021). Despite the important role of women, gender inequalities in access to agricultural resources (such as land, inputs, and credit) and decision-making limit their potential with significant implications for agricultural productivity, food security, and their overall well-being in the country (CGIAR Research Program on Climate Change, Agriculture and Food Security, 2021; Doss et al., 2011; Food and Agriculture Organization of the United Nations et al., 2013; Quaye et al., 2016).

Estimates from the 2022 State of Food Security and Nutrition report suggest that progress toward food security in Ghana is halting, with about 1.6 million people experiencing severe food insecurity between 2019 and 2021 (Food and Agriculture Organization of the United Nations et al., 2013; Food and Agriculture Organization of the United Nations et al. et al., 2022). Ghanaian women were more likely to experience food insecurity compared to men (45% vs. 40%, respectively), particularly in rural areas (women, 61%; men, 53%) (Ghana Statistical Service, 2022). Research elsewhere has found that food-insecure women were more likely to be poor, obese, and less likely to meet the recommended dietary allowance for macronutrients and

micronutrients compared to those who were food-secure (Johnson et al., 2018a; Ma et al., 2021; Shariff & Khor, 2005).

In Ghana, malnutrition in the form of overweight (OW; BMI 25.0-29.9 kg/m^2) and obesity (OB; BMI ≥ 30.0 kg/m^2) among women of reproductive age (WRA) has been rising in both the urban (49%) and rural (28%) areas (Agyapong et al., 2020; Ghana Statistical Service et al,, 2015; Global Nutrition Report, 2022; Lartey et al., 2020; Ofori-Asenso et al., 2016). In 2019, there was an estimated 41% and 17% of OW and OB women, respectively (Global Nutrition Report, 2022). Micronutrient deficiencies continue to persist with an estimated 62% of women having at least one deficiency and about 24% inflicted with the double burden of OW and OB together with at least one deficiency (Christian et al., 2022; Coomson & Aryeetey, 2022). Low-quality diets are among the factors that contribute to women's nutritional issues (Amugsi et al., 2016; Kobati et al., 2012). Estimates from 2008 national-level data showed only about 43% of women (n=2262) achieved dietary diversity of ≥ 5 (out of nine food groups) (Amugsi et al., 2016). There is a need for multifaceted approaches to address factors contributing to these nutrition concerns.

Nutrition-sensitive agriculture (NSA) has the potential to affect the underlying determinants of poor nutrition in rural households. Six pathways have been proposed that link agriculture to nutrition, including (1) income, (2) food availability and access, (3) food prices, (4) women's social status, access, and control over resources, (5) women's time, and (6) women's health and nutrition (Kadiyala et al., 2014; Ruel et al., 2013; Sharma et al., 2021). Women's empowerment is an integral component of most of these pathways. Cross-sectional studies have provided some

evidence of the role of women's empowerment on household food security and women's nutrition, however, the findings with different empowerment indicators suggest a complex relationship (Doss, 2006; Haddad, 1999; Ruel et al., 2018). In addition, the evidence highlights the important role of context and intra-household gender dynamics in achieving the desired outcomes (Harris-Fry et al., 2020; Malapit & Quisumbing, 2015; Sharma et al., 2021; Sraboni & Quisumbing, 2018).

In the most recent systematic review (2021) examining the impact of NSA interventions, only four studies provided evidence on the women's empowerment pathways (Sharma et al., 2021). There is a paucity of evidence from NSA interventions demonstrating the impact on women's empowerment, intra-household gender dynamics, and consequently food security and women's nutritional outcomes (Ruel et al., 2018; Sharma et al., 2021; van den Bold et al., 2013). In addition, the differences in operationalization and measurement of women's empowerment make it challenging to draw conclusions from the available evidence. With the development of multidimensional measurement tools such as the Project-level Women's Empowerment in Agriculture Index (pro-WEAI) that allow for comparison across contexts, there exists the opportunity to improve the evidence base (Malapit et al., 2019). Nevertheless, such global indices need to be complemented with contextual information given that qualitative evidence suggests that local definitions of empowerment may be shaped by social norms and context (Meinzen-Dick et al., 2019; O'Hara & Clement, 2018; Rubin et al., 2018).

The Ghana government through the Ministry of Food and Agriculture has implemented strategies (such as the Gender and Agriculture Strategy II) and has a technical directorate (Women in

Agriculture and Development [WIAD]) to mainstream gender in the agricultural development process to improve women's access to services and resources to boost agricultural productivity and achieve food security (Food and Agriculture Organization of the United Nations, 2018). More specific policy actions, such as the establishment of farmer-based organizations (FBO), have been promoted to effectively reach farmers, including women, and provide services to them. However, these efforts towards gender mainstreaming in the agriculture sector have rarely been tracked with gender disaggregated tools, particularly within households, to monitor the progress that could inform further policy actions. Moreover, a recent review of national food and agriculture policies of five African countries including Ghana highlighted the poor focus on NSA (such as strengthening multisectoral collaboration and promoting farmers' market access and production of nutritious foods) to improve nutritional outcomes (Asirvatham et al., 2022). Thus, there is a need to leverage existing policies to deliver effective strategies to strengthen their nutrition sensitivity.

The *Scaling Up Women's Agripreneurship through Public-Private Linkages to Improve Rural Women's Income, Nutrition, and the Effectiveness of Institutions in Rural Ghana* (referred to as *LinkINg Up)* project was implemented as an integrated NSA intervention to scale up activities and services to women farmers/agricultural entrepreneurs and their households (Abdu et al., 2022). The primary outcomes of the project were to empower women, strengthen the capacity of institutions, and improve women's diets. The *LinkINg Up* initiative partnered with local institutions (Department of Food and Agriculture, Upper Manya Krobo Rural Bank, District Assembly, Ghana Health Service, Ghana Education Service, Business Advisory Centre, and local government (District Assembly) offices in the Upper Manya Krobo District [UMKD],

Lower Manya Krobo Municipality [LMKM], and Yilo Krobo Municipality [YKM]) to provide in-kind loans (i.e., poultry or vegetable loan input package), agriculture and nutrition education to female members of existing FBO. The initiative adopted Heifer's Passing on the Gift® community development approach where the repayment of loans provided funds for a new set of participants following a 12-month repayment cycle. Half of the women in the intervention group were enrolled in Phase 1 (2019-2020); their repaid loans then supported the remaining women who were enrolled in Phase 2 (2021-2022).

1.2 Overall goal

Using a mixed method approach, this dissertation aimed to investigate (i) measures of women's empowerment and intra-household gender dynamics among farmers/agricultural entrepreneurs and (ii) the relationship of these measures with women's nutritional outcomes and household food security in rural Ghana.

1.3 Specific Objectives

Within the context of the *LinkINg Up* project, the thesis objectives were:

- To explore local meanings and perceptions of empowerment among women farmers and their male partners (Manuscript 1).
- To investigate the relationship of women's empowerment, men's empowerment, and household gender equality with women's participation in FBO, women's and men's nutritional status, and household food security (Manuscript 2).
- To examine the association between the *LinkINg Up* intervention and endline women's and men's empowerment and household gender equality (Manuscript 3).

- To examine if endline empowerment and household gender equality mediate the association between the *LinkINg Up* intervention and women's diet quality and household food security (Manuscript 3).

Chapter 2. Literature review

2.1 Women's nutrition situation in Ghana

2.1.1 Nutritional status

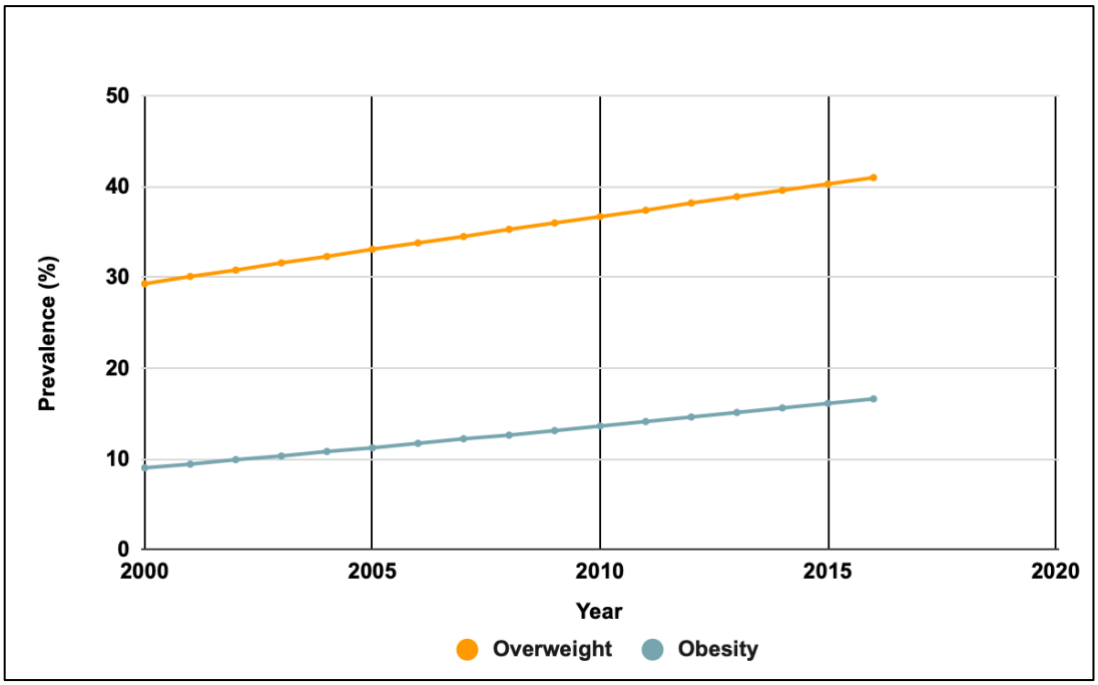
The nutritional status of women is an important indicator of the overall well-being of society. (Black et al., 2008; Davidson et al., 2011). In 2019, only 6.6% of Ghanaian women of reproductive age (WRA) were undernourished (Body Mass Index [BMI] < 18.5 kg/m^2) (Global Nutrition Report, 2022). However, differences existed in underweight prevalence between women in the rural (7%) and urban areas (5%) and between the lowest and highest income quintiles (11% vs. 4%, respectively) (Ghana Statistical Service et al., 2015). The rates of undernutrition also varied across age groups with the prevalence being highest among younger females between 15-19 years with a prevalence of almost 14%. Considerable differences also existed across regions, ranging from a prevalence of 3.5% in the Central region to 7.2%, 9.3%, and 11.2% in the Volta, Upper East, and Northern regions, respectively.

A new public health concern among Ghanaian WRA is the increasing rates of overweight (OW; BMI 25.0-29.9) and obesity (OB; BMI ≥ 30.0) in the country (Agyapong et al., 2020; Lartey et al., 2020; Ofori-Asenso et al., 2016). Estimates of OW and OB from the years 2000 to 2016 showed an increase from 29% and 9%, respectively, to 41% and 17% (Figure 2.1) (Global Nutrition Report, 2022). The 2014 Ghana Demographic and Health Survey reported OW and OB rates being high in urban areas (49%) yet affecting nearly one-third of the population in the rural areas (28%), suggesting a serious nutritional problem. Regional differences were substantial with the highest occurring in the more urbanized areas, the Greater Accra (57.3%) and Ashanti regions (45.4%), and the lowest in Northern Ghana (12%). The prevalence rates were higher

among women with secondary or higher education (49%) when compared with those with no education (27%), highest among those within the age 40-49 years (56%) and increased with parity (12.2 % for no births; 28.6% for one birth; 51.5% for ≥ 2 births) (Ghana Statistical Service et al., 2015; University of Ghana et al., 2017). A study found that higher education increased the likelihood of being OW and OB by about 10% (aOR = 1.08; 95% CI: 1.04, 1.12) (Amugsi et al., 2019). Another study reported that the likelihood of OW and OB increased among women by almost 3-fold with older age (aOR = 2.56; 95% CI: 1.19, 5.52) and about 4-fold with parity (aOR = 3.88; 95% CI: 1.68, 8.97) (Appiah et al., 2014). The difference between OW and OB also persists across income categories with a greater prevalence among the highest (60%) wealth quintiles when compared to the lowest (13%) (Ghana Statistical Service et al., 2015). Important nutrition-related risk factors of OW and OB include total energy intake (aOR = 1.001; 95% CI: 1.000,1.001)) and lower levels of physical activity (aOR = 3.14; 95% CI: 1.30, 7.57) among women in Ghana (Appiah et al., 2014; Nyakotey et al., 2022).

Overweight and OB have serious health implications, increasing the burden of disease among the Ghanaian population (Dai et al., 2020; Ng et al., 2014). These conditions increase the risk of non-communicable diseases (NCD) such as cardiovascular disease (i.e., hypertension, stroke), diabetes, and different types of cancers which have impacts on quality of life and health costs (Coomson & Aryeetey, 2022; Lartey et al., 2020; Nyakotey et al., 2022). About 37% of all deaths in Ghana were attributed to NCD in 2016. Similar to findings reported in other countries, A study in Ghana found that OW status was a determinant of metabolic syndrome, which was 2.2-fold (95% CI: 1.29, 3.58) higher among women than men (Abagre et al., 2022; Krishnamoorthy et al., 2022; Lloyd et al., 2012)

Figure 2.1 Trend in overweight and obesity in Ghanaian women of reproductive age



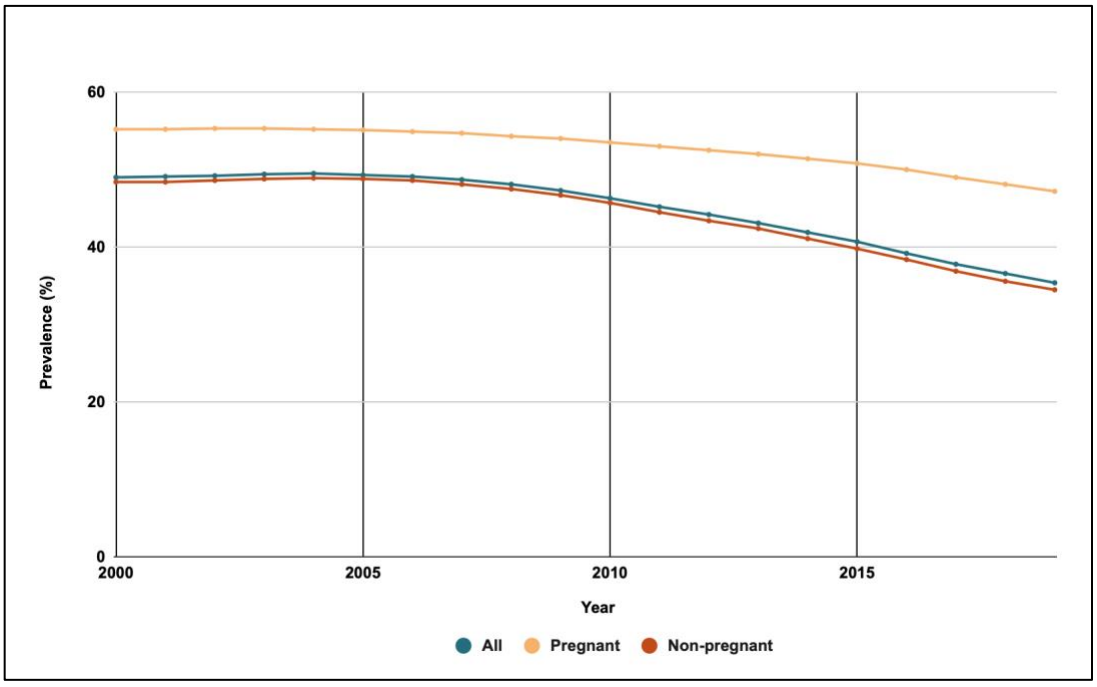
Source: Global Nutrition Report, 2022. https://globalnutritionreport.org/resources/nutrition-profiles/africa/western-africa/ghana/

2.1.2 Micronutrient status

The triple burden of malnutrition, defined as the coexistence of undernutrition, overnutrition, and micronutrient deficiencies, is also present in Ghanaian society (Coomson & Aryeetey, 2022; Popkin et al., 2020). Women of reproductive age are at risk of deficiencies because of their high requirements for micronutrients such as iron, folic acid, vitamin A, and zinc (Ramakrishnan, 2002). In Ghana, micronutrient deficiencies among WRA remain an important public health issue with an estimated 62% of women having at least one deficiency and about 24% inflicted with the double burden of OW and OB together with at least one deficiency (Christian et al., 2022; Coomson & Aryeetey, 2022). In 2014, about 42% of Ghanaian WRA were anemic (32% mild, 10% moderate, and < 1% severe) with a higher prevalence among adolescents 15-19 years (48%) followed by pregnant and lactating women (45%) (Ghana Statistical Service et al., 2015). About 2.7 million WRA were reported with anemia in 2019, which is about 35% of Ghanaian

women (Figure 2.2) (Food and Agriculture Organization of the United Nations et al., 2022; Global Nutrition Report, 2022). However, this represents a substantial decrease when compared with earlier estimates ranging from 49% to 37% between 2000 and 2018, respectively (Figure 2). Nevertheless, it remains a serious micronutrient deficiency among women in the country (Ghana Statistical Service et al., 2015; Coomson and Aryeetey, 2022). Factors contributing to the high rates of anemia among Ghanaian WRA include poor-quality diets that are low in iron amongst other causes related to poverty and poor standard of living (e.g., malaria and helminth infection) (Ghana Statistical Service et al., 2015).

Figure 2.2 Trend of prevalence of anemia in Ghanaian women of reproductive age



Source: Global Nutrition Report, 2022. https://globalnutritionreport.org/resources/nutrition-profiles/africa/western-africa/ghana/

Iron deficiency and iron deficiency anemia were present among non-pregnant women in Ghana at the rates of 14% and 9%, respectively, with 40% of anemia occurring simultaneously with iron deficiency, constituting the main driver of anemia among WRA (University of Ghana et al., 2017). Other micronutrient deficiencies among the non-pregnant population group include folate

deficiency with an estimated prevalence of more than 50% as well as B12 deficiency at 7%. Other deficiencies that have been reported include zinc (12%) and vitamin D (12%). Estimates of vitamin A deficiency are low at the national level with about 1.5% among non-pregnant women. However, a study conducted in the Eastern region of Ghana reported a 7% deficiency and 29% insufficiency in vitamin A among non-pregnant women (Gernand et al., 2019).

2.1.3 Dietary patterns and diet quality

The nutritional well-being of Ghanaian women is influenced by a wide range of factors (Nti, 2008). An immediate determinant of the nutritional and micronutrient status of WRA is dietary intake. Ghanaian women's diets have been found to be less than optimal in terms of nutrients, particularly among rural women (Amugsi et al., 2016; Kobati et al., 2012). Monotonous meals that are based on cereals and starchy roots dominate Ghanaian diets with low consumption of micronutrient-rich foods in some geographic regions (Amugsi et al., 2016; Galbete et al., 2017). National level data shows among mothers with children under the age of three, 86% consumed grains, 65% roots and tubers, 65% fruits and vegetables that are not vitamin A rich, 61% vitamin A rich foods, 88% animal source foods (fish, meat, shellfish) and 17% milk and milk products (Ghana Statistical Service et al., 2009). Estimates of grains and protein-rich food consumed were higher among women living in urban residences when compared with those in rural areas, where diets are mostly roots and tubers. Consumption of animal-source food also differed regionally with the highest (96%) consumption among women in the Greater Accra region.

Rousham et al. (2020) found in a study that 62.9% (95% CI: 59.2%, 66.6%) of total energy intake was from carbohydrates among Ghanaian adults. Foods frequently consumed include maize, cassava, yam, cocoyam, and plantain with these staples being the most highly consumed in rural households (Galbete et al., 2017). Meanwhile, in a study conducted in the Coastal and

Guinea Savannah zones of Ghana, over 70% of non-pregnant and non-lactating women did not meet the estimated average requirement for energy (Kobati et al., 2012). Furthermore, more women in the Guinea Savannah zone did not meet the requirements for protein, vitamin A, vitamin C, and calcium.

While the information on women's diets is limited, the 2017 Ghana Micronutrient Survey estimated that on average Ghanaian women consume 4.4 food groups with the consumption rate being much lower in the rural areas and among the lowest socio-economic groups (University of Ghana et al., 2017). The food group average estimate was the same for pregnant, lactating, and non-pregnant women. Using data from the 2008 Ghana Demographic and Health Surveys to assess dietary diversity (DD), only about 43% of women (n = 2262) achieved DD of ≥ 5 (out of nine food groups) (Amugsi et al., 2016). Women's consumption estimates were below the recommendations (DD ≥ 5) for the minimum dietary diversity for women (MDD-W), which assesses the micronutrient adequacy of women's diets (Food and Agriculture Organization of the United Nations et al., 2016). Women's dietary diversity in Ghana has been associated with higher education (aOR = 1.6, 95% CI: 1.12, 2.20) and the highest wealth quintile (aOR = 1.8, 95% CI: 1.05, 3.14) (Amugsi et al., 2016).

2.2 Food insecurity

Ghana has made significant efforts over the past few decades toward achieving food security as evidenced by the country meeting the Millennium Development Goal of halving hunger in 2015. Between the period of 1990 to 2012, Ghana reduced food insecurity by 35% among its population (Food and Agriculture Organization of the United Nations et al., 2013). Nevertheless, the most recent Comprehensive Food Security and Vulnerability Analysis estimated that about

11.7% (3.6 million people) of Ghana's population are food insecure (Government of Ghana et al., 2020). The prevalence of food insecurity is highest in rural areas (78% of the total, 2.8 million people) when compared with urban areas (22% of the total, 0.8 million) (Government of Ghana et al., 2020; Food and Agriculture Organization of the United Nations et al., 2022).

Food insecurity is an underlying determinant and a contributing factor to women's poor nutritional outcomes (Ma et al., 2021; Ruel et al., 2013). Similar to global food insecurity patterns observed between women (31.9%) and men (27.6%), Ghanaian women were more likely to be food insecure compared to men (45% vs. 40%) at the national level (Ghana Statistical Service, 2022; Food and Agriculture Organization of the United Nations et al., 2021). These rates are higher among rural women (61%) compared to men (53%) (Ghana Statistical Service, 2022). Food insecurity has been associated with lower dietary diversity (β= −0·27, 95% CI−0·47, −0·07) among adults (Shinwell et al., 2022). Food-insecure women were more likely to be poor, obese, and less likely to meet the recommended dietary allowance of macronutrients and micronutrients compared to food-insecure men or food-secure women (Johnson et al., 2018a; Ma et al., 2021; Shariff & Khor, 2005).

Food insecurity in Ghana has been associated with poverty, smallholder farmers as well as female-headed households (Acheampong et al., 2022; Kansanga et al., 2022; World Food Programme et. al, 2013). In 2012, it was estimated that about 38% and 30% of households headed by women were the most severely or moderately food insecure in the Upper East and Upper West regions of Ghana, respectively (Food and Agriculture Organization of the United Nations et al., 2013). Women also fall among the poorest within these regions. For instance, data showed that 62% of households headed by women fell within the lowest wealth quintiles when

compared with their male-headed household counterparts. Food insecurity prevents women from accessing safe and nutritious foods, which further limits the quantity and quality of diets that they can consume to meet their dietary needs and lead healthy life (Gyasi et al., 2022). Pobee et al. (2020) found among food-insecure Ghanaian women that 59% were deficient in at least one nutrient, while 18% were deficient in two nutrients.

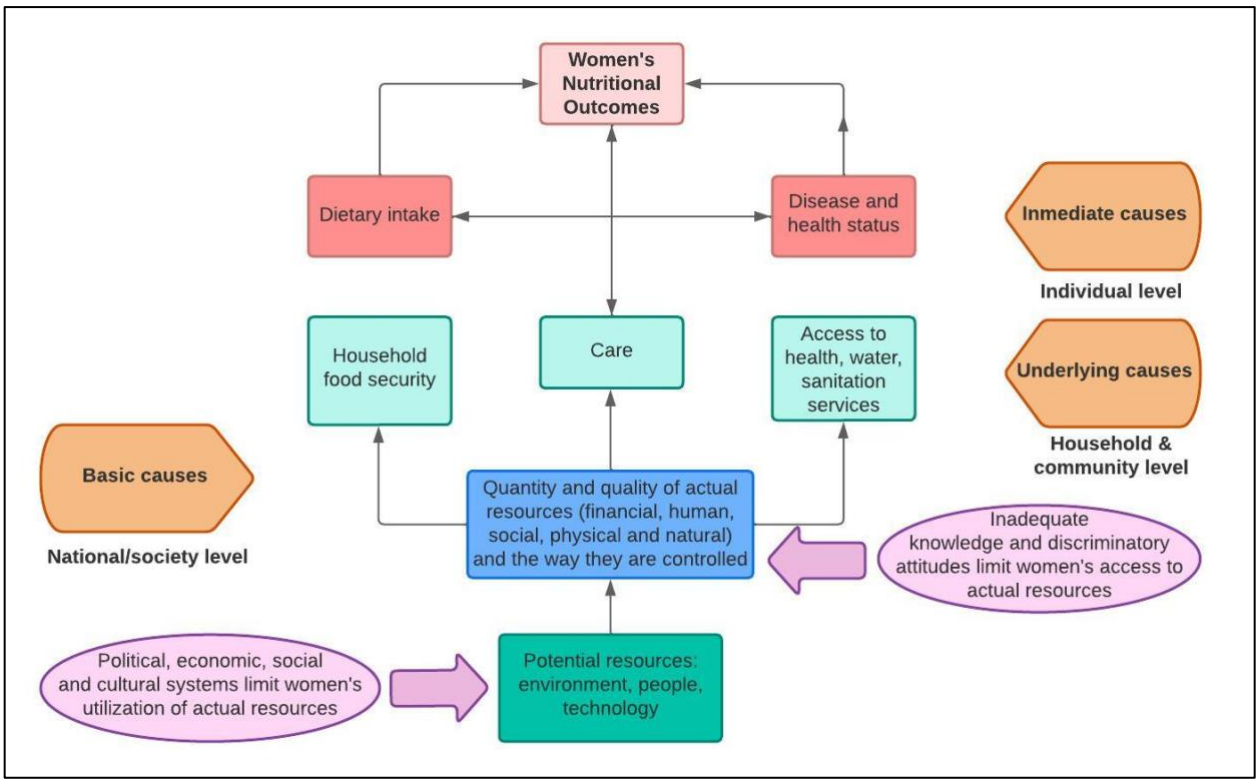
2.3 Gender inequality

Gender inequality can be described as a situation in which women and men have unequal power, rights, responsibilities, and opportunities in their various social contexts. This stems from the social construction of gender in which distinct behaviours, attributes, roles, and responsibilities are unevenly ascribed to people within social structures (Klasen, 2017). These gender-based differences between men and women may vary across time, between and within countries and regions as well as within population groups (e.g., class, race, ethnicity). Gender differences within communities are influenced by social norms, religious and ethnic beliefs, and practices as well as economic factors.

Gender inequality is one of the causes of poor nutrition among women (Taukobong et al., 2016). Achieving the United Nations Sustainable Development Goal (SDG) of gender equality (SDG 5) has been linked with improvements in poverty (SDG 1) and hunger (SDG 2). The United Nations International Children's Emergency Fund (UNICEF) conceptual framework shows the multiple layers (basic, underlying, and immediate) of causes that are linked with nutritional status (United Nations International Children's Emergency Fund, 1991). Within a given society, gender affects the availability, accessibility, and utilization of resources (Kabeer, 2012; Klasen, 2017). van den Bold et al. (2013) in an adaptation of the UNICEF conceptual framework theorized that a

political, economic, social, and cultural environment that constrains women will limit their access and utilization of potential resources (Figure 2.3). Also, women having inadequate knowledge as well as discriminatory gender norms and practices will have limited access and control of actual resources (financial, human, and social capital).

Figure 2.3 Adapted UNICEF conceptual framework showing the causes of malnutrition and the links with gender equality



Source: van den Bold, Quisumbing, and Gillespie, 2013

This in turn will affect the underlying and immediate determinants and ultimately lead to poor nutritional outcomes.

Globally, there is an inequitable distribution of income, opportunities, and resources between men and women (World Economic Forum, 2022). For instance, in 2020, it was estimated that the ratio of extreme poverty would be 121 women for every 100 men aged 23-35 by 2030 (United Nations, 2020). Furthermore, the majority (62.8%) of the females living in extreme poverty were

expected to be living in Sub-Saharan Africa (SSA) (United Nations, 2022). In the SSA region, 46% of women compared to 75% of men earn cash income as fewer women are employed as wage and salary workers compared to men (20% vs 31%, respectively) (World Bank, 2018). In addition, twice as high a percentage of women (32%) have roles as unpaid family workers than men (16%) and work more hours in the domestic sphere (5 hours vs 1.5 hours, respectively). Also, only about 20% of customary laws and practices grant equal rights to women and men in terms of ownership of assets.

Narrowing the gender gap between men and women through the empowerment of women has been core to policies globally for decades to enable women to gain power and control over resources and challenge existing inequities within their social contexts (Cornwall, 2016). While gender equality is the goal, the gaps between theory and practice have limited the ability to achieve and track progress to date. The common gaps agreed upon by researchers and policy practitioners include 1) the way in which empowerment has been defined and operationalized, 2) the lack of sex-disaggregated, comparable, and culturally relevant data on empowerment to track progress and inform policy, and 3) the explicit focus on women without targeting men and institutions to achieve gender equality (Alkire et al., 2013; Asaolu et al., 2018; Cornwall, 2016; Johnson et al., 2016; Richardson, 2018; Wanner & Wadham, 2015).

2.4 Defining empowerment

Empowerment is a complex construct with multiple terminology and definitions found in the literature (Ibrahim & Alkire, 2007). This concept has been a subject of debate; however, a common agreement is that empowerment is multidimensional and a progression from a state of disempowerment to one of empowerment (Kabeer, 1999; Malhotra et al., 2002). Across the definitions in the literature, there is a common theme that empowerment is a process that is

composed of two defining elements. Firstly, it involves an expansion of agency where people have the ability to act on what they value. Secondly, the formal and informal institutional environments serve as facilitators or constraints for people to exercise their agency (Ibrahim & Alkire, 2007).

Kabeer (1999) defines empowerment as "an expansion in people's ability to make strategic life choices in a context where this was previously denied to them." She describes the concept as a transformative process where people who have been denied the power to make a choice gain such power. Malhotra et al. (2002) go further to define women's empowerment as "women's ability to make decisions and affect outcomes of importance to themselves and their families". Applying to poor people as well as other marginalized groups, Narayan (2005) described empowerment as "the expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control, and hold accountable institutions that affect their lives". Alsop et al. (2006) have further described empowerment as "the enhancement of a group or individual's capacity to make effective choices, that is, to make choices and then to transform those choices into desired actions and outcomes". A central theme in these descriptions is the exercising of *agency*, which Malhotra et al. (2002) and Kabeer (1999) have described as the concept that best captures the empowerment process.

2.4.1 Definition of women's empowerment

In drawing the different empowerment definitions specifically for women, researchers have argued that elements of women's empowerment are distinct from that of other socially marginalized groups (Malhotra et al., 2002). Malhotra et al. (2002) highlighted the importance of applying an intersectional lens for policies and projects targeted toward women's empowerment. They argue that women are part of several cross-cutting disempowered groups (class, age, and

ethnic minorities) in society. Furthermore, the household and interfamilial structures are among the main contributors to disempowerment for women which is not the same for other socially disadvantaged groups. Thus, for women's empowerment to take place, the systemic transformation of patriarchal systems which perpetuate unequal relations based on gender, must occur together with changes in the formal institutions.

At the 1995 Women's Conference in Beijing, three fundamental elements were identified as comprising gender equality and women's empowerment (United Nations, 1995). These include (1) it is a social, economic, and political process, (2) power is central to the concept, and (3) it is a process that involves a restructuring of social, economic, and political power. Stromquist (1995) suggested that women's empowerment constitutes a cognitive, psychological, economic, and political component. It involves a level of critical consciousness on the part of the women of their current status to act individually and/or collectively toward social change. Women's empowerment should not only be a *top-down* process in which women are only beneficiaries; women's empowerment should be a *bottom-up* process where women themselves are significant actors in the change that is being realized while systemic transformations within formal and informal institutions and organizational processes are also taking place (Bennet, 2002; Johnson et al., 2016; Malhotra et al., 2002).

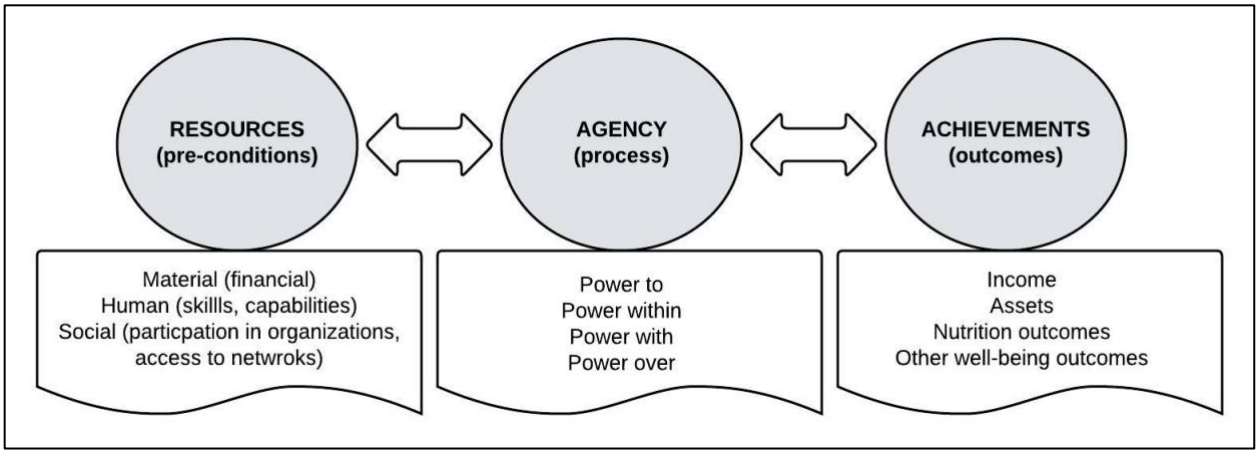
2.4.2 Conceptualization of women's empowerment

2.4.2.1 The empowerment framework

In an effort to compile the literature, Kabeer (1999) conceptualized the empowerment process as encompassing three inter-related dimensions: (1) *resources*, the preconditions for making choices, (2) *agency*, the process in which choices are made, and (3) *achievements*, the outcomes of the choices made (Figure 2.4). Kabeer has argued that these dimensions are linked, hence

important in determining the empowerment process, including in the process of measuring this concept.

Figure 2.4 Kabeer (1999) empowerment framework

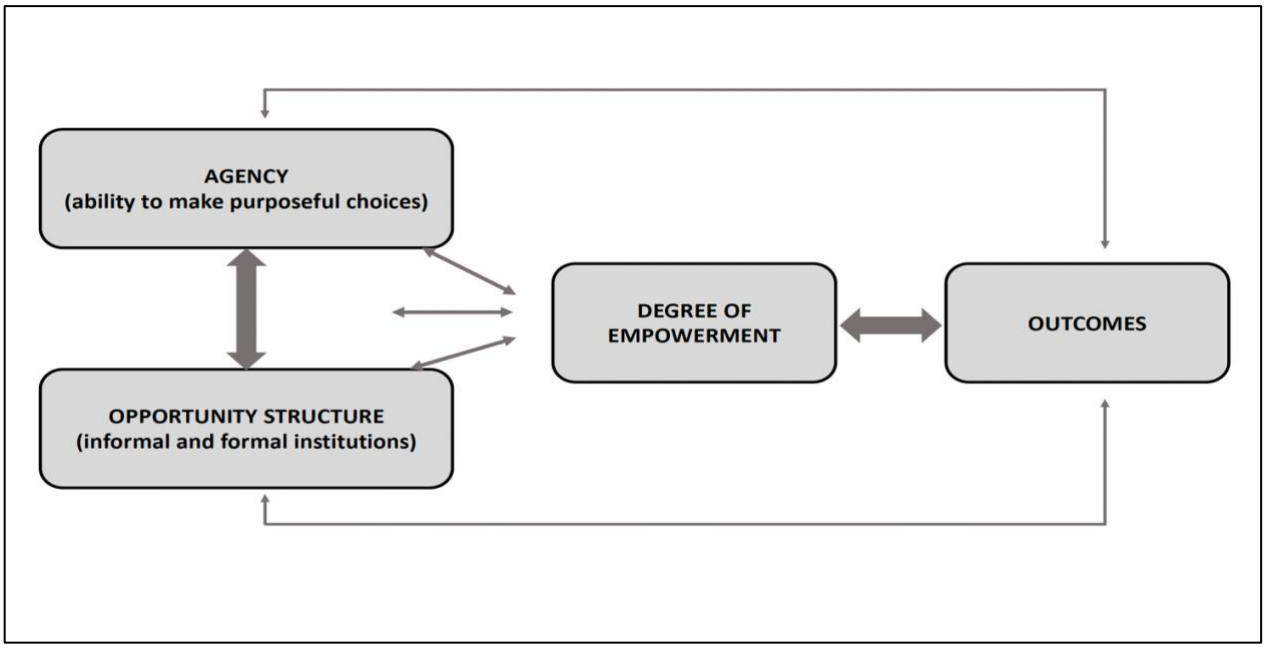


Source: Kabeer, 1999

Drawing from works in the social theory literature that strongly suggest a relationship between agency and structure, Alsop et al. (2006) conceptualized empowerment as composed of two interrelated dimensions: (1) *agency*, the capacity for purposive action by actors, and (2) *opportunity structures*, the environmental and institutional factors that govern the transformation of choices into desired outcomes (Figure 2.5). These authors have further suggested in their framework that the interaction between these dimensions is a determinant of the degree of empowerment as well as the outcomes of the process. These levels could be understood by analyzing how choice is exercised through (1) identifying whether the options for choice exist, (2) people's use of choice, and (3) outcomes of choice.

In a similar framework to that of Alsop and colleagues, however, applying it to both individuals and groups, Narayan (2005) conceptualized the empowerment process as comprising of four building blocks (Figure 2.6). The first two related to agency (individual/collective assets and

Figure 2.5 Alsop et al. (2005) empowerment framework



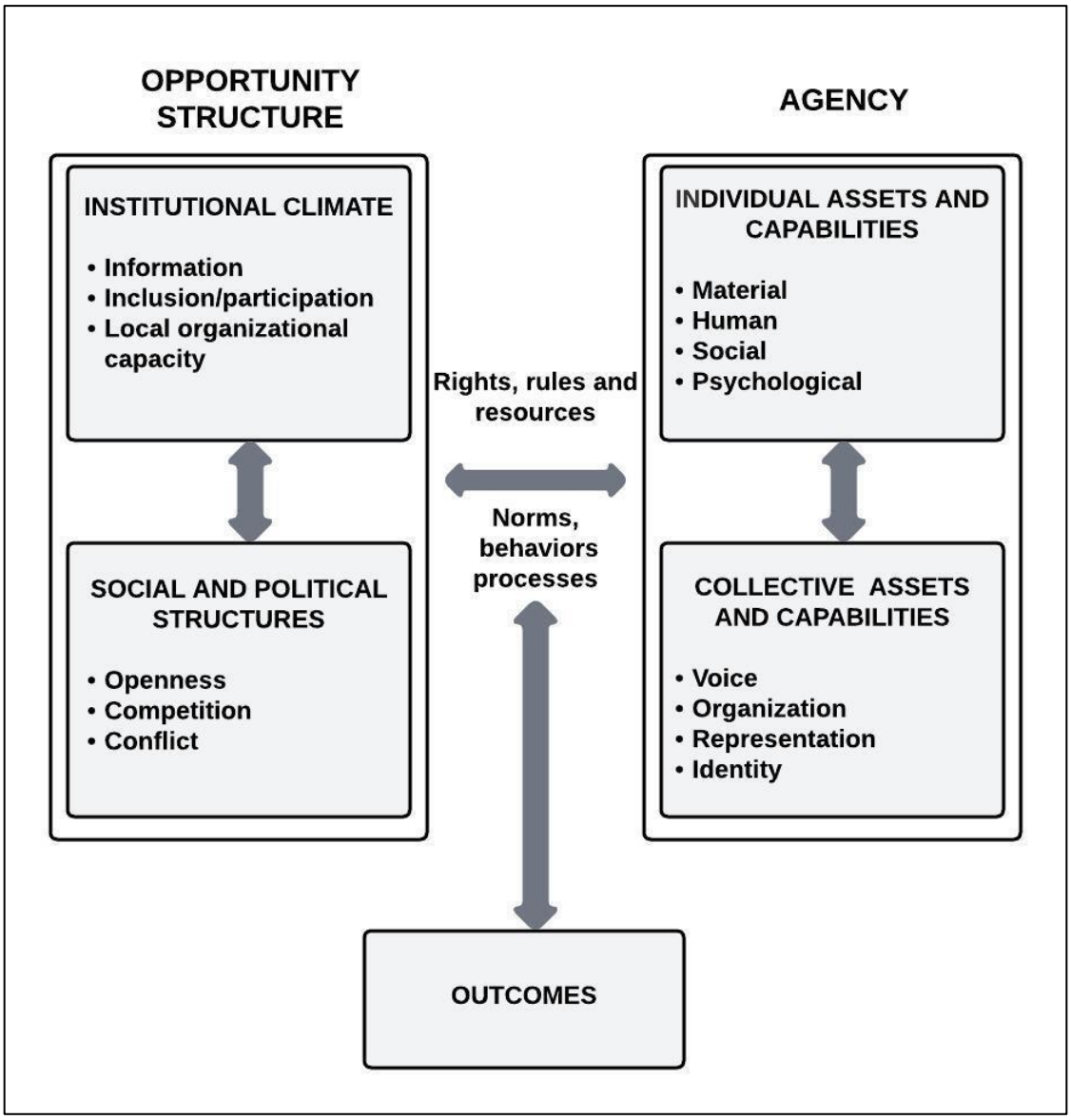
Source: Alsop et al., 2006

and capabilities) and the second two are related to opportunity structures (institutional climate and socio-political structures). Similar to Kabeer (1999) and Alsop et al. (2006), these components are all interlinked, and their interactions are important for people to achieve empowerment as well as the outcomes of the empowerment process.

2.4.2.2 Resources and opportunity structures

In Kabeer's (1999) framework, resources are the sources of power that expand an individual's or group's ability to exercise choice. Resources are the enabling factors that facilitate the empowerment process. Because empowerment is multidimensional, these factors can take a number of forms including material, human, and social (Kabeer, 1999, 2012). Resources can also be thought of as the "opportunity structures - the formal and informal social, political and institutional context" described in Alsop et al. (2006) and Narayan (2005) frameworks,

Figure 2.6 Narayan (2005) empowerment framework



Source: Narayan, 2005

which could serve as enablers or constraints for accessing the assets for the effective exercising of agency by different actors (Alsop & Heinsohn, 2005; Narayan, 2005). These structures could include the formal law, rules and policies, regulatory frameworks, rights, informal laws, norms, values, behaviours, and practices of a given context that govern how people behave as well as determine how resources are allocated, used, and distributed. Other components of the

opportunity structure proposed by Narayan (2005) framework include the institutional climate which comprises access to information, accountability, inclusion and participation, and local organizational capacity as well as the social and political structures which include competition, conflict, and openness. Although formal laws may support equitable access to assets, informal rules and practices may render them ineffective, thus emphasizing the need for analyzing both structures in understanding the empowerment process.

2.4.2.3 Agency

Agency has been defined as the ability to set one's goals and act upon them (Kabeer, 1999). This is in line with Sen's (1985) conceptualization of agency as "what a person is free to do and achieve in pursuit of whatever goals or values he or she regards as important" (Ibrahim & Alkire, 2007; Sen, 1985, 1999). Women's exercising of agency is influenced by individual or collective access to resources in their various forms as well as the overcoming formal and informal institutional barriers in their various contexts (Alsop & Heinsohn, 2005; Ibrahim & Alkire, 2007; Kabeer, 1999; Narayan, 2005).

In the framework of empowerment, Kabeer (1999) adopts the four types of power proposed by Rowlands (1995) in describing the different forms of agency for assessing empowerment: (1) "power to", the act of working towards one's goals, (2) "power within", the innermost desire to change one's life (3) "power over" was, challenging of power relations or the status quo to bring about change to one's life, and (4) "power with", collective power or women acting together as agents to challenge existing inequities and bring about change to their lives. On the other hand, Alsop et al. (2006) and Narayan (2005) in their frameworks suggest assessing assets (e.g., material, financial) and capabilities (e.g., human, social) as agency indicators. Agency can be exercised individually and/or collectively, and across various domains: socio-cultural,

economic, political, and psychological. It may also occur across different levels such as the family, community, and state (Kabeer, 1999; Malhotra et al., 2002; Samman & Santos, 2009).

2.4.2.4 Achievements/Outcomes

Well-being outcomes are attained through the interaction between resources, opportunity structures, and agency (Alsop & Heinsohn, 2005; Kabeer, 1999, 2012; Narayan, 2005). Given the interactions between the framework components and the relational nature of this concept, the dimensions could influence one another. For instance, the outcomes could influence the exercising of agency which will in turn influence the access to resources and/or opportunity structures.

2.4.3 Measurement of women's empowerment

The measurement of women's empowerment has varied greatly in the literature (Carlson et al., 2015; Cunningham et al., 2015; Malhotra et al., 2002; Pereznieto & Taylor, 2014; Samman & Santos, 2009; van den Bold et al., 2013). There has been a general lack of agreement among researchers about the best ways to measure this concept with multiple indicators proposed (Carlson et al., 2015; Ibrahim & Alkire, 2007; Kabeer, 1999; Pereznieto & Taylor, 2014; Richardson, 2018). This, in part, has been attributed to the multidimensionality of the empowerment concept as well as the different ways in which researchers define and operationalize their empowerment terms (Malhotra et al., 2002). Measurement efforts have included both indirect (e.g., women's education) and direct (e.g., decision-making) measures, used either alone or in a composite index (Alkire et al., 2013; Heckert & Fabic, 2013; Ibrahim & Alkire, 2007; van den Bold et al., 2013). The indirect measures have been largely criticized for their inability to capture the agency component of empowerment and instead represent resources and/or opportunity structures for empowerment (Kabeer, 1999; Richardson, 2018). Over the

years, there has been a shift toward more direct measures as researchers agree that this best captures the agency component of the empowerment process (van den Bold et al., 2013).

2.4.4 Challenges with measurements of women's empowerment

A number of challenges have been associated with the measurement of women's empowerment (Richardson, 2018). Although there is a demonstrated agreement about the fundamental elements of empowerment, the indicators that comprise this concept may vary across cultural contexts (Malhotra et al., 2002). The values and attributes associated with empowerment in one area may not have relevance in another (Malhotra et al., 2002; Richardson, 2018). For instance, women's mobility often measured as an aspect of agency for women in South Asia may not serve as a useful indicator for women in Sub-Saharan Africa where women are more mobile (Heckert & Fabic, 2013). Additionally, evidence suggests that *emic* and *etic* meanings and perceptions of empowerment do not always align (Doneys et al., 2020; Meinzen-Dick et al., 2019; O'Hara & Clement, 2018). Thus, existing tools may not entirely capture the specific ways women may or may not feel empowered.

In a qualitative study conducted in Bangladesh, communities did not perceive having the power to make decisions as a quality of an empowered woman, rather women's empowerment was associated with honor and respect (Rubin et al., 2018). In Nepal, high levels of decision-making, mobility, and control over income related to agricultural production were not perceived as reflecting women's empowerment (O'Hara & Clement, 2018). In qualitative interviews, women shared their interpretation of these domains in their environment. High mobility reflected the substantial time spent walking to the markets to sell farm produce and represented their high work burden. Control over the income earned represented decisions only on small household

purchases; these were not enough to change the existing household gender dynamics and influence empowerment.

Systematic reviews of studies have also highlighted other measurement challenges. (Alsop & Heinsohn, 2005; Malhotra et al., 2002; van den Bold et al., 2013). Studies did not incorporate or describe a theoretical framework in the defining and conceptualizing of women's empowerment. In addition, studies often failed to make explicit the dimensions of empowerment being measured as well as the potential pathways through which women's empowerment may occur (Richardson, 2018). Another common practice among studies was the use of composite indices based on the combination of different indicators of empowerment (Agarwala & Lynch, 2006; Richardson, 2018). Composite indices may be limited in their ability to provide information on the areas in which women experience empowerment since evidence suggests that women may experience greater control in certain aspects of their lives but not in others (Richardson, 2018). However, recent global efforts such as the Women's Empowerment in Agriculture Index (WEAI) and its more recent versions allow for the analysis of the individual indicators of empowerment (Alkire et al., 2013; Malapit et al., 2019). Nevertheless, such global indices estimate women's empowerment based on pre-assigned weights to different indicators and cut-off points, thus may represent outsider values of an empowered woman rather than those of the women if data were not complemented with contextual information collected through qualitative approaches (Kabeer, 1999). There are certain nuances of empowerment that are specific to some contexts which universal quantitative instruments may not provide. Furthermore, a limited number of studies have focused on measuring the process of empowerment using data collected across time (Malhotra et al., 2002).

2.5 Agriculture in Ghana

The agriculture sector in Ghana plays an important role in the growth and development of the country. About 29.8% (3.8 million people) of the labour force was employed in the agriculture sector in 2019 making it one of the largest employers in the economy (Roser, 2022). Although not the highest contributor to the Ghanaian economy, agriculture contributed 20% to the gross domestic product (GDP) in 2019 (Nyamekye et al., 2021). The majority of people employed in the agriculture sector were in (61%) rural areas, among the lowest wealth quintile (88%), and had no education (77%) (Ghana Statistical Service et al., 2015). Those employed were predominantly subsistence smallholder farmers (Food and Agriculture Organization of the United Nations, 2012).

2.5.1 Gender and agriculture in Ghana

Using data from 156 countries, the Global Gender Gap Index recently estimated a gender gap of 32% across four domains: health, education, economic opportunities, and political representation (World Economic Forum, 2022). Ghana ranked poorly at 108 out of 146 countries with persistent gaps between women and men across the country and particularly among rural populations engaged in the agriculture sector (Food and Agriculture Organization of the United Nations, 2018; World Economic Forum, 2022).

Nearly 57% of Ghanaian women are employed in agriculture and about 46% provide labour in agricultural production (CGIAR Research Program on Climate Change, Agriculture and Food Security, 2021). Yet, compared to 48% of men, 72% of rural women farmers were estimated as low-income earners despite them being employed as farmers as a main source of livelihood (Food and Agriculture Organization of the United Nations, 2012). Women are more likely to be employed as unpaid family workers as well as face time constraints by juggling both productive

and domestic activities. Estimates showed the time allocated to domestic activities by men and women differ with about 65% of men spending between 0-10 hours/week on domestic activities and 89% of women spending ≥ 10 hours (Food and Agriculture Organization of the United Nations, 2012; Quaye et al., 2016). Women also have limited control over land with data showing only about 29% of women having ownership when compared to 65% of men (Doss et al., 2011). They also have smaller farms and produce less diverse crops compared to their male counterparts. Only about 12% of women were estimated to farm on a large scale (>5 acres) and only 10% of women farmers compared to 34% of men have access to agriculture information through extension services (Doss, 2002; Food and Agriculture Organization of the United Nations, 2012; Quaye et al., 2016). Other estimates suggest that women (33%) are constrained in accessing fertilizer input compared to men (67%) (CGIAR Research Program on Climate Change, Agriculture and Food Security, 2021). Furthermore, they have limited access to formal credit resulting in their greater reliance on informal networks (e.g., family, money lenders) as well as non-governmental organizations (NGO) and cooperatives as a source of credit (Food and Agriculture Organization of the United Nations, 2012). In low- and middle-income countries, it has been estimated that closing the gender gap in productive resources could increase women-owned farm yields by 20% to 30%, thereby increasing the total agricultural output by 4% and reducing food insecurity by 17% (Food and Agriculture Organization, of the United Nations 2011).

2.5.2 Ghana agriculture policies to empower women

In 1992, the Ghana government adopted a National Gender Policy to promote women's empowerment and gender equality (Ministry of Gender, Children and Social Protection, 2015). The policy aimed to mainstream gender in the national development processes. In line with the

national policy, the Ministry of Food and Agriculture developed the Gender and Agriculture Strategy (GADS I and GADS II) to guide the implementation of the Ghana Shared Growth and Development Agenda (GSGDA II), Medium Term Agriculture Sector Investment Plan (METASIP II) and Food and Agriculture Sector Development Policy (FASDEP II), to ensure gender mainstreaming in the agriculture sector (Food and Agriculture Organization of the United Nations, 2018). The objectives of GADS I and GADS II were to address challenges related to women's empowerment, food security, and poverty. Nevertheless, gender indicators have rarely been applied to track the progress of national gender strategies in informing policy recommendations. Also, while there are existing gender strategies (GADS II) in the Ghana agriculture sector, there is currently no existing policy.

2.5.3 Farmer-based organizations

Farmer-based organizations (FBO) are promoted in Ghana for agriculture and rural development (Salifu et al., 2012). In the 4,743 registered FBO, about 42% of the members were women in 2018 (Ministry of Food and Agriculture Ghana, 2018). The Government of Ghana views delivering extension services to groups by local institutions as an efficient and cost-effective way of reaching farmers, and this has been promoted through policies such as the FASDEP II (Ministry of Food and Agriculture Ghana, 2007; Salifu et al., 2012). Most farmers join FBO voluntarily to access technical support from agriculture extension agents and benefit from governmental and NGO projects that provide loans, input, and training support to groups rather than individuals (Salifu & Funk, 2012). They also join groups to benefit from labor exchange, pooling of resources, and accessing credit through local credit schemes or formal institutions. About 58% of FBO in Ghana were reported in 2010 as externally started (i.e., started by government institutions, and NGO), while the remaining were started by individuals living

within the same communities to access support from the government and NGOs. These groups also carry out a range of activities which have been used to categorize them into production, processing, marketing, and multipurpose FBO. While the FBO is a platform for women farmers to access resources and services that allow them to expand their choices, gaps remain in gender mainstreaming in the Ghana agriculture sector (Food and Agriculture Organization of the United Nations, 2012). Women's participation in these groups has been rarely assessed through a gender lens to monitor the progress that will inform policy decisions.

2.6 Nutrition-sensitive agriculture and women's empowerment

Nutrition-sensitive agriculture (NSA) has the potential to affect the underlying and basic determinants of poor nutrition (Black et al., 2013; Sharma et al., 2021). Six pathways have been proposed that link agriculture to nutrition and women's empowerment is an integral component of most of these pathways (Kadiyala et al., 2014; Ruel et al., 2013; Sharma et al., 2021). These include (1) food availability and access from own production, (2) income from the sale of agricultural commodities produced, (3) food prices from changes in supply and demand, (4) women's social status and access to and control over resources, (5) women's time use in agriculture, and (6) women's health and nutrition status. These six pathways could be influenced by factors in the enabling environment that include the food environment, natural resources, health services, clean water, and sanitation (Kadiyala et al., 2014). Meanwhile, social norms, skills, and household gender dynamics could influence women's empowerment (pathways 3,4, and 5).

There have been a number of systematic reviews that have been published over the years to assess empirical evidence on the agriculture-nutrition linkage (Ruel et al., 2013; Ruel et al., 2018; Sharma et al., 2021). The most recent reviews concluded that the quality of evidence has

improved on the impact of agriculture on nutrition, although studies still continue to be underpowered (Ruel et al., 2018). Studies have demonstrated impacts on agricultural production, income, household access and consumption of nutrient-rich foods, and dietary diversity (Kumar et al., 2018a; Miller et al., 2014; Olney et al., 2016; Osei et al., 2017). Authors of reviews reported that improving women's status and empowerment is essential for mediating the role of agriculture on nutrition (Berti et al., 2004; Kumar et al., 2018b; Ruel et al., 2018). However, there are still gaps in understanding the extent to which NSA interventions lead to women's empowerment and gender equality (Johnson et al., 2018; Ruel et al., 2018; Sharma et al., 2021; van den Bold et al., 2013). Although randomized controlled trials have been used, they lack gender-specific strategies nor have explicit goals on empowerment (Johnson et al., 2018b; Richardson, 2018; van den Bold et al., 2013). In addition, the construct has been inconsistently defined and operationalized making it difficult to compare results across studies (Herforth & Ballard, 2016; Johnson et al., 2018b) Furthermore, gender is embedded within societal norms and values, and the domains of empowerment that are affected by NSA in a particular context may vary (Ruel et al., 2018). In addition, most studies have focused on assessing one-time point and individual indicators, while very few studies have looked at empowerment as a multidimensional construct across time (Crookston et al., 2021; Kumar et al., 2018a; Olney et al., 2016; Quisumbing et al., 2021; Waid et al., 2022). There have been calls to improve the measurement and the evidence base on women's empowerment within the context of interventions targeted to rural women farmers with goals of empowerment and improving food security and nutritional outcomes (Ruel et al., 2018; van den Bold et al., 2013).

Johnson et al. (2018b) have recently suggested a framework for projects aiming to empower women and analyzed approaches used in 13 agriculture projects and their linkages with different

empowerment domains. They advocated that projects should differentiate between gender approaches to reach, benefit, and empower women and they should make explicit the theory of change, based on the project activities. Projects with explicit empowerment goals may affect women's empowerment through multiple pathways, including increasing women's: 1) financial resources (e.g., credit), 2) access to and control over assets, 3) knowledge and skills through training, 4) social networks, and 5) interaction with institutions, services, and markets. In addition, projects that include men with the aim of influencing gender norms through sensitization may have a greater chance of empowering women. However, there is still a need for evidence to assess the level of change in empowerment that can be expected given the context and intervention approach used over a specified period of time.

Since 2018, there have been improvements in the assessment of women's empowerment due to the development of Project-level Women's Empowerment in Agriculture Index (pro-WEAI), a multidimensional tool to measure women's empowerment and gender equality by assessing women's empowerment relative to that of men of the same household (Alkire et al., 2013; Malapit et al., 2019). The pro-WEAI tool is grounded in Kabeer's (1999) theory on empowerment and focuses on measuring three forms of agency (power to [i.e., instrumental], power within [i.e., intrinsic], and power with [i.e., collective]) proposed by Rowlands (1995). Furthermore, the tool allows for comparability across contexts. Between 2018-2022, there has been a growing number of projects that have assessed the impact of NSA interventions on women's empowerment using the validated pro-WEAI (Crookston et al., 2021; Quisumbing et al., 2021; Waid et al., 2022). In addition, these studies are among the few that have investigated men's empowerment and gender equality outcomes.

Findings from the studies using the pro-WEAI tool provide some evidence of the linkage between NSA with different empowerment indicators. In a cluster-randomized controlled trial in Bangladesh, Waid et al. (2022) examined the impact of a three-year homestead food production intervention on women's and men's empowerment, and household gender equality. Women in the intervention groups had 8-fold greater odds of being empowered (aOR = 7.7, $p < 0.001$) and 4-fold higher odds of achieving household gender equality (aOR = 3.5, $p < 0.001$) compared to controls. Furthermore, intervention women had a higher likelihood of empowerment in specific domains, including attitudes about domestic violence (aOR = 3.5, $p < 0.001$), ownership of assets (aOR = 2.6, $p < 0.01$), control over income (aOR = 1.8, $p < 0.05$), group membership (aOR = 14.0, $p < 0.001$), and membership in influential groups (aOR = 166.8, $p < 0.001$). Meanwhile, male partners of women in the trial group had higher odds of empowerment in self-efficacy (aOR = 2.3, $p < 0.01$) post-intervention. However, the study did not measure empowerment at baseline and was unable to identify the level of change to be expected based on the trial.

In another 17-month cluster randomized controlled trial with four treatment arms in Bangladesh, Quisumbing et al. (2021) showed significant positive impacts on women's empowerment scores and prevalence (the increase ranged from 0.04 to 0.07, and 8 to 13 percentage points (pp), respectively in the four arms), household gender equality (increase by 8pp and 13 pp in only two arms), and the indicator for access to and decisions on financial services (increase ranging from 19 to 23 pp in the four arms). All four intervention arms (agricultural production training; nutrition behavior change communication [BCC]; agriculture production training and nutrition BCC; agricultural production training, nutrition BCC, and gender sensitization) did not differ significantly in their impact on empowerment. However, men's empowerment scores and

prevalence only improved in the nutrition BCC arm (+0.03 and +10 pp, respectively). In contrast, a 17-month longitudinal quasi-experimental intervention conducted in Burkina Faso through women's savings groups did not show a significant association with women's and men's empowerment, or household gender equality at endline. However, differences-in-differences estimates showed the study was significantly associated with an increase (DID = 0.36, $p < 0.01$) in the number of indicators women achieved adequacy in the treatment group compared to the comparison group even though they did not achieve the threshold for empowerment (Crookston et al., 2021). Authors of the study report that both the treatment and the control groups were members of women's savings groups with access to other interventions which may have limited their ability to evaluate the association between the project and empowerment.

2.7 Women's empowerment, household food security and women's nutrition outcomes

Cross-sectional studies have demonstrated a linkage between women's empowerment in agriculture with household food security (Ruel et al., 2018). Women with access to resources are found to invest more in the dietary needs of the household (Doss, 2006; Haddad et al., 1997; Quisumbing & Maluccio, 2000; Quisumbing & Maluccio, 2003). Data from Ghana showed that households in which women owned land had higher budget shares allocated to food expenditures (Doss, 2006). Women's empowerment in three domains of the WEAI (income, production, and leadership) was positively associated with household availability of carbohydrates, protein, and fat with women's control over income being the highest predictor of nutrient intake within the household (Tsiboe et al., 2018). Meanwhile, in Bangladesh, membership in groups, decision-making over credit, ownership and rights over assets were positively correlated with household per capita energy availability and dietary diversity (DD) (Sraboni et al., 2014).

Very few studies have assessed the relationship between women's empowerment with women's diet quality and nutritional outcomes. However, the available evidence suggests a complex relationship as the empowerment domains and the associated dietary and nutrition outcomes vary across different settings (Ruel et al., 2018; Taukobong et al., 2016). In Ethiopia, the likelihood of undernourishment was 4-fold higher among mothers who did not have any decision-making power regarding household income (aOR 4.13; 95% CI: 2.20, 7.77) (Motbainor et al., 2017). The overall empowerment score of women in the WEAI domains and participation in credit decisions were positively correlated ($p < 0.01$) with women's DD but not BMI in northern Ghana (Malapit & Quisumbing, 2015). In contrast, overall empowerment was associated with both women's DD and BMI in Nepal (Malapit et al., 2015). Women had a higher DD ($p < 0.05$) in households where they participated in decision-making and when they were part of a social or economic group. Furthermore, women's control over income ($p < 0.01$) and reduced workload ($p < 0.05$) were positively associated with women's BMI. In Bangladesh, the quality of women's diets (DD and intakes of protein, energy, and iron) were positively associated with the number of groups and asset decisions a woman participated in as well as a reduced gender gap within the household (Sraboni & Quisumbing, 2018). In contrast, narrowing the gender gap within the household did not show any association with dietary indicators and nutritional status among women in Ghana (Malapit & Quisumbing, 2015).

There is a paucity of studies conducted within NSA interventions investigating the mediating role of women's empowerment on household food security and women's nutritional outcomes (Kumar et al., 2018a; Riddle et al., 2021; Ruel et al., 2018). In addition, Fox et al. (2018) have argued that NSA interventions do not focus on women across the life cycle, given that most have focused on pregnant and lactating mothers. Furthermore, with the rising rates of overweight and

obesity across women of all ages, there is a need to investigate the linkages between women's empowerment and gender equality with other nutrition indicators beyond those related to women's reproductive role (Fox et al., 2018; Riddle et al., 2021).

2.8 Conclusion

Poor nutritional status, micronutrient deficiencies, and food insecurity continue to affect women, particularly those in rural households in Ghana. Empowering women in the agriculture sector may be key to improving these outcomes and multi-sectoral NSA interventions have the potential to promote such outcomes. However, there are still gaps in understanding the extent to which different strategies lead to women's empowerment and gender equality. This is due to the gaps in measurement resulting from the poor understanding of how empowerment varies across different contexts. Furthermore, there is little empirical evidence investigating empowerment over time to assess the level of change to be expected given a specific intervention. In addition, there is a lack of understanding of how empowerment mediates the relationship between agriculture, household food security, and women's nutrition outcomes.

Bridge 1

Rural Ghanaian women play a vital role in the agriculture sector participating as different actors across the value chain. Women's empowerment is one of the proposed pathways through which agriculture is linked to food security and women's nutritional outcomes. Yet, empirical evidence demonstrating this linkage is scarce, in part due to the complexity of the empowerment construct. There is some theoretical understanding of the concept of empowerment, but operationalization and measurement efforts have rarely matched the existing theories. In addition, the literature demonstrates that inconsistencies exist between how empowerment is defined by outsiders and local people who are beneficiaries of projects.

To address the gap identified in the literature, the next chapter employed a qualitative approach to explore local meanings and perceptions of women's empowerment among women and men farmers in three districts of rural Ghana. The study identified the six dimensions of women's empowerment that were relevant to the study context: social/cultural, economic, cognitive, psychological, relational, and collective (Appendix 1).

Chapter 3. Manuscript 1

Local meanings and perceptions of women's empowerment: qualitative evidence from female and male farmers in rural Ghana

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3.1 Abstract

Assessing the relationship between empowerment and nutrition along the agriculture-nutrition pathway is limited by dissimilar *emic* and *etic* views of the construct, limited understanding of its contextual variation, and measurement difficulties. This study explored local meanings and perceptions of empowerment among women and men farmers in rural Ghana. The qualitative study took place within the *LinkINg Up* project, a quasi-experimental, nutrition-sensitive agriculture intervention (ClinicalTrials.gov NCT03869853) in three sub-districts of the Eastern Region. The intervention was implemented through farmer-based organizations (FBO) that were selected using a set of criteria such as female representation and level of member participation. Within the FBO, all women were recruited to participate along with one male adult family member (spouse/partner, older son, father). Non-FBO members (women and their male family member) from the same communities were also enrolled as a comparison group. This manuscript addresses an independent research question on empowerment, not the *LinkINg Up* intervention outcomes. For the question, participants (53 females and 45 males) were selected purposefully based on FBO membership of the woman (member, non-member). During the first three months of the project, eight focus group discussions (FGD) with women and seven FGD with men were conducted to probe into local understandings of empowerment and women's empowerment (WE). The FGD were translated to English from the local language and transcripts were coded using a Constructivist Grounded Theory approach (open, axial, selective coding) with MAXQDA 2022.

Women and men described empowerment in terms of an individual's capability to improve circumstances by setting and meeting intentional and measurable goals. The construct of empowerment was made up of internal and external components. Internal components were those that were essential to allow one to be empowered, such as self-confidence, while the

external components of empowerment were related to personal and community factors that empowered people, for example, asset ownership and social support. *Emic* understandings of WE were often related to women's relationships with others and their roles (reproductive, productive, and community) within the studied context. The local descriptions of an empowered woman were categorized as someone who: i) exhibits qualities that are perceived to help one achieve goals, ii) takes actions to achieve goals, and iii) works with others to achieve own goals or common goals. When assessing WE in the study area, it is important to incorporate measures for women's goal-setting capacity in relation to farming and business activities, and their ability to implement their goals, while taking into account relational aspects.

Key words: Nutrition-sensitive agriculture, Farmers, Empowerment, Emic, Women, Gender, Low-income population, Ghana

3.2 Introduction

Women's empowerment (WE) is a component of three of the six pathways linking agriculture to nutrition, including i) social status and access to and control over resources, (ii) time use in agriculture, and (iii) health and nutrition status [1]. However, supporting evidence on WE role remains limited due to weak study designs and the construct being inconsistently defined and operationalized [2, 3]. Measurement efforts have included both indirect (example, land ownership) and direct (example, decision making) measures, used either alone or in a composite index [4-7]. While such measures can provide information on the progress in achieving global gender equality targets, some researchers have argued that they represent outsider perspectives of what it means to be empowered [8]. Evidence suggests that *emic* and *etic* meanings and perceptions of empowerment do not always align [8-10]. Thus, existing tools may not entirely capture the specific ways women may or may not feel empowered. In addition, there is limited understanding of how men view WE.

The challenge in defining and measuring empowerment arises first from its multidimensionality. Since women play multiple roles within society, empowerment can occur across different dimensions of their lives. Malhotra et al. [11] have proposed a broad set of dimensions in which WE may occur (familial/interpersonal, socio-cultural, psychological, economic, and political domains) that requires different assessment indicators. Achieving empowerment in one dimension may have a positive spillover effect in other domains, but this may not always be the case. Empowerment can occur in some dimensions and not in others [11, 12].

Because gender is embedded within societal norms and values, the domains of empowerment that are important to a particular context may vary [6, 12]. The values and attributes associated

with empowerment in one context may not have relevance in another [8, 10, 13]. For instance, a qualitative study in Bangladesh found communities did not perceive having the power to make decisions as a quality of an empowered woman, rather WE was associated with honor and respect [14]. In Nepal, high levels of decision-making, mobility, and control over income related to agricultural production were not perceived as reflecting WE. In qualitative interviews, women shared their interpretation of these domains in their environment. High mobility reflected the substantial time spent walking to the markets to sell produce and represented their high work burden. Control over the income earned represented decisions only on small household purchases; these were not enough to change the existing household gender dynamics and influence empowerment [8]. These qualitative results further highlight the importance of examining the context in which WE indicators are measured.

There is a global call for a balance between context-specific and universally applicable indicators to design and assess efforts made towards WE [10]. Yet, much of the research on the local definitions of empowerment has been conducted in South Asia [6, 15]. Few qualitative studies have investigated this subject across the African context, a region that is multiethnic and multicultural with different traditional values and systems [15, 16]. Evidence is needed to guide the development of culturally appropriate tools and to inform sustainable interventions that meet the needs of women. Given the highlighted gaps, this study explored local meanings and perceptions of empowerment among women and men farmers in rural Ghana.

3.3 Materials and methods

3.3.1 Setting and participants

This qualitative study took place within a larger quasi-experimental, nutrition-sensitive agriculture intervention (*LinkINg Up*) designed to improve the quality of life of rural Ghanaian

women agricultural entrepreneurs and their families in three sub-districts of the Eastern Region of Ghana. The project districts are primarily rural settlements with similar social and cultural structures [17-19]. They are dominated by the patrilineal Krobo ethnic group [20]. The 2010 population census reported a population of more than 70,000 in each sub-district [17-19]. The main economic activities are crop farming and trading of raw and processed agricultural products, primarily by women in district markets.

3.3.2 *LinkINg Up* project

The project partnered with local institutions to provide loans, and agriculture and nutrition education to female members of existing farmer-based organizations (FBO). A detailed description of the *LinkINg Up* project has been previously published [21]. Half of the female FBO members were enrolled in Phase 1 [2019-2020]; their repaid loans then supported the remaining women who were enrolled in Phase 2 [2021-2022]. The project staff also enrolled a sample of female non-FBO members from a census of farmers from the same communities. A male adult who self-identified as the primary male decision-maker within the same household as the enrolled women was also recruited. This article discusses data from only six communities participating in Phase 1; women and their corresponding male family members were interviewed during the first three months of the project to ensure participants' views and ideas were not influenced by the project activities.

3.3.3 Study approach

The qualitative research is based on the philosophical approach of Constructivist Grounded Theory which proposes that the researcher and participants co-construct experience and meanings during data collection and analysis [22]. The interview guides probed into understanding how participants described empowered farmers in their context, the attributes of

an empowered woman and man farmer, and how they were perceived by others within the community. This paper focuses on general descriptions of empowerment and WE.

Translation of the concept empowerment/empowered

The translation of the term empowerment into the local dialect (Krobo) was carried out through multiple steps. First, a set of questions was given to three local research assistants to guide them in identifying different phrases in Krobo that reflected the concept of empowerment. Next, the research team identified four local key informants who were interviewed about local phrases for empowerment. The most common phrase was selected and pretested in neighbouring communities. Based on the responses, the final phrase *Hewami womi* (back-translated as empowerment or encouragement) was selected and incorporated into the interview guide.

3.3.4 Participants and data collection

Data were collected using focus group discussions (FGD) following a semi-structured protocol. The FGD guides were translated to Krobo by three local research assistants through deliberations to reach consensus. Communities and participants included in the FGD were selected purposefully based on FBO membership of the woman (member, non-member). Eight FGD with women and seven FGD with men from six communities were conducted between December 2019 and February 2020. To ensure that the views of all project communities were represented, we aimed to include at least two FGD, one female and one male per community, with approximately 6-8 participants per group. The FGD were conducted by the local research assistants in Krobo and in a few instances Ewe (another local dialect) based on the participants' preference. Data collection was iterative. All 1.5 to 2 h FGD were audio-recorded, translated to English, transcribed, and then reviewed after each session to determine if saturation was reached.

3.3.5 Data analysis

All transcripts were imported into MAXQDA 2022. Data were analysed using the inductive approach, Constructivist Grounded Theory coding [22]. The first stage of analysis involved open coding - codes were assigned to phrases, sentences, and paragraphs related to the discussion on empowerment and empowered women. The constant comparison technique was applied to identify similarities and differences in the data [23]. The codes that were developed inductively were then used to code similar text from other FGDs while generating new codes. For the second stage, focused coding identified the emerging categories from codes and concepts generated in the open coding phase. The constant comparison method was applied again with the focused codes to identify, refine properties, and integrate core categories by looking at the relationships between them. The aim of this phase of analysis was theoretical saturation. At the final stage, theoretical coding was used to identify the connections and integrate core categories that represent the overarching themes discussed by the participants to formulate the final theory on the meanings of empowerment as well as the meanings and perceptions of WE [24]. The first author coded and analyzed all FGD with women and men. The results were drafted by AA; the final themes and their interpretations were agreed by AA and GSM. Interpretations were also shared with a local research assistant for member checking.

Ethics

Ethical approval for this study was obtained from the institutional review boards of McGill University (# 377-0219) and the University of Ghana College of Basic and Applied Sciences (# 035/18-19).The consent forms were signed or witnessed thumbprints were obtained before the FGD. Information that would identify communities or participants were omitted when presenting the results. *LinkINg Up* is registered at ClinicalTrials.gov (NCT03869853).

3.4 Results and discussion

Participants' characteristics

The FGD included 54 women (56% [n=30] were FBO members) and 44 men (64% [n=28] were from households of women FBO members). Eight percent (n=8) of the respondents were from a female-headed household. Female respondents were 45.5 ± 13.0 years old, while men were 50.7 ± 13.1 years old. The majority (89%, n = 48) of the women were in a union (married or cohabiting), while the rest were single (n=2), widowed (n=3) or divorced (n=1). About 33% (n=18) of the women had never attended school, while 98% (n=43) of the men had received some form of education. Most (88%, n=86) of the respondents were of Krobo ethnicity and 94% (n=49) of women reported farming as their primary occupation.

Local definitions of empowerment

Women and men farmers defined empowerment in several ways. The most salient definition was an individual's capability to improve their circumstances in the present and for the future by setting and meeting intentional and measurable goals. Improvements in participants' circumstances were often expressed as freedom from poverty, moving ahead in life, and having a better life for themselves and their families.

> *"Empowerment is as we are getting into another year, you will set a goal and farm on a larger scale than the previous year […….]. You have that goal so you plan of making a bigger farm than the previous years so you will force and work hard and succeed."*- ***Female participant***

> *"Empowerment is like; as we are getting to farming season this year, you will plan that you should have about six bags of corn, so you have to start early and buy chemicals. As I have goats and chickens, I have to sell some and use the money to buy chemicals so that I will get that number of bags that I planned. So that is empowerment*."- ***Male participant***

Participants described empowerment as having internal and external components. Internal components were those that were essential to allow one to be empowered and included the belief

that one had the capabilities needed to succeed in what one was doing and benefit from it. In addition, self-motivation and having the attitude and mindset for success were essential. Pursuing one's goals by making decisions, expanding one's knowledge, seeking support (example, taking loans from peers or institutions), and tapping into one's social network to seek help, advice, and encouragement were other ways respondents described empowerment. Having good relationships with others by supporting, advising, and sharing information to help them achieve their goals was another way empowerment was described.

> *"Empowerment means having faith that what you are doing will be good. Then it will go on well."– **Female participant***

> *"You have set a goal which is before you with the intention of getting profit out of it. You take a good decision and encourage yourself to do it and if you do that, you get what you want. You will work hard to get what you want" – **Male participant***

The internal descriptions of empowerment were consistent with the categorizations of power that have been proposed in previous research [25, 26]. These types of power include (1) *power within,* described as the innermost desire to change one's life as well as self-efficacy, (2) *power to*, described as the act of working towards one's goals and (3) *power with,* described as collective power or the process of working with others.

The external components of empowerment were related to personal and community factors that facilitate empowerment. Participants discussed succeeding in farming (example, harvesting good yields, selling, and making profit), ownership of agricultural assets, access to capacity-building opportunities related to farming, access to bank loans to hire farm labor and purchase inputs, and social support (example, advice from others) to help them achieve their goals. Human relationships strengthened farmers sense of self-efficacy and ability to achieve one's goals.

"Maybe I am doing something which I am stuck in the way, so I will come and seek for advice from my brother to help me do it well and he will also advise me on it or show me how to do it well or he will say what you are doing will help you so I will stand by you so that you do it well, that is empowerment. – ***Male participant***

"Empowerment is maybe I want to clear the land and farm on it but I don't have money so I will come to you and borrow it from you to do it. If the person gives you the money, he/she has empowered you." – ***Female participant***

Meanings and Perceptions of women's empowerment

An empowered woman farmer was described in a variety of ways and aligned mostly with expressions of agency that are found in the literature [10, 25-27]. The most common description was someone who set goals, planned, and worked hard to achieve goals. Most of the goals were related to farming and business activities, finances, building assets, and investing in children's education for the present and future to ultimately ensure a sustainable livelihood for her and the family. The descriptions of an empowered woman included someone who: i) exhibits qualities conducive to achieving set goals, ii) takes actions to achieve goals, and iii) works with others to achieve their own or common goals. All of these categories interact with each other and are promoted or inhibited by factors that are present at different levels (individual, relational, market, and institutional). The findings suggest diverse expressions of agency in our study context.

Exhibiting qualities that help one to achieve goals

Women and men discussed an empowered woman farmer as a self-determined individual who set goals and implemented them. The act of defining goals that are in line with a woman's values is an essential component of individual agency in empowerment as it demonstrates self-reflection and desire for change [27, 28]. The majority of the goals discussed were set by the woman herself to improve her life and take care of her children and the household. However, a few respondents described the empowered woman as someone who set common goals with her

family and planned together with her husband for their present and future. Households that set common goals have been linked to better gender equality in farm and household tasks [29].

Both women and men expressed that an empowered woman was obedient (to her husband and others) and submissive, qualities that reflect societal norms and expectations of how a woman should behave and yield social acceptance. Meinzen-Dick et al. [10] found similar findings and argued that women conforming to social norms could be a form of agency as it allows women to maintain social ties as well as achieve their goals. An empowered woman was also described as committed to her work, hardworking, and efficient with her time, allowing her to fulfil both her domestic responsibilities and to be committed to the planned activities that help her to reach her goals.

> "*A woman farmer who is empowered is someone who wakes up early, and if she will be going to the farm, she will do everything fast and will leave for the farm before the sun sets in. When she goes to the farm, she will be working hard for some time and rest. She will come home and go back to the farm in the evening. With this, you can see that, that person has empowered herself in the farm." –* ***Female participant***

> ***"****She submits herself to her husband and also takes care of her children. She will put everything in order before leaving the house and then finish all the household chores, dress for the children and send them to school." –* ***Male participant***

Participants expressed that an empowered woman farmer was sincere and trustworthy which helped her to acquire loans from colleagues, customers, and financial institutions. She also had the mindset for success and believed she will succeed in what she did. Finally, an empowered woman farmer was a person of faith who believed and had the fear of God, which allowed her to act on her goals. All together, these qualities enable a woman to exert her choices, decisions, and preferences to reach her goals [26, 27].

Acting to achieve one's goals

Acting on one's goals was another important aspect of empowerment. An empowered woman farmer was described as someone who aimed to farm on a large area of land and hired labour support to clear her farm, sow seeds, and harvest her produce. Both female and male discussants noted that clearing land was particularly difficult for women to carry out singly and employing support helped women reach their farming-related goals such as high yields and diversity of crops. With hired labour, women were able to sell more products at the local markets and use the profits for further farm enterprise investments to grow the farming business.

Participants also described an empowered woman as having control over her farming activities; she decided when to farm as well as when and how much to sell. An empowered woman was also described as someone who was entrepreneurial or a businesswoman who took on different opportunities to reach her goals. She applied good marketing and business skills when selling her produce. She took her time to sell her produce, sold in bulk, and developed her knowledge of local market prices and the products that were in demand. Participants expressed that this empowered woman was someone who used the knowledge and skills she had to plan and achieve her goals. She also aimed to produce good quality products to attract customers and gain profits.

> *"I will use what my grandmother told me as an example, she advised us by telling us that, she became a businesswoman which nobody gave her money. Her parents did not give her anything, but her friends are boys and when they are going to farm, she will follow them. When they weed, she will also weed. She got a land, and she had a maize and cassava farm. When the maize matured, she harvested it and sent it to the market to sell. When she come back home, she used the money she had to buy maize from other people in the community and she started to sell. That thing made her a businesswoman and a farmer. So, I think if you plan from the beginning and you work on it, it will help you"* – ***Female participant***

In addition to investing in her farming, an empowered woman also invested her profits into other businesses. She did not rely on one source of income but engaged in a range of activities to provide her with capital to sustain her farming and income to use for her household. She also

managed her finances as she was described as someone who saved money and budgeted towards achieving goals. An empowered woman also had autonomy over how she spent money. Similarly, in Cambodia women exercised more freedom when they earned their own income [9]. An empowered woman also had a bank account with the local bank which enabled her to grow her savings and take loans for her farming or business activities. She aimed to pay her loans on time to assure future financial interactions to improve her farm and business. An empowered woman also engaged with the agriculture extension agents which allowed her to access training, advice, and input support (example, seeds and chemicals) and loans, which helped her to improve her farming. In addition, she sought advice and support from family and community members, particularly in relation to her farming activities such as sowing, planting and harvest crops.

Working with others to achieve goals

From participants' perspectives, WE was relational and achieved through an interconnectivity with others. Participants perceived WE as being dependent on the woman's diverse relationships with others. Consistent with these findings, other studies conducted in low-income communities have found that WE was understood more as relational [9, 10]. An empowered woman was described as respectful to others in her life, including her husband, family and community members which allowed her to gain support in achieving her plans and goals as well as earned her respect at the community level. Mutual respect among spouses promotes household harmony and may allow women to negotiate their preferences [10, 26]. Indeed, the participants in the present study described an empowered woman as someone who maintained a good relationship with her husband/partner which enabled her to have a say in household decisions and gain the

man's support for activities related to her goals. She also has a good relationship with other people.

An empowered woman was someone in a position to help and support others, including women and youth within the community with advice, money, and food which in turn built her network of people from whom she sought support for her farming and livelihood activities. Indeed, the empowered woman influenced others in the community since her decisions and voice were valued in the community and people sought her advice in relation to their farming and other matters. For instance, a respondent gave an example of an empowered woman who used her own farm as an example to demonstrate and advise others on how she was able to achieve good yields so they could improve on their own farms. In a study in Cambodia, transferring knowledge to others was important for strengthening bonds [9]. The empowered woman also communicated well with others which helped her to be successful. An empowered woman was also part of a group in the community from which she derived membership benefits such as borrowing money to hire labour support for the farm.

> *"A woman is not as strong as the man so she will hire labourers to clear the land. Maybe she is also not having money so if she is in a group, she will go and borrow money to buy chemicals and hire people to spray and weed the farm. In order to do well in farming, a woman will have to join a group to borrow money [……]."* – ***Female participant***

The empowered woman also supported her husband/partner on the farm and contributed financially to the household. As one female respondent said, supporting each other helped them to plan together for their family and the future. An empowered woman was described as being united with her husband and farming together, as women were not being able to carry out activities such as clearing land in which the man provided support. However, not all respondents agreed with the idea of farming together with a husband/partner as a pathway to achieving

women's goals. Some women voiced that they were not able to have enough produce to sell to make profits when they farmed together with male partners as men took control of most of the produce.

> *"Some men will ask you not to have your own farm, but the woman should support him to farm and at the end, he will compensate the woman [……]. The man can compensate the woman with one sack of maize but if the woman works on her own farm, she will get more than that. If the man did not permit her, she cannot have her own farm".* ***– Female participant***

Contextual facilitators and barriers to women's empowerment

Individual factors**.** A woman farmer having her own farm on rented or owned land, formal education, and literacy were important contributors to WE. On the other hand, poor farm-related planning, poor agricultural practices, and lack of financial resources were individual-level factors that prevented empowerment.

Relational factors. Relational facilitators were the most discussed factors contributing to WE. In particular, this included support from the husband, children, and other family members with farming activities, household chores, and childcare. Community and group support with farming activities and advice were also considered empowering.

Relational factors could also act as barriers to empowerment. Male partners or other family members may refuse to support women with land or allow women to have their own farms. Lack of support (financial, labour) from the family, men's refusal to accept women's decisions, and the household financial burden on the woman as a result of men reducing their financial contribution were also identified as barriers to empowerment.

Institutional factors. Support in the form of farm inputs, equipment, and timely technical training from the local agriculture institutions was an important facilitator of WE. Difficulty with

access to bank loans due to refusal, delay, or high-interest rates was discussed as a barrier to empowerment.

Marketing factors. Having customers that purchased farm produce in bulk and good market prices that contributed to profit facilitated WE. Poor roads/infrastructure and difficulty transporting produce to the market were mentioned as barriers to WE.

3.5 Conclusion

This study explored how women and men farmers perceived empowerment and WE within their context. We found that local farmers understood empowerment in multiple ways, but most of the focus was on different forms of agency. *Emic* understandings of WE were often related to women's relationship with others and their triple roles (that is reproductive, productive, and community) within the studied context. In particular, women's roles as farmers and entrepreneurs are well recognized in the study area. Hence, there was a lot of focus on women's economic empowerment. When assessing WE in the study area, these results suggest incorporating measures in three areas: (i) assessing women's goal-setting capacity in relation to farming and business activities, finances, building assets, and investing in children's education, (ii) their ability to implement their goals, and (iii) the relational aspects. The finding that women's empowerment may be facilitated or inhibited by contextual factors suggests that sustainable nutrition-sensitive agriculture interventions need to intervene at different levels to achieve the best outcomes.

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Bridge 2

The previous chapter examined women farmers' and their male family members' understandings of empowerment. Our results revealed nuances that allowed for the identification of dimensions of women's empowerment in agriculture that were important to local people. The women placed a lot of value on interdependence (i.e., relationships and being part of groups) rather than independence in defining women's empowerment. The findings highlighted the importance of relational factors that should be incorporated into the measurement and design of projects to empower women.

Participants also discussed that factors in the environment may either promote or inhibit women's empowerment across the dimensions and these factors were present at the individual, familial, institutional, and market levels. Having access to material resources through institutions (e.g., agriculture, finance) was important. Participating in groups facilitated empowerment as it allowed women to build their relational capacity and access resources from local institutions.

The Ghanaian government currently has the mandate to deliver agriculture-related services to farmers through farmer-based organizations (FBO). In 2018, an estimated 42% of FBO members were women in Ghana. Given the qualitative results showing that group participation may lead to women's empowerment through its different benefits, the next chapter examined the association between women's participation in FBO with women's empowerment, male family member's empowerment, and household gender equality. Furthermore, we examined the association between empowerment and gender equality with women's and men's nutritional status, and household food security.

Chapter 4. Manuscript 2

The association of women's participation in farmer-based organizations with female and male empowerment and its implication for nutrition-sensitive agriculture interventions in rural Ghana*

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Running head: Groups, empowerment, and nutrition in rural Ghana

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Data Sharing

Data described in the manuscript, code book, and analytic code will be made available (in deidentified form) upon request pending application to the PI (Marquis) and approval.

4.1 Abstract

Background

Few studies have examined the influence of women's participation in farmer groups on female and male empowerment, which is considered essential to improving nutrition.

Objective

The study aimed to (1) assess the empowerment of Ghanaian women farmers, one adult male family decision maker, and the household gender equality, and (2) investigate the relationship of empowerment and household gender equality with women's participation in farmer-based organizations (FBO), women's and men's nutritional status, and household food security.

Methods

A cross-sectional study investigated secondary outcomes using baseline data from a nutrition-sensitive agriculture intervention implemented through FBO in rural Ghana (ClinicalTrials.gov (NCT03869853). Existing FBO in eight communities were selected based on six criteria (e.g., participation level, readiness to change). Female FBO (n=166) and non-FBO (n=164) members together with a male family member (n=205) provided data on individual and household characteristics; empowerment was measured across 11 indicators with the project-level Women's Empowerment in Agriculture Index. Generalized linear mixed models tested the associations between empowerment and household gender equality with FBO membership, nutritional status, and household food security.

Results

Women's FBO membership was associated with an increased likelihood of women's empowerment (aOR =3.25; 95% CI [1.97, 5.33]) and household gender parity (aOR= 2.82; 95% CI [1.39, 5.84]) but not men's empowerment. Household food insecurity, but not nutritional status, was positively associated with women's FBO participation and individual empowerment

indicators (financial services). Food insecurity was negatively associated with women's empowerment indicator related to attitudes about domestic violence (aβ = -0.78; 95% CI [-1.35, -0.21]) and men's overall empowerment (aβ = -0.79; 95% CI [-1.58, -0.01]).

Conclusions

Understanding the complexity in which FBO participation, empowerment, nutritional status, and food security are linked is critical in designing interventions that promote gender equality and improved nutrition.

Keywords

Nutrition-sensitive agriculture; Empowerment; Nutritional status; Food security; Gender; Agriculture; Farmer-based organizations; Rural; Ghana

Teaser text:

Women's participation in farmer-based organizations and household food security are differentially linked to women's and men's empowerment**.**

4.2 Introduction

In Ghana persistent gaps exist between women and men across the country, particularly among rural populations engaged in agriculture (1, 2). Nearly 50% of rural Ghanaian women are employed as farmers, yet they lag behind men in accessing agricultural resources such as productive assets, inputs, labor, and extension services (2, 3). Estimates show Ghanaian men own three times more farms, have larger landholdings, and are more likely than women to access formal financial services in the rural areas (3, 4). Women are more likely to be employed as unpaid family workers and face time constraints due to time allocated to domestic activities (89% of women spending 10 or more hours/week compared to 65% of men spending between 0-10 hours/week), further affecting women's productivity in the agriculture sector (3, 5). Closing the gender gap has been advocated as a human right and a key step to achieving the Sustainable Developmental Goals related to improved nutritional status and household food security (6-8).

Empowerment is the process by which people expand their capabilities to make choices that are important to them and is key to reducing the gender gap (9). Community groups have been shown to be effective in providing knowledge and resources needed for individuals to exercise their choices at the individual, household, and community levels (9, 10). Participation in farmer - based organizations is one pathway that may contribute to the empowerment of rural women (10, 11). A recent study showed women's membership in dairy producer organizations improved their use of income, ownership and decision-making over land and assets, and control over productive decisions (12). Women's empowerment in agriculture has been linked with nutrition through three theoretical pathways (13). Yet, evidence from studies looking at this linkage are limited due to methodological limitations and contextual differences in definitions of empowerment (13-15). However, researchers have demonstrated the benefits of improvement in

different domains of empowerment, including (i) women with control over resources invested in the nutrition of the household, (ii) increased group membership and ownership over assets positively correlated with household food security, and (iii) more decisions related to agricultural production was negatively associated with the risk of obesity among women (16-20). Nevertheless, few studies have investigated the relationship between empowerment in agriculture and women's own nutritional status (13). Available evidence on the empowerment indicators also suggest differential linkages across regions which may influence the design of local policies and interventions to empower women (7, 15).

Most studies assessed the impact of group participation on women's empowerment only (21). Few researchers have looked at the impact of women's participation in groups on the empowerment of other household members (22-24). Although studies have reported on improvement in household income and diet quality, some evidence has pointed towards changes in intra-household dynamics when women's status and bargaining power were improved, including male disempowerment and feelings of threats to male authority (25-27). In other cases, male partners reported reducing their contribution to household food expenses (26). Changes in household dynamics could negatively impact some domains of women's empowerment, increasing intra-household conflicts to the detriment of the nutritional status of the household members and household food insecurity (28, 29).

Farmer-based organizations are promoted in Ghana for agriculture and rural development (30). In the 4,743 registered FBO, about 42% of the members were women in 2018 (31). The Government of Ghana views delivering extension services to groups by local institutions as an

efficient and cost-effective way of reaching farmers, and this has been promoted through policies such as the Food and Agriculture Sector Development Policy (FASDEP II) (30, 32). As such, most farmers join FBO voluntarily to access technical support from agriculture extension agents and benefit from governmental and non-governmental organization (NGO) projects that provide loans, input, and training support to groups rather than individuals(33). They also join groups to benefit from labor exchange, pooling of resources, and accessing credit through local credit schemes or formal institutions. About 58% of FBO in Ghana were reported in 2010 as externally started (i.e., started by government institutions, NGOs), while the remaining were started by individuals living within the same communities to access support from the government and NGOs. On average, FBOs comprise 36 members and meet regularly to access support. These groups also carry out a range of activities which have been used to categorize them into production, processing, marketing, and multipurpose FBO. While FBO are a platform for women farmers to access resources and services that allow them to expand their choices, gaps remain in gender mainstreaming in the Ghana agriculture sector(3) .Women's participation in these groups have been rarely assessed through a gender lens to monitor progress that will inform policy decisions (2).

Given highlighted gaps in the literature and the interest in empowerment as a pathway to gender equality and improved nutritional related outcomes, this study aimed to (i) assess the empowerment of Ghanaian women farmers who are members and non-members of FBO, one adult male decision maker, and the household gender equality, and (ii) investigate the relationship between women's participation in FBO, adult nutritional status, and household food security with women's and men's empowerment and household gender equality.

4.3 Methods

This cross-sectional study investigated secondary outcomes using baseline data collected as part of the Scaling Up Women's Agripreneurship through Public-Private Linkages to Improve Rural Women's Income, Nutrition, and the Effectiveness of Institutions in Rural Ghana (*LINkING Up)* project, a quasi-experimental, nutrition-sensitive agriculture intervention designed to improve the quality of life of rural Ghanaian women agricultural entrepreneurs and their families in three districts of the Eastern Region of Ghana. The *LINkING Up* initiative was designed to sustainably build on lessons learned from a previous cluster randomized controlled trial, *Nutrition Links (NL),* an integrated agriculture and nutrition education intervention implemented in the Upper Manya Krobo District of Ghana (2014-2017), by scaling up activities and services to women and their households (34). The rationale was that sustained integrated approaches that increase agricultural productivity, diversify incomes, and enhance knowledge and skills among all stakeholders are needed to improve the well-being of rural communities. As a result, the *LINkING Up* coordinators engaged with the *NL* sustainability committee that was formed during the project to guide in the planning and selection of districts for the scale up of activities and services. The *LINkING Up* initiative partnered with local institutions [Department of Food and Agriculture, Upper Manya Krobo Rural Bank, District Assembly [the local government], Ghana Health Service, and Ghana Education Service in the Upper Manya Krobo District (UMKD), Lower Manya Krobo Municipality (LMKM), and Yilo Krobo Municipality (YLKM)] that were selected through stakeholder engagement, to provide loans (i.e., poultry input loan package or vegetable loan input package), and agriculture and nutrition education to female members of existing FBO. The initiative adopted Heifer's Passing on the Gift® community development approach where the repayment of loans provided funds for a new set of participants following a

12-month repayment cycle. As such, the study sample was divided into two groups, Phase 1 (2019-2020) and Phase 2 (2021-2022), with each phase accounting for 50% of women recruited as study participants from the selected FBO groups. While loan inputs were only provided to women during their corresponding phase cycle period, capacity building, technical and financial trainings as well as other services provided by the partnered institutions were open to all women in the FBO groups (both phase 1 and phase 2 participants). Note that the *LINkING Up* activities were still ongoing for the phase 2 participants at the time of writing this manuscript.

4.3.1 Sample

A list of all existing FBO with at least 40% female membership for the three districts in the Eastern Region of Ghana were collected from a database of registered FBO available at the Ministry of Food and Agriculture. The 2017-2018 regional report on FBO in Ghana estimated that about 2,475 (27.3%) out of 9,072 members were women in the 496 FBO in the Eastern region (31). Active FBO in the selected project districts (UMKD, n=7 ; LMKM, n=7; YLKM, n=10) were shortlisted to be assessed against the inclusion and exclusion criteria defined by the *LINkING Up* partners to participate in the initiative. The FBO executive officers (i.e., leaders, secretary) and local agriculture extension agents (AEA) gathered information for each of the FBO for the previous four months on (i) percentage of female members, (ii) meeting schedule (i.e., frequency, expected meetings and actual meetings held) and location, (iii) number of meetings, dates, and average attendance, (iv) previous work with non-governmental organizations, and (v) FBO activities (e.g., production, processing). Using this information, the AEA evaluated the FBO using a rating scale of 1-5 (5= highest) on the members level of participation, leadership potential, congeniality within the group, ease of collaboration, group's need and potential impact, and readiness to change. A final score (UMKD, 29.3 ± 3.5; LMKM, 19 ± 0.7; YLKM, 17.8 ± 2.0) was generated for each FBO by adding the ratings in each of the

aforementioned categories. The highest ranked FBO by the AEAs were then evaluated for distance, proximity to each other, and alignment with the economic activities proposed by the *LINkING Up* initiative, and a total of eight FBO (UMKD, n=2; LMKD, n=1; YLKM n= 5) were chosen to participate. The focus on active FBO (i.e., those that were meeting regularly and carrying out activities together) was to test the feasibility and sustainability of the *LINkING Up* initiative for scaling up among other existing FBO in the districts.

The selected FBO were on average 34.4 members, women only (n=5) and mixed (n=3) groups, and engaged in different activities which include production, processing, labour support and village savings and loan group. One of the FBO was a multipurpose group, four were solely a production group, and the remaining were a combination of production, processing and either savings/loans or social support group. Most (n=5) of the FBO were formed by an AEA and the others were self-formed then registered with the support of the AEA at Department of Food and Agriculture. All members reported joining the groups voluntarily. The selected FBO reported that group meetings were held either weekly or twice monthly. In most cases, the FBO members were from the same communities.

In most of the selected FBO, all women were enrolled to participate in the project. The few women who chose not to participate did not differ in demographic characteristics with the women who participated in the project. Since the project was divided into two phases, larger FBO self-selected the members who would participate in the first and second phases of the project. We checked for differences between these participants and only found a significant difference in marital status (P=0.043) between the phase 1 and 2 female participants and no difference in other characteristics such as age, education for women and men. For all the households where a female FBO member enrolled to participate, a male adult living in the house

and who identified as primary male decision maker within the same household was also recruited for the project surveys. The rationale for including men was to assess women's empowerment relative to the male adult decision maker in the household. Some of these males (UMKD, n=29; LMKD, n=47) were also members of the FBO groups that were mixed but were not selected based on this characteristic. For households where both the woman and man were in the FBO, they were both registered. However, in this study we only focus on the woman's FBO membership. Hence, all the results on the relationship between FBO participation and outcomes of interest are referring to the woman's participation in FBO, so we interpret this study results as the benefits related to the woman's participation.

In addition to the FBO members, a sample of women who were not members within each FBO community were recruited as a comparison group for the project. These participants were selected randomly from a census of farmers who were not members of FBO within the same communities. In one district, enumerators faced challenges finding the randomly selected residents as they were not home and replaced them at random with the next available person (e.g., neighbour). Similarly, male adult in the comparison group households were also recruited into the project.

The *LINkING Up* project recruited 330 households with 166 women (82 Phase 1 and 84 Phase 2) who were FBO members and 164 women (83 Phase 1, and 81 Phase 2) who were non-members. In addition, the staff enrolled 205 adult male family members (201 spouses or partners, one father, and three sons) who self-identified as primary decision makers within the household. While the project aimed to recruit men from all 330 households, this was not possible with our sample since 25.4% (n= 84) of our households were female-headed and the remainder of men in the identified dual adult households (n=41) were not available (i.e., due to illness, travel) to be

interviewed during the period of data collection. The comparison of women in female-headed households with those in dual adult households showed a significant difference in age, ethnicity, marital status, and household size. Meanwhile, the comparison of the characteristics of women in the 205 households where a man was interviewed with those in the households (n= 41) where a man was not interviewed showed only a significant difference in marital status. As a whole, the comparison of women paired with men and those women not paired with men showed significant differences in ethnicity, marital status, age, household size, and headship.

4.3.2 Data collection

The data for this analysis were collected by trained field staff using electronic tablets between November 2019 and January 2020 for phase 1 and between November 2020 and January 2021 for phase 2. The primary outcomes of the study include empowerment (women's empowerment, male empowerment, and household gender parity), women's and men's body mass index (BMI) and household food security.

Empowerment outcomes were measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI), a standardized tool to capture the empowerment and agency of women and men in the agriculture sector as well as the gender gap within the household (35). This survey was administered to both the recruited woman and man in each household. For households that did not have a man enrolled in the project, only the woman was assessed. Empowerment was measured across 11 equally weighted indicators: (1) autonomy in income, (2) self-efficacy, (3) attitudes about domestic violence, (4) control over the use of income, (5) input in productive decisions (participation in decisions for household agriculture activities), (6) asset ownership (land and household assets), (7) mobility, (8) access to and decisions on financial services, (9) work balance, (10) group membership, and (11) membership in influential groups. Information for one pro-WEAI indicator, respect among household members, was incomplete for

female-only households and therefore was not used in this study. The survey questions on group types for calculating the empowerment indicators related to group membership and membership in influential groups did not include FBO as one of the response options.

Weight (kg) and height (cm) were measured in duplicate using standardized methods with a digital scale (Tanita Corporation of America, Inc., Arlington Heights, IL, USA) and stadiometer (Shorr Production, Olney, MD, USA), respectively. Household food security was measured using the 15-item Latin American and Caribbean Food Security Scale (36). Data were also collected on covariates: sociodemographic characteristics (age, education, marital status, ethnicity) and household characteristics (family composition, and assets).

4.3.3 Data Analysis

Empowerment was assessed in three ways: overall empowerment (women and men), empowerment in the individual indicators, and household gender parity. The empowerment variables were calculated as follows. First, women and men were independently classified for each of the 11 indicators (adequate=1; inadequate=0) based on their survey responses compared to the pro-WEAI pre-determined thresholds defined in Malapit et al. (2019). Second, the empowerment score for each participant was calculated by multiplying the binary variable (0 or 1) for each indicator by the weight of 0.09 (all indicators weighted 1/11) and summing up the scores. Third, participants were classified as empowered (score ≥ 0.80) or disempowered (score < 0.80). We chose achieving empowerment between 8 and 9 indicators (cut off ≥ 0.80) as our cut off because 8 out of 11 indicators (cut off ≥ 0.72) was lower than what was recommended and 9 out of 11 indicators (cut off ≥ 0.82) was greater than what was recommended. The analysis with the individual indicators focused on the five indicators (attitudes about domestic violence, mobility, access to and decisions on financial services, group membership, and membership in

influential groups) that were significantly different between women FBO and non-FBO members.

The gender parity variable was constructed only for the households (n= 205) where a woman and a male pair were interviewed (35). An intra-household empowerment gap was determined by comparing the empowerment scores of each woman and her male pair. All households where a woman was empowered irrespective of the male adult's score, or if she was not empowered but her score was equal to or greater than her male pair's score were classified as achieving gender parity. Households where a woman was not empowered and her score was lower than the male pair's score were classified as households lacking gender parity.

The Body Mass Index (BMI) was calculated as weight (kg)/height (m^2) and used as a continuous variable. For household food security, households were categorized based on the number of affirmative answers; this differed for households without children (food secure (0), mildly food insecure (1-3), moderately food insecure (4-6), and severely food insecure (7-8)) and households with children (food secure (0), mildly food insecure (1-5), moderately food insecure (6-10) and severely food insecure (11-15). Finally, a binary variable was created: food secure, food insecure (including mildly, moderately, and severely).

Household size was included as continuous variables. All other explanatory variables were categorical: FBO membership (member, non-member), education (none, primary, secondary, or higher), age (< 35, 35-44, 45-54, ≥ 55 y), marital status (married/cohabiting, not married/cohabiting), ethnicity (Krobo, other), and project phase (phase 1, phase 2).

The wealth variable was derived from a principal component analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment,

mechanized farm equipment, owns house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator). Wealth scores were extracted from the first component and categorized by tertile (low, middle, high).

Descriptive statistics based on women's FBO participation for women and their male family member were tested using independent Student's *t* test for continuous variables and chi-squared test of independence for categorical variables. Continuous variables were presented as mean ± SD.

4.3.3.1 Primary analysis

To develop the final adjusted models, chi-square tests, Student's *t* test, and unadjusted logistic or linear regressions were used to examine bivariate associations between the outcome variables (empowerment, BMI, and food security) and explanatory variables. The independent variables with a p-value < 0.10 in the bivariate analysis were included into the final models to control for covariates. Relevant variables that were associated with the outcomes in published literature were also included in the final models even if they were not significant in the bivariate analysis. We also included project phase in all our models. Multicollinearity between explanatory variables was checked by the variance inflation factor; no model had a value greater than 10.

The association between women's FBO membership and the empowerment variables was tested with generalized linear mixed model (PROC GLIMMIX) adjusting for covariates and the random effects of clusters (i.e., community). The random effect of cluster was not statistically significant in our models but was still retained in the analysis. The association between women's FBO membership and the empowerment variables with nutrition outcomes (women's BMI, men's BMI, and household food security) was initially tested with generalized linear mixed model (PROC GLIMMIX that included (i) the interaction between empowerment and FBO

membership, (ii) covariates, and (iii) the random effects of clusters. The interaction term was not significant in any of our models and the results did not vary with or without the interaction term. Thus, the interaction term was dropped from the models. We adjusted the alpha levels and corrected the confidence intervals for all covariates with more than two categories using the Dunnett's method (37). We performed ex-post power analysis of minimum detectable differences for each of our models with empowerment outcomes (38). All analyses were conducted using SAS 9.4 version (SAS Institute Inc). The level of significance was set at < 0.05.

4.3.3.2 Secondary analysis

Two types of analysis were conducted for women and men in separate mixed effects models. First, the association between women's FBO membership with each individual empowerment indicator as an outcome was tested with generalized linear mixed model (PROC GLIMMIX) adjusting for covariates and the random effects of clusters. The p-values for the five individual empowerment indicators were corrected for multiple hypothesis testing following the Benjamin et al. (2006) method for q-value corrections (39, 40). Second, the association between the five individual indicators as covariates with nutrition outcomes (women's BMI, men's BMI, and household food security) was tested with generalized linear mixed model (PROC GLIMMIX adjusting for other covariates and the random effects of clusters.

Ethical approval

The ethical approval for this study was obtained from the institutional review boards of McGill University (# 377-0219) and the University of Ghana College of Basic and Applied Sciences (# 035/18-19). All participants provided informed written consent after project staff provided a detailed explanation of the project as well as an understanding that their anonymized data may be used in future analyses. Data were registered and stored in a secured server and the permission to access to data was granted by the principal investigators (GSM, EKC) with personal identifiers

removed. Participants received non-monetary compensation (i.e., bar of soap, a small farm implement) for the completion of the surveys. Participants were made aware that there were no immediate benefits but their participation in the research activities would help guide the development of interventions to enhance the work and wellbeing of women engaged in agriculture-based livelihood activities. The project was registered at ClinicalTrials.gov (NCT03869853).

4.4 Results

Demographic characteristics

This analysis included 316 households (316 women and 198 men); 14 women and 7 men had incomplete data. There were 191 households with no missing data for both the woman and man. The proportion of female adult households did not differ between FBO members and non-FBO members (24.2% vs 27.7%; P = 0.48). Over half of the households reported experiencing food insecurity with a higher proportion reported by FBO households (Table 1). There were differences in household characteristics by phase with a higher rate of food insecurity in phase 1 compared to phase 2 (65.5% vs 52.2%; $P < 0.02$). There were no differences in individual characteristics of male pairs of the FBO and non-FBO members. Women FBO members had a higher mean BMI compared to non-FBO members (Table 4.1).

Empowerment of participants

Women FBO members were more empowered than non-FBO members in overall empowerment and as measured in five of the 11 individual indicators (Table 4.1). The mean empowerment score for FBO members was higher than their counterparts (0.82 ± 0.13 vs 0.73 ± 0.16; $P < 0.001$). The FBO women compared to non-FBO women reported a higher number of groups in which they were active members (1.65 ± 0.9 vs; 0.96 ± 0.7; $P < 0.001$) or influenced their

community (1.31 ± 1.1 vs 0.62 ± 0.7; $P < 0.001$) as well as access to credit sources (1.09 ± 1.3 vs 0.76 ± 0.94; $P < 0.01$).

The male pairs of FBO members had a higher empowerment score than male pairs of non-FBO members (0.83 ± 0.13 vs 0.79 ± 0.14; $P = 0.03$). Similar to the women, they reported a higher number of groups in which they were active members (1.42 ± 1.1 vs 0.92 ± 0.86; $P < 0.001$) or influenced their community (1.22 ± 1.2 vs 0.62 ± 0.77 ± 0.9; $P < 0.01$), and access to credit sources (1.23 ± 1.3 vs 0.83 ± 0.9; $P < 0.02$). Households of FBO members were more likely to achieve gender parity (Table 4.1).

Women without a male pair were more likely to be empowered in household productive decisions (93.3% vs 86.2%; $P < 0.05$), ownership of land and other assets (90.9% vs 81.5%; $P < 0.05$), and control over the use of income (90.1% vs 81.0%; $P < 0.05$). Compared to the first phase, being part of the second phase of the project was associated with women being more empowered (48.5 % vs 61.2 %; $P < 0.05$), having a higher empowerment score (0.75 ± 0.2 vs 0.79 ± 0.1; $P < 0.01$), and more empowered in attitude about domestic violence (66.1% vs 76.4%; $P < 0.05$) , access to and decisions on financial credit (57.6% vs 68.5%; $P < 0.05$), and membership in influential groups (53.9% vs 69.7%; $P < 0.01$). In contrast, men in the first phase were more empowered (74.6% vs 36.7%; $P < 0.02$), had a higher empowerment score (0.84 ± 0.1 vs 0.79 ± 0.1; $P < 0.01$), and were more empowered in mobility (80.5% vs 54.0%; $P < 0.001$), group membership (81.4% vs 62.1%; $P < 0.01$), and membership in influential groups (70.3% vs 47.1%; $P < 0.01$) compared to those in the second phase. Household gender parity did not differ between the two project phases.

Primary analysis

Empowerment and women's FBO membership

In the adjusted model for all women, the odds of being empowered was 3.3 times higher for FBO members compared to non-members (Table 4.2). The results were similar when the models were run separately for women with an adult male pair (aOR = 3.22, 95% CI [1.67, 6.19]) and those without a pair (aOR = 2.96, 95% CI [1.23, 7.09]). On the other hand, women's FBO membership was not associated with empowerment of the male family member. Households of women participating in FBO were 2.8 times more likely to achieve gender parity. Secondary or higher education increased the odds of women's empowerment by more than two-fold and household gender parity by about four-fold.

FBO membership and empowerment with nutrition outcomes

Women's FBO membership and empowerment were not associated with women's and men's BMI (Table 4.3). In all adjusted models, the likelihood of household food insecurity was higher among households where a woman was participating in FBO (Table 4.4). Overall women's empowerment was not associated with household food insecurity in both models including all women and women from households with a male family member. Among paired households, male empowerment was negatively associated with household food insecurity (aβ = -0.79, 95% CI [-1.58, -0.01) (Table 4.4). Household gender parity was not associated with household food insecurity.

Secondary analysis

FBO membership and individual empowerment indicators

Women's FBO membership was positively associated with the individual indicators of women's empowerment related to attitudes about domestic violence (aOR = 1.66, 95% CI [0.99, 2.76]), access to and decisions on financial services (aOR = 1.71, 95% CI [1.05, 2.76]), mobility (aOR = 1.98, 95% CI [1.18, 3.32]), group membership (aOR = 2.74, 95% CI [1.42, 5.26]), and membership in influential groups (aOR = 3.12, 95% CI [1.87, 5.21]) (Supplementary Table 4.1). Women's FBO participation was not associated with men's individual empowerment indicators (Supplementary Table 4.2). Our ex-post power analysis showed we were powered to detect differences in the empowerment indicators for women's models but not men's models (Supplementary Table 4.3).

Individual empowerment indicators with nutrition indicators

There was no significant association between the five individual empowerment with women's and men's BMI (Supplementary Table 4.4). Women's empowerment related to attitudes about domestic violence was negatively associated with household food insecurity (aβ = -0.78, 95% CI [-1.35, 0.21]). Meanwhile, empowerment in access to and decisions on financial services was positively associated with household food insecurity among women (aβ = 0.88, 95% CI [0.35, 1.14]) and men (aβ = 0.97, 95% CI [0.17, 1.77]) (Supplementary Table 4.4 and 4.5).

4.5 Discussion

Our analysis demonstrated that women's FBO membership was associated with a greater likelihood of their overall empowerment, and with specific indicators of attitudes about domestic violence, access to and decisions on financial credit, mobility, group membership, and membership in influential groups. Our findings are consistent with studies that show group participation contributes to women's empowerment (10, 21). Brody et al. (2017) included qualitative studies in a systematic review and provided insight about pathways to empowerment

through self-help group (SHG) participation. Female members' reported improvements in their self-confidence, and they were more confident speaking in public. The enhanced respect from husbands, other household, and community members made a way for women to participate more in household decisions. The decrease in experiences of domestic violence among members was attributed to solidarity within the groups. Women's participation equipped them with financial skills which is not surprising given that credit and savings activities are often core to SHG activities. Finally, the self-help groups made women more aware of their rights through involvement in social activities, built their social networks, and enabled them to take on leadership roles within their communities. Indeed, in our study there was evidence of leadership characteristics among FBO members. In comparison to non-FBO members, they were more likely to be active members of other groups and participate in groups that had an influence within their communities. This may reflect a difference in the leadership capabilities of women who join an FBO as well as suggest that FBO may promote members to join and be active in other groups. Group-based approaches that facilitate programs to improve the empowerment of rural women can be expected to enhance the well-being of women and their families (22, 41, 42). Brody et al. (2017) found that participation in self-help groups (SHGs) improved women's economic and political empowerment, mobility, and decisions regarding their reproductive health (effect sizes ranging from 0.06-0.41 SD).

In the present study, we found that the likelihood of household gender equality was higher in households where a woman was participating in an FBO. However, women's FBO membership was not associated with overall male empowerment. Similarly, in India, women's SHG membership was associated with lower household inequality, with a 34% reduction in the

difference between women's and men's empowerment scores (23). However, in contrast to our results, women's SHG participation was associated with men's empowerment in the domains of decisions on financial credit and control over income. The lack of a relationship between women's FBO participation and male empowerment in our analysis does not suggest the absence of a relationship since our ex-post power analysis showed we were underpowered to detect a difference if it existed among our male sample. We did not have a large enough sample of male participants given that 25% of our households were female only and 12% of the households did not have a man available for interview at the time of the surveys. We recommend that future studies put this into consideration when calculating their sample size. The finding that women's participation in FBO may contribute to reducing the gender gap in empowerment has important implications for rural women and the Ghana agriculture sector. Closing the gender gap in agriculture in low-resource countries could result in a 2.5-4 percent increase in agricultural output, hence contributing to food security (43).

Women's group membership does not appear to affect all areas of empowerment. Kumar et al. (2021) found in their study in India that SHG membership was only weakly associated with women's ownership of assets. In Uganda, a study reported that women's membership in agriculture cooperatives did not change domestic and farm-related division of labor for the household (44). There may be different reasons why group membership may not impact all indicators of empowerment. The groups may vary in their characteristics, such as the type (mixed vs women only; functional activities), socio-cultural norms, and involvement of men in group activities that promote changes in gender roles and expectations (10, 12, 45). These factors can constitute barriers to women's active participation within the farmer organizations (46). In

addition, groups may be more focused towards improving women's incomes and community development rather than challenging social norms embedded within societies that disempower women (21). For empowerment to occur, women have to be active agents (9, 47). There is a need to further integrate gender-sensitive strategies within farmer groups to promote women's active participation and empowerment.

In the current study, households of women participating in FBO were more likely to be food insecure and had a higher BMI compared to non-members, suggesting that group membership alone may not be sufficient to improve nutrition-related indicators. In a review of South Asia studies, authors reported that group-based approaches that lacked clear nutrition goals and strategies were less likely to achieve nutrition impact (48). Integrating transformative approaches like nutrition behavior change communication together with gender sensitization in groups may be important to maximize the nutrition benefits of FBO among rural women farmers in Ghana (22, 48).

Kumar et al. (2018) proposed four pathways to nutrition impact through women's group-based approaches with women's empowerment highlighted as one of the essential components for achieving impact. There is evidence showing that different dimensions of empowerment affect individual and household nutrition (22, 42, 49, 50). Moreover, many of the dimensions associated with nutrition are extrinsic in nature and may be influenced by active group participation (42). For instance, in Ghana, women's empowerment in the domains of income and production were positively associated with household availability of macronutrients; women's control over income was the highest predictor of nutrient intake (51). Women's land ownership

has been linked also with higher budget shares allocated to food in the household (17). In the present study, overall women's empowerment was not associated with adult nutritional status and household food security. Consistent with our findings, Quisumbing et al. (2021) found that overall women's empowerment was not associated with women's BMI, women's dietary diversity score, as well as household dietary diversity score, particularly among the analyses conducted with data from African countries. In this study, male overall empowerment was a better predictor of household food security. In a meta-analysis, households headed by men were found to be less food insecure compared to female headed households (52). The focus of recent interventions on women only appears contrary to these results. Households where both women and men jointly received information on market access and nutrition compared to women only have shown better food security indicators (53).This further highlights the need to include men in nutrition-sensitive agriculture interventions aiming to empower woman and improve the nutrition of the household.

The individual empowerment indicators showed different associations with household food security than overall empowerment. For example, empowerment in access and decisions on financial services for both women and men were associated with a higher likelihood of household food insecurity. This was unexpected given that studies have shown that household access to credit and women's decision making over credit were positively linked with household food security (19, 50, 54). Our finding perhaps reflects the strain in some households of borrowing at high interest rates. On the other hand, women's empowerment related to attitudes about domestic violence was associated with a decreased likelihood of household food insecurity. Among married women in Nepal, food insecurity has been associated with a higher

likelihood of intimate partner violence (55). Local policies and nutrition-sensitive agriculture interventions focused on improving household food security and women's empowerment within the studied context could focus on addressing these two indicators.

Our assessment of the relationship between women's FBO membership and empowerment has limitations. First, women voluntarily joined and participated in the FBO in their communities prior to the study. Although we did not find any significant difference between FBO and non FBO members in demographic characteristics, women who join FBO may be different across unobservable characteristics related to the different domains, introducing selection bias into our estimates. Second, our study design limited our ability to infer direction of causality. Women who joined groups and their male counterparts may have been empowered before joining the group or increased their empowerment through participation before this study. Although we acknowledge the first two limitations of the study, the pro-WEAI tool has intrinsic and extrinsic indicators that allows one to make a case for the finding that FBO may influence women's empowerment. The indicators with associations with FBO membership for women, with the exception of attitudes about domestic violence, were less intrinsic, meaning they are likely to be influenced by activities related to the group, which may then suggest some contribution of the FBO. Finally, we had a combination of mixed and women-only groups, and we did not assess women's participation level in the FBO. Although the selected FBO had high female membership and were active within their community, individual variation in the level of participation existed. The influence that highly active participation may have for both women's and men's empowerment may be underestimated. The results should be interpreted with caution against these limitations.

Despite the limitations, the study contributes to the few studies that examine the role of women's participation in farmer groups on women's and men's empowerment, as well as the linkage between empowerment in agriculture and nutrition related indicators in the African context. The results suggest that FBO in Ghana are an important tool to promote empowerment in nutrition-sensitive agriculture interventions for rural communities, although in combination with nutrition education, other gender-sensitive measures, and a better understanding of the impact on the different dimensions of empowerment.

Finally, our results show the outcomes of women's participation within existing groups designed to promote Ghana's agriculture and rural development policy. Women's participation within these groups needs to be well understood so effective approaches can be implemented to maximize benefits, promote gender equality, and improve food security and nutrition.

Acknowledgment

The authors responsibilities were as follows— GSM, EKC, and NDD conceptualized the *LINkING Up* study design. EKC oversaw project implementation and data collection. AA developed the research question around women's empowerment assessment; GSM, EKC, NDD, and AA developed the survey tools. AA analyzed the data and drafted the manuscript. FG and GSM supported the analysis and interpretation of the results. All authors contributed to and approved the final manuscript.

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Table 4.1 Characteristics and empowerment indicators of women and men farmers in rural Ghana, by woman's FBO membership

	Women			Men		
Variables	FBO [1] (n =157)	Non-FBO (n =159)	P value[2]	FBO (n = 101)	Non-FBO (n =97)	P value[2]
Individual						
Age group, y			0.34			0.39
< 35	32 (20.4)	44 (27.7)		11 (10.9)	17 (17.5)	
35-44	44 (28.0)	38 (23.9)		25 (24.8)	28 (28.9)	
45-54	43 (27.4)	35 (22.0)		29 (28.7)	25 (25.8)	
≥ 55	38 (24.2)	42 (26.4)		36 (35.6)	27 (27.8)	
Ethnicity[3]			0.95			0.46
Krobo	128 (81.5)	130 (81.8)		86 (85.2)	86 (88.7)	
Education[4]			0.06			0.92
None	43 (27.4)	53 (33.3)		9 (8.9)	10 (10.3)	
Primary	62 (39.5)	43 (27.1)		24 (23.8)	24 (24.7)	
Secondary or higher	52 (33.1)	63 (39.6)		68 (67.3)	63 (65.0)	
Marital status[5]			0.94			0.16
Married/cohabiting	117 (74.5)	119 (74.8)		99 (98.0)	97 (100)	
BMI, kg/m^2	26.1 ± 6.5	24.7 ± 5.9	0.04	23.1± 6.9	22.8 ± 10.6	0.81
Household						
Size, #	5.1 ± 1.9	5.2 ± 2.0	0.46	5.5 ± 2.4	5.2 ± 1.6	0.23
Wealth[6]			0.30			0.44
Low	49 (31.2)	58 (36.5)		29 (28.7)	33 (34.0)	
Medium	49 (31.2)	54 (33.9)		31 (30.7)	33 (34.0)	
High	59 (37.6)	47 (29.6)		41 (40.6)	31 (31.9)	
Food security[7]			0.05			< 0.01
Food insecure	100 (63.7)	84 (52.8)		68 (67.3)	46 (47.4)	
Phase of enrollment						
Phase 1	74 (47.1)	80 (50.3)		63 (62.4)	49 (50.5)	
Phase 2	83 (52.9)	79 (49.7)		38 (37.6)	48 (49.5)	
Empowerment[8]						
Empowered (1 = empowered)[9]	109 (69.4)	66 (41.5)	< 0.001	73 (72.3)	61 (62.9)	0.15
Household gender parity[10]	73 (76.0)	56 (58.9)	0.01			
Empowered in individual indicators[11]						

Attitude about domestic violence (y)	119 (75.8)	103 (64.8)	0.03	89 (88.1)	80 (82.5)	0.26
Access to and decisions on credit (y)	108 (68.8)	89 (55.9)	0.01	75 (74.3)	61 (62.9)	0.08
Mobility (y)	121 (77.1)	99 (62.3)	0.004	70 (69.3)	66 (68.0)	0.84
Group membership (y)	141 (89.8)	121 (76.1)	0.001	79 (78.2)	64 (65.9)	0.05
Membership in influential groups (y)	116 (73.9)	82 (51.6)	< 0.001	66 (65.4)	52 (53.6)	0.09

Data shown are n (%) or mean ± standard deviation

FBO: farmer-based organization; BMI: body mass index. [1]FBO in the women's and men's column indicates that the respondent woman in the household is participating in an FBO; non-FBO in the women's and men's columns indicates that the woman of the household is not participating in an FBO. [2]Independent Student *t* test for continuous variables; Chi-Squared test of independence for categorical variables.[3]Krobo, the local ethnic group, was compared to others (Akan, Ewe, Ga, among others). [4]Highest level of education completed. [5]Married/cohabiting compared to not married cohabiting. [6]Wealth: tertiles for the first component of a principal components analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment (i.e., hand tools), mechanized farm equipment (i.e., tractor), house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator).[7]Food security: classification based on the 15-item Food Insecurity Experience Scale (36). Food secure and food insecure (included mildly, moderately, and severely food insecure). [8]Empowerment outcomes measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). [9]Empowered: scored at least 80% or greater in the 11 empowerment indicators (≥0.80).[10]Household gender parity calculated only for the households (n= 191) were a woman and a male adult family member were interviewed. Households where a woman was empowered irrespective of the adult male's score, or if she was not empowered but her score was equal to or greater than her male's pairs score were classified as achieving gender parity; households where a woman was not empowered, and her score was lower than the male pairs score were classified as households lacking gender parity. [11]Included persons empowered in the selected pro-WEAI indicators for the study.

Table 4.2 Association between women's FBO participation with women's and men's empowerment[1] and household gender parity[1] in rural Ghana

	Women's empowerment[2] (n=316)	Men's empowerment[3] (n=198)	Household gender parity[4] (n=191)
Women's FBO membership[5]			
Member	3.25 (1.97, 5.33) ***	1.53 (0.80, 2.92)	2.82 (1.39, 5.84) **
Not member *(ref)*			
Individual			
Women's Age group, y			
35-44	2.09 (0.90, 4.87)	—	2.07 (0.73, 9.96)
45-54	2.43 (0.97, 6.09)	—	1.98 (0.39, 9.94)
≥ 55	1.03 (0.40, 2.64)	—	0.87 (0.15, 5.10)
< 35 *(ref)*			
Men's Age group, y			
35-44	—	0.61 (0.18, 2.10)	1.73 (0.43, 6.89)
45-54	—	0.63 (0.18, 2.16)	1.75 (0.35, 8.68)
≥ 55	—	1.36 (0.38, 4.83)	1.60 (0.27, 9.36)
< 35 *(ref)*			
Women's education[6]			
Primary	1.43 (0.70, 2.89)	—	1.22 (0.46, 3.21)
Secondary or higher	2.64 (1.22, 5.68) **	—	4.00 (1.40, 11.46) **
None *(ref)*			
Men's education[6]			
Primary	—	1.17 (0.31, 4.34)	0.55 (0.11, 2.63)
Secondary or higher	—	1.96 (0.58, 6.67)	0.50 (0.11, 2.13)
None *(ref)*			
Marital status[7]			
Married/cohabiting	0.69 (0.37, 1.30)	—	—
Not married/cohabiting *(ref)*			
Household			
Size, #	0.84 (0.74, 0.96) *	0.87 (0.75, 1.02)	0.91 (0.76, 1.08)
Phase of enrollment			
Phase 2	1.54 (0.93, 2.54)	0.50 (0.25, 0.97) *	1.91 (0.95, 3.85) †
Phase 1 *(ref)*			
Intercept	0.69 (0.17, 2.75) **	3.42 (0.52, 22.52) *	0.70 (0.07, 6.90) *

† p<0.1 * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are odd ratios (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. FBO: farmer-based organization. [1]Empowerment outcomes measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Empowered: scored at least 80% or greater in the 11 empowerment indicators (≥0.80). Household gender parity calculated only for the households (n= 191) were a woman and a male adult family member were interviewed. Households where a woman was empowered irrespective of the adult male's score, or if she was not empowered but her score was equal to or greater than her male's pairs score were classified as achieving gender parity; households where a woman was not empowered and her score was lower than the male pairs score were classified as households lacking gender parity. [2]Model included all women participants from both paired (male and female) and female only households with complete data for all variables. [3]Model includes men from paired (male and female) households with complete data for all variables. [4]Model includes households with complete data for all variables for both the woman and the male adult family member (n=191). [5]Woman in the household is participating in an FBO. [6]Highest level of education completed. [7]Married/cohabiting compared to not married cohabiting.

Table 4.3 Association between women's and men's nutritional status with women's participation in FBO, women's and men' empowerment and household gender parity in rural Ghana

	Women's BMI[1]			Men's BMI[1]		
	Model 1[2]	Model 2[3]	Model 3[3]	Model 1[2]	Model 2[3]	Model 3[3]
Women's FBO membership[4]						
Member	0.91 (-0.31, 2.35)	0.22 (-1.80, 2.24)	0.25 (-1.74, 2.25)	-0.03 (-2.76, 2.70)	-0.02 (-2.77, 2.71)	-0.09 (-2.80, 2.60)
Not member *(ref)*						
Women's empowerment[5]						
Empowered	0.80 (-0.65, 2.27)	1.10 (-0.99, 3.20)	—	0.45 (-2.24, 3.16)	0.24 (-2.59, 3.07)	—
Not empowered *(ref)*						
Men's empowerment[5]						
Empowered	—	-1.22 (-3.43, 0.98)	—	—	0.78 (-2.21, 3.78)	—
Not empowered *(ref)*						
Household gender parity[5]						
Yes	—	—	0.89 (-1.28, 3.07)	—	—	0.93 (-1.99, 3.86)
No *(ref)*						
Individual						
Women's Age group, y						
35-44	0.96 (-1.39, 3.33)	2.72 (-0.89, 6.35)	2.87 (-0.74, 6.48)	-1.75 (-6.58, 3.08)	-1.60 (-6.49, 3.28)	-1.87 (-6.73, 2.98)
45-54	-0.48 (-3.00, 2.02)	0.71 (-3.82, 5.26)	0.92 (-3.60, 5.45)	2.67 (-3.42, 8.77)	2.80 (-3.33, 8.94)	2.63 (-3.45, 8.72)
≥ 55	-1.21 (-3.76, 1.33)	0.82 (-4.35, 5.99)	0.97 (-4.19, 6.14)	-1.56 (-8.52, 5.38)	-1.46 (-8.44, 5.50)	-1.56 (-8.50, 5.38)
< 35 *(ref)*						
Men's Age group, y						
35-44	—	-0.85 (-4.90, 3.19)	-0.90 (-4.95, 3.15)	2.20 (-3.24, 7.65)	2.22 (-3.23, 7.68)	2.12 (-3.33, 7.57)
45-54	—	0.00 (-4.60, 4.61)	0.01 (-4.68, 4.53)	1.18 (-5.04, 7.41)	1.16 (-5.08, 7.41)	1.11 (-5.11, 7.34)
≥ 55	—	-0.81 (-6.01, 4.38)	-1.08 (-6.25, 4.09)	3.36 (-3.60, 10.32)	3.21 (-3.79, 10.22)	3.30 (-3.65, 10.27)
< 35 *(ref)*						

Women's education[6]						
Primary	0.71	0.87	0.84	0.43	0.41	0.41
	(-1.31, 2.73)	(-2.01, 3.76	(-2.04, 3.73)	(-3.45, 4.33)	(-3.48, 4.31)	(-3.47, 4.30)
Secondary or higher	-0.01	-0.40	-0.38	2.01	2.07	1.89
	(-2.22, 2.20)	(-3.36, 2.55)	(-3.35, 2.58)	(-1.99, 6.03)	(-1.96, 6.10)	(-2.14, 5.92)
None *(ref)*						
Men's education[6]						
Primary	—	2.55	2.53	-1.44	-1.50	-1.35
		(-1.79, 6.91)	(-1.82, 6.88)	(-7.30, 4.41)	(-7.37, 4.37)	(-7.21, 4.51)
Secondary or higher	—	1.99	1.88	1.01	0.89	1.12
		(-2.03, 6.01)	(-2.13, 5.90)	(-4.38, 6.40)	(-4.53, 6.32)	(-4.28, 6.53)
None *(ref)*						
Household						
Size, #	—	—	—	—	—	—
Wealth[7]						
Medium	-1.27	-0.26	-0.28	-1.48	-1.45	-1.54
	(-3.22, 0.67)	(-3.03, 2.51)	(-3.06, 2.48)	(-5.22, 2.25)	(-5.20, 2.29)	(-5.29, 2.19)
High	1.10	1.74	1.70	-0.26	-0.29	-0.26
	(-0.92, 3.13)	(-0.99, 4.49)	(-1.03, 4.44)	(-4.01, 3.47)	(-4.04, 3.45)	(-4.00, 3.47)
Low *(ref)*						
Phase of enrollment						
Phase 2	0.20	-0.37	- 0.25	3.73	3.88	3.63
	(-1.39, 1.80)	(-2.35, 1.60)	(-2.21, 1.70)	(0.81, 6.64) *	(0.90, 6.86) *	(0.71, 6.56) *
Phase 1 *(ref)*						
Intercept	24.58	22.61	21.78	22.52	22.14	22.29
	(21.29, 27.88) ***	(17.29, 27.92) ***	(16.57, 26.98) ***	(15.01, 30.03) ***	(14.49, 29.79) ***	(14.73, 29.84) ***

† p<0.1 * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are beta coefficients (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. Each column represents a single mixed effects model adjusted for covariates with the outcome variables. BMI: body mass index; FBO: farmer-based organization. [1]BMI was calculated as weight (kg)/height (m^2). [2]Model included all women participants from both paired (male and female) and female only households with complete data for all variables (n=316). [3]Model included only households with complete data for all variables for both the woman and the male adult family member (n=191). [4]Woman in the household is participating in an FBO. [5]Empowerment outcomes measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Empowered: scored at least 80% or greater in the 11 empowerment indicators (≥0.80). Household gender parity calculated only for the households (n= 191) were a woman and a male adult family member were interviewed. Households where a woman was empowered irrespective of the adult male's score, or if she was not empowered but her score was equal to or greater than her male's pairs score were classified as achieving gender parity; households where a woman was not empowered, and her score was lower than the male pairs score were classified as households lacking gender parity. [6]Highest level of education completed. [7]Wealth: tertiles for the first component of a principal components analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment (i.e., hand tools), mechanized farm equipment (i.e., tractor), house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator).

Table 4.4 Association between household food insecurity with women's participation in FBO, women's and men's empowerment and household gender parity in rural Ghana

	Household food insecurity[1]		
	Model 1[2]	Model 2[3]	Model 3[3]
Women's FBO membership[4]			
Member	0.53 (0.02, 1.03) *	0.78 (0.08, 1.48) *	0.73 (0.05, 1.42) *
Not member *(ref)*			
Women's empowerment[5]			
Empowered	-0.41 (-0.93, 0.10)	-0.42 (-.1.16, 0.31)	—
Not empowered *(ref)*			
Men's empowerment[5]			
Empowered	—	-0.79 (-1.58, -0.01) *	—
Not empowered *(ref)*			
Household gender parity[5]	—	—	-0.48 (-1.24, 0.27)
Yes			
No *(ref)*			
Individual			
Women's Age group, y			
35-44	0.75 (-0.07, 1.57)	0.92 (-0.34, 2.18)	0.96 (-0.27, 2.20)
45-54	0.6 (-0.21, 1.52)	0.82 (-0.76, 2.41)	0.76 (-0.81, 2.34)
≥ 55	0.43 (-0.44, 1.30)	1.19 (-0.63, 3.02)	1.37 (-0.43, 3.19)
< 35 *(ref)*			
Men's Age group, y			
35-44	—	0.63 (-0.73, 2.01)	0.67 (-0.69, 2.04)
45-54	—	-0.20 (-1.82, 1.40)	-0.17 (-1.77, 1.41)
≥ 55	—	-0.39 (-2.20, 1.40)	-0.50 (-2.29, 1.28)
< 35 *(ref)*			
Women's education[6]			
Primary	- 0.13 (-0.83, 0.56)	0.18 (-0.79, 1.16)	0.26 (-0.71, 1.24)
Secondary or higher	-0.05 (-0.80, 0.69)	0.45 (-0.55, 1.46)	0.45 (-0.54, 1.45)
None *(ref)*			
Men's education[6]			
Primary	—	1.08 (-0.43, 2.60)	0.92 (-0.57, 2.43)
Secondary or higher	—	0.76 (-0.63, 2.17)	0.52 (-0.86, 1.91)
None *(ref)*			
Household			
Size, #	—	—	0.17 (-0.01, 0.36) †

Wealth[7]			
Medium	—	—	—
High	—	—	—
Low *(ref)*			
Phase of enrollment			
Phase 2	-0.44 (-0.95, 0.06) †	-0.44 (-1.15, 0.26)	-0.31 (-1.02, 0.38)
Phase 1 *(ref)*			
Intercept	0.29 (-0.75, 1.34) †	-0.68 (-2.97, 1.61)	-1.19 (-4.51, 0.52)

† p<0.1 * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are beta coefficients (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. Each column represents a single mixed effects model adjusted for covariates with the outcome variables. BMI: body mass index; FBO: farmer-based organization. [1]Food security: classification based on the 15-item Food Insecurity Experience Scale (36). Food secure and food insecure (included mildly, moderately, and severely food insecure). [2]Model included all women participants from both paired (male and female) and female only households with complete data for all variables (n=316). [3]Model included only households with complete data for all variables for both the woman and the male adult family member (n=191). [4]Woman in the household is participating in an FBO. [5]Empowerment outcomes measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Empowered: scored at least 80% or greater in the 11 empowerment indicators (≥0.80). Household gender parity calculated only for the households (n= 191) were a woman and a male adult family member were interviewed. Households where a woman was empowered irrespective of the adult male's score, or if she was not empowered but her score was equal to or greater than her male's pairs score were classified as achieving gender parity; households where a woman was not empowered, and her score was lower than the male pairs score were classified as households lacking gender parity. [6]Highest level of education completed. [7]Wealth: tertiles for the first component of a principal components analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment (i.e., hand tools), mechanized farm equipment (i.e., tractor), house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator).

Supplementary Table 4.1 Association between women's FBO participation with individual empowerment indicators[1] among women in rural Ghana

	Attitudes about domestic violence	Access and decisions on financial services	Mobility	Group membership	Membership in influential groups
Women's FBO membership[2]					
Member	1.66 (0.99, 2.76) *	1.71 (1.05, 2.76) *	1.98 (1.18, 3.32) **	2.74 (1.42, 5.26) **	3.12 (1.87, 5.21) ***
Not member *(ref)*					
Individual					
Women's age group, y					
35-44	1.02 (0.42, 2.48)	1.16 (0.51, 2.63)	2.76 (1.14, 6.69) *	1.12 (0.36, 3.45)	0.92 (0.38, 2.22)
45-54	0.84 (0.33, 2.12)	1.31 (0.54, 3.19)	2.37 (0.93, 6.02)	1.08 (0.33, 3.49)	0.98 (0.38, 2.49)
≥ 55	0.82 (0.31, 2.16)	1.01 (0.40, 2.52)	1.38 (0.53, 3.54)	0.53 (0.16, 1.68)	0.66 (0.25, 1.74)
< 35 *(ref)*					
Women's education[3]					
Primary	1.27 (0.62, 2.60)	1.30 (0.66, 2.58)	0.76 (0.36, 1.61)	1.26 (0.53, 2.97)	0.86 (0.43, 1.73)
Secondary or higher	1.41 (0.66, 3.03)	1.78 (0.85, 3.72)	0.93 (0.42, 2.07)	1.79 (0.69, 4.65)	2.64 (1.20, 5.79) *
None *(ref)*					
Women's marital status					
Married/cohabiting	1.55 (0.84, 2.85)	0.76 (0.41, 1.40)	1.63 (0.88, 3.02)	1.10 (0.59, 2.03)	1.17 (0.63, 2.18)
Not married/cohabiting *(ref)*					
Household					
Size, #	0.87 (0.76, 0.99) *	1.04 (0.92, 1.18)	0.88 (0.77, 1.01)	0.87 (0.74, 1.01) †	0.93 (0.82, 1.06)
Phase of enrollment					
Phase 2	1.83 (1.10, 3.05)	1.57 (0.96, 2.58)	0.76 (0.45, 1.29)	1.10 (0.59, 2.03)	1.69 (1.01, 2.82) *
Phase 1 *(ref)*					
Intercept	1.82 (2.12, 7.06) *	1.47 (0.17, 2.61)	1.67 (0.41, 6.71) **	5.63 (1.09, 29.12)	

† p<0.1, * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are odd ratios (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. All models included women participants from both paired (male and female) and female only households with complete data for all variables (n=316). FBO: farmer-based organization. [1]Empowerment indicators measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Individual empowerment indicators were classified as adequate, based on the pre-determined thresholds for the pro-WEAI. P-values for the five different models that estimated the association between women's FBO membership and empowerment were corrected for multiple hypothesis testing following the Benjamin *et al.* (2006) method for q-value corrections(39, 40). [2]Woman in the household is participating in an FBO. [3]Highest level of education completed.

Supplementary Table 4.2 Association between women's FBO participation with individual empowerment indicators[1] among men in rural Ghana

	Attitudes about domestic violence	Access and decisions on financial services	Mobility	Group membership	Membership in influential groups
Women's FBO membership[2]					
Member	1.58 (0.65, 3.83)	2.14 (1.07, 4.28)	0.80 (0.39, 1.64)	2.11 (1.00, 4.46)	1.76 (0.89, 3.47)
Not member *(ref)*					
Individual					
Women's age group, y					
35-44	1.71 (0.35, 8.33)	0.71 (0.19, 2.55)	1.73 (0.46, 6.46)	0.48 (0.12, 1.86)	0.33 (0.09, 1.16)
45-54	1.62 (0.22, 11.48)	1.30 (0.26, 6.36)	1.67 (0.30, 9.07)	0.58 (0.11, 3.12)	0.36 (0.07, 1.70)
≥ 55	0.92 (0.09, 8.78)	0.33 (0.05, 1.91)	4.50 (0.55, 36.57)	0.43 (0.06, 3.11)	0.60 (0.10, 3.64)
< 35 *(ref)*					
Men's age group, y					
35-44	1.62 (0.29, 8.89)	1.90 (0.46, 7.87)	0.47 (0.10, 2.12)	0.31 (0.25, 5.31)	1.23 (0.30, 5.00)
45-54	0.75 (0.11, 5.09)	1.15 (0.24, 5.54)	0.82 (0.14, 4.87)	0.97 (0.17, 5.32)	1.30 (0.26, 6.33)
≥ 55	1.29 (0.14, 12.00)	1.70 (0.29, 10.06)	0.47 (0.06, 3.42)	2.67 (0.38, 18.63)	2.28 (0.40, 12.97)
< 35 *(ref)*					
Women's education[3]					
Primary	1.38 (0.34, 5.57)	0.95 (0.36, 2.50)	0.74 (0.24, 2.25)	0.92 (0.31, 2.73)	0.90 (0.33, 2.42)
Secondary or higher	0.64 (0.18, 2.28)	2.27 (0.82, 6.25)	0.61 (0.20, 1.86)	1.15 (0.38, 3.52)	0.96 (0.53, 2.63)
None *(ref)*					
Men's education[3]					
Primary	1.35 (0.16, 10.87)	1.32 (0.31, 5.65)	0.10 (0.09, 2.63)	1.62 (0.31, 8.31)	1.83 (0.42, 7.89)
Secondary or higher	0.80 (0.12, 5.23)	1.47 (0.39, 5.57)	0.19 (0.17, 3.95)	1.46 (0.33, 6.39)	3.57 (0.91, 14.02) †
None *(ref)*					
Household					
Size, #	1.06 (0.84, 1.34)	0.93 (0.79, 1.10)	1.01 (0.85, 1.21)	0.89 (0.75, 1.06)	0.96 (0.81, 1.13)
Phase of enrollment					
Phase 2	0.64 (0.21, 1.98)	0.90 (0.46, 1.78)	0.61 (0.23, 1.65) ***	1.15 (0.42, 3.12) **	0.96 (0.39, 2.36) **
Phase 1 *(ref)*					
Intercept	2.30 (9.77, 51.88) †	1,10 (0.12, 9.97) †	8.88 (0.57, 137.52)	4.81 (0.37, 62.60) *	1.17 (0.10, 12.56)

† p<0.1, * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are odd ratios (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. All models included adult male family members from paired (male and female) households with complete data for all variables (n=191). FBO: farmer-based organization. [1]Empowerment indicators measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Individual empowerment indicators were classified as adequate, based on the pre-determined thresholds for the pro-WEAI.

P-values for the five different models that estimated the association between women's FBO membership and empowerment were corrected for multiple hypothesis testing following the Benjamin *et al.* (2006) method for q-value corrections (39, 40). [2]Woman in the household is participating in an FBO. [3]Highest level of education completed.

Supplementary Table 4.3 Minimum detectable difference in empowerment indicators[1] by women's FBO membership[2]

	Empowerment	Attitudes about domestic violence	Access and decisions on financial services	Mobility	Group membership	Membership in influential groups
Women	0.16	0.14	0.15	0.15	0.12	0.16
Men	0.18	0.13	0.18	0.17	0.18	0.20

[1]Empowerment indicators measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Empowered: scored at least 80% or greater in the 11 empowerment indicators (≥0.80). Individual empowerment indicators were classified as adequate, based on the pre-determined thresholds for the pro-WEAI. [2]Woman in the household is participating in an FBO.

Supplementary Table 4.4 Association between women's and men's nutritional status and household food security with individual empowerment indicators among women[1] in rural Ghana

	Women's BMI[2,4] (n=316)	Men's BMI[2,5] (n=191)	Household food security[3,4] (n=316)
Attitudes about domestic violence			
Empowered	0.97 (-0.59, 2.54)	1.04 (-1.98, 4.06)	-0.78 (-1.35, -0.21) **
Not empowered *(ref)*			
Access to and decisions on financial service			
Empowered	0.68 (-0.78, 2.15)	-0.79 (-3.48, 1.89)	0.88 (0.35, 1.41) **
Not empowered *(ref)*			
Mobility			
Empowered	-0.73 (-2.32, 0.85)	1.13 (-1.94, 4.20)	0.11 (-0.44, 0.67)
Not empowered *(ref)*			
Group membership			
Empowered	0.74 (-1.64, 3.12)	0.69 (-3.98, 5.37)	0.43 (-0.40, 1.27)
Not empowered *(ref)*			
Membership in influential groups	0.97 (-0.89, 2.83)	-0.85 (-4.48, 2.78)	-0.44 (-1.11, 0.22)
Empowered			
Not empowered *(ref)*			
Individual			
Women's age group, y			
35-44	1.23 (-1.14, 3.60)	-2.01 (-6.99, 2.95)	0.69 (-0.15, 1.54)
45-54	-0.01 (-2.55, 2.52)	1.94 (-4.39, 8.28)	0.53 (-0.20, 1.27)
≥ 55	-0.75 (-3.32, 1.81)	-1.83 (-8.94, 5.28)	0.36 (-0.38, 1.11)
< 35 *(ref)*			
Men's Age group, y			
35-44	—	2.20 (-3.50, 7.92)	—
45-54	—	1.78 (-4.74, 8.31)	—
≥ 55	—	3.46 (-3.69, 10.62)	—
< 35 *(ref)*			
Women's education[6]			
Primary	0.85 (-1.14, 2.86)	0.68 (-3.29, 4.66)	-0.16 (-0.79, 0.47)
Secondary or higher	-0.08 (-2.26, 2.08)	2.04 (-2.04, 6.13)	-0.16 (-0.85, 0.51)
None *(ref)*			
Men's education[6]			
Primary	—	-1.27 (-7.39, 4.83)	—
Secondary or higher	—	1.24 (-4.38, 6.86)	—
None *(ref)*			

Household			
Wealth[7]			
Medium	-1.29 (-3.38, 0.79)	-1.68 (-5.78, 2.42)	—
High	1.05 (-1.35, 3.46)	-0.73 (-5.44, 3.97)	—
Low *(ref)*			
Phase of enrollment			
Phase 2	-0.09 (-1.57, 1.39)	2.91 (-0.02, 5.86) †	-0.45 (-0.97, 0.07)
Phase 1 *(ref)*			
Intercept	23.30 (20.11, 26.49) ***	18.03 (9.55, 26.50) ***	0.30 (-1.02, 1.63)

† p<0.1 * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are beta coefficients (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. All five empowerment indicators included in the models as covariates. Multicollinearity between explanatory were checked by the variance inflation factor (VIF). BMI: body mass index.[1]Empowerment indicators measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Individual empowerment indicators were classified as adequate, based on the pre-determined thresholds for the pro-WEAI. [2]BMI was calculated as weight (kg)/height (m^2). [3]Food security: classification based on the 15-item Food Insecurity Experience Scale (36). Food secure and food insecure (included mildly, moderately, and severely food insecure). [4]Model included all women participants from both paired (male and female) and female only households with complete data for all variables (n=316). [5]Model included only households with complete data for all variables for both the woman and the male adult family member (n=191). [6]Highest level of education completed. [7]Wealth: tertiles for the first component of a principal components analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment (i.e., hand tools), mechanized farm equipment (i.e., tractor), house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator).

Supplementary Table 4.5 Association between women's and men's nutritional status and household food security with individual empowerment indicators among men[1] in rural Ghana

	Women's BMI[2] (n=191)	Men's BMI[2] (n=191)	Household food security[3] (n=191)
Attitudes about domestic violence			
Empowered	-2.33 (-5.05, 0.37) †	1.67 (-2.04, 5.39)	-0.03 (-0.98, 0.90)
Not empowered *(ref)*			
Access and decisions on financial service			
Empowered	-0.53 (-2.76, 1.68)	-1.73 (-4.73, 1.25)	0.97 (0.17, 1.77) *
Not empowered *(ref)*			
Mobility			
Empowered	0.32 (-1.93, 2.57)	1.58 (-1.54, 4.71)	0.57 (-0.26, 1.40)
Not empowered *(ref)*			
Group membership			
Empowered	1.07 (-2.29, 4.43)	3.05 (-1.52, 7.63)	-0.88 (-2.16, 0.40)
Not empowered *(ref)*			
Membership in influential groups	0.62 (-2.37, 3.62)	-0.48 (-4.58, 3.60)	-1.02 (-2.10, 0.06) †
Empowered			
Not empowered *(ref)*			
Individual			
Women's Age group, y			
35-44	3.57 (-0.05, 7.19) †	-1.75 (-6.65, 3.15)	0.85 (-0.43, 2.14)
45-54	1.59 (-2.93, 6.11)	2.32 (-3.87, 8.52)	0.70 (-0.92, 2.33)
≥ 55	1.14 (-4.04, 6.34)	-2.12 (-9.19, 4.94)	1.46 (-0.45, 3.38)
< 35 *(ref)*			
Men's Age group, y			
35-44	-0.71 (-4.77, 3.34)	2.20 (-3.39, 7.79)	0.61 (-0.80, 2.08)
45-54	-0.16 (-4.76, 4.43)	1.55 (-4.78, 7.88)	-0.28 (-1.94, 1.38)
≥ 55	-1.26 (-6.46, 3.92)	3.02 (-3.98, 10.04)	-0.37 (-2.25, 1.50)
< 35 *(ref)*			
Women's education[4]			
Primary	1.04 (-1.82, 3.91)	0.56 (-3.32, 4.45)	0.12 (-0.88, 1.13)
Secondary or higher	-0.26 (-3.19, 2.66)	2.06 (-1.19, 6.05)	0.24 (-0.80, 1.29)
None *(ref)*			
Men's education[4]			
Primary	2.45 (-1.88, 6.79)	-0.70 (-6.70, 5.28)	1.35 (-0.18, 2.89)
Secondary or higher	1.52 (-2.51, 5.57)	1.58 (-4.05, 7.22)	0.97 (-0.45, 2.41)
None *(ref)*			
Household			

Wealth[5]			
Medium	0.25 (-2.54, 3.05)	-0.97 (-5.02, 3.07)	—
High	1.88 (-0.86, 4.63)	-0.08 (-4.70, 4.52)	—
Low *(ref)*			
Phase of enrollment			
Phase 2	0.34 (-1.72, 2.41)	3.54 (0.46, 6.63) *	-0.62 (-1.41, 0.16)
Phase 1 *(ref)*			
Intercept	22.74 (16.69, 28.80) ***	14.91 (6.09, 23.72) ***	

† p<0.1 * p<0.05, ** p<0.01, *** p<0. 001.

Values shown are beta coefficients (95% Confidence Intervals adjusted for multiple group comparisons using Dunnett's method) from generalized linear mixed models that were adjusted for the random effect of clusters. All models included adult male family members from paired (male and female) households with complete data for all variables (n=191). All five empowerment indicators included in the models as covariates. Multicollinearity between explanatory were checked by the variance inflation factor (VIF). BMI: body mass index.[1]Empowerment indicators measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (35). Individual empowerment indicators were classified as adequate, based on the pre-determined thresholds for the pro-WEAI. [2]BMI was calculated as weight (kg)/height (m^2). [3]Food security: classification based on the 15-item Food Insecurity Experience Scale (36). Food secure and food insecure (included mildly, moderately, and severely food insecure).[4]Highest level of education completed. [5]Wealth: tertiles for the first component of a principal components analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment (i.e., hand tools), mechanized farm equipment (i.e., tractor), house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator).

Bridge 3

In manuscript 1, farmers provided local understandings of women's empowerment and the facilitators and barriers. Participation in groups was an important facilitator as it provided access to support services from local institutions. However, the high interest and loan rates of the local rural bank and money lenders were considered barriers. They also discussed difficulties in accessing financial loans. The previous chapter (manuscript 2) reported that women's empowerment and household gender equality were positively linked with women's participation in farmer-based organizations (FBO). However, this FBO participation as well as women's and men's empowerment in access to and decisions on financial loans had a negative association with household food security. Given these findings, the next chapter (manuscript 3) investigated whether an FBO-based, nutrition-sensitive agricultural intervention with reduced-interest loans was associated with (1) empowerment, household gender equality, women's diet quality, and household food security, and (2) if a change in empowerment and household gender equality mediated the association between the intervention and nutrition outcomes.

Chapter 5. Manuscript 3

Women's empowerment mediates the association between a multi-sectoral nutrition-sensitive agriculture intervention with household food insecurity but not diet quality in rural Ghana*

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Running title: Women's empowerment, household food security, and diet

Abbreviations:

aβ: adjusted beta coefficients

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aOR: adjusted Odds Ratio

CI: confidence intervals

FBO: Farmer-based organization

MDD-W: minimum dietary diversity for women

NSA: Nutrition-sensitive agriculture

OW: Overweight

OB: Obesity

pro-WEAI: Project-level Women's Empowerment in Agriculture Index

WRA: Women of reproductive age

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5.1 Abstract

Background

Improved women's empowerment is suggested as a mediating pathway for the influence of nutrition-sensitive agricultural (NSA) interventions on women's diet and household food security.

Objective

The study aimed to (i) examine the association between an NSA intervention and endline women's empowerment, men's empowerment, and household gender equality, and (ii) investigate if a change in empowerment and household gender equality mediated the association between the NSA intervention and women's diet and household food security.

Methods

The *LinkINg Up* project was a 12-mo quasi-experimental multisectoral NSA intervention that provided in-kind agricultural loans (i.e., poultry or vegetable input loan package), and agriculture and nutrition education to female members of existing farmer-based organizations (FBO) [ClinicalTrials.gov (NCT03869853)]. The intervention group (n = 166) included women who were FBO members, while the comparison group (n = 164) included women farmers who were not part of FBO. Male partners (n =205) from the same households were also recruited to participate in the project. Empowerment and household gender equality were measured using the Project-level Women's Empowerment in Agriculture Index. Women's diet was assessed using three 24-hr dietary recalls. The Food and Agriculture Organization's indicator of minimum dietary diversity for women of reproductive age as well as energy, macronutrient and micronutrient intakes were estimated. Regression-based mediation models adjusting for covariates, baseline values, and clustering were used to test empowerment and household gender equality as potential mediators for the study outcomes.

Results

The intervention had an indirect negative association (aβ = -0.22; 95% CI [-0.51, -0.05]) with household food insecurity mediated by its positive association with women's empowerment. The association with other potential mediators (endline male empowerment, household gender equality) was not significant. Women's empowerment did not mediate the association with most diet outcomes (minimum dietary diversity, macronutrient, and micronutrient intakes). However, the intervention had a direct positive association (aβ = 0.65; 95% CI [0.07, 1.11]) with women's egg consumption at endline.

Conclusions

Multisectoral NSA interventions delivered through local institutions and farmer groups may improve household food security outcomes through enhanced women's empowerment.

Keywords

Nutrition-sensitive agriculture; Women's empowerment; Diet quality; Diet diversity; Food security; Gender; Agriculture; Farmer-based organizations; Rural; Ghana

5.2 Introduction

Poor nutrition remains an important issue among women of reproductive age (WRA) in Ghana. While the country has witnessed declining rates of undernutrition over the last two decades, malnutrition facing WRA in the form of overweight (OW; body mass index [BMI] 25.0-29.9 kg/m^2) and obesity (OB; BMI ≥ 30.0 kg/m^2) has been rising in the country in both urban and rural areas (1-5). Moreover, micronutrient deficiencies among Ghanaian women are still an important public health concern with an estimated 62% of women having at least one deficiency and about 24% inflicted with the double burden of OW/OB together with at least one deficiency (6, 7). About 2.7 million WRA were estimated to be anemic in 2019 (8, 9).

Diet-related risk factors associated with OW/OB and micronutrient deficiency among Ghanaian WRA include total energy intakes and dietary patterns that are high in carbohydrates and low in protein and micronutrient-rich foods (5, 10-12). While data on women's diets across the life cycle are limited, an analysis of national-level data from the 2008 Ghana Demographic and Health Surveys estimated that only about 43% of women achieved diet diversity of ≥ 5 food groups (out of nine) (12). In addition, food insecurity has been estimated to be higher among Ghanaian women compared to men (45% vs. 40%, respectively) at the national level and an even greater gap in rural communities (women, 61%; men, 53%) (13). A study found that food-insecure women were more likely to be obese and less likely to meet the recommended dietary allowance of macronutrients and micronutrients compared to food-insecure men or food-secure women (14-16).

Agriculture employs about 61% of the rural population and 88% of the poorest households in Ghana (4). Among those who are economically active in the agriculture sector in Ghana, about

50% are women (17). Nutrition-sensitive agricultural (NSA) interventions have the potential to address the underlying and basic determinants of poor nutritional outcomes (18, 19). These could occur through different pathways that influence (1) food availability and access from home production, (2) income from the sale of agricultural commodities produced, (3) food prices from changes in supply and demand, (4) women's social status and access to and control over resources, (5) women's time use in agriculture, and (6) women's health and nutrition status (18-20). Systematic reviews report strengthening women's empowerment, particularly pathways 4, 5, and 6 are essential for mediating the role of agriculture in nutrition (21-23). However, these three pathways may be influenced by intra-household gender dynamics including the empowerment of the male decision-maker and household gender inequality (19, 24).

Cross-sectional studies have demonstrated associations between women's empowerment in agriculture with household food security and women's nutritional outcomes (21). Women's empowerment related to income, production, and leadership have been positively correlated with the availability of energy and macronutrients within the household (25). Meanwhile, overall women's empowerment score in agriculture measured across the domains of the Women's Empowerment in Agriculture Index (WEAI) and empowerment indicators related to credit decisions, decision-making over assets, and membership in groups were positively associated with women's diet quality (diet diversity and intakes of energy, protein, zinc, and iron) (26-28). However, Sraboni and Quisumbing (2018) found that a reduced gender gap within the household favors men's and not women's diet quality in Bangladesh.

More recently, there is empirical evidence showing that NSA interventions may lead to improved women's empowerment, men's empowerment, and household gender equality (29-31). However, there is a paucity of evidence from experimental studies investigating the mediating role of empowerment and intra-household gender indicators on women's diet quality and household food security outcomes (21, 22, 32). The little evidence that exists does not focus on women across the life cycle, given that most have focused on pregnant and lactating mothers in relation to their reproductive roles (33). With the rising rates of OW/OB co-existing with micronutrient deficiencies, there is a need to better understand the role of empowerment and gender equality in addressing the double burden of malnutrition (32, 33). Given the highlighted gaps, this study aimed to investigate the role of women's empowerment, men's empowerment, and household gender equality in mediating the linkage between agriculture, household food security, and women's diet quality within the context of a multi-sectoral NSA intervention.

5.3 Methods

The Scaling Up Women's Agripreneurship through Public-Private Linkages to Improve Rural Women's Income, Nutrition, and the Effectiveness of Institutions in Rural Ghana (*LinkINg Up*; NCT03869853) project was designed to improve the quality of life of rural Ghanaian women agricultural entrepreneurs and their families in three districts of the Eastern Region of Ghana. The project partnered with local institutions in different sectors (e.g., agriculture, health, and finance) to provide an integrated intervention to women farmers that was delivered through farmer-based organizations (FBO). These farmer associations are typically formed by the Ghana Department of Food and Agriculture, non-governmental organizations, or individuals living within communities to improve farmer access to agricultural resources and services (34). A detailed description of the intervention and data collection has been published elsewhere (35). They are summarized here.

5.3.1 Study sites

Eight communities from three districts (Upper Manya Krobo District [UMKD], Yilo Krobo Municipality [YLKM], and Lower Manya Krobo Municipality[LMKM]) were selected based on the availability of an active community-based FBO (i.e., those meeting on a regular basis and carrying out group activities) with at least 30% female representation (Figure 5.1). The FBO that were selected in the study districts (UMKD, n=7; LMKM, n=7; YLKM, n=10) were those who were active in the last four months before the project started. The FBO were assessed also on members' level of participation, leadership potential, collaborative capacity as well as the accessibility of the community.

5.3.2 Study design and sample selection

The study used a 12-mo quasi-experimental longitudinal design. The intervention group (n = 166) included women who were members of the FBO in their community and who self-selected to participate in the project. As reported by Abdu et al. (2022), there were no significant differences in the demographic characteristics between FBO women members that participated and those who chose not to participate. The most common reasons for not participating include, (i) inability to acquire locally available coop building materials and construct the coop at own expense to receive the loan, particularly for female only households, and (ii) the lack of support from male family members to build the coop. The study enrolled a comparison (non-intervention) group (n = 164) that included women farmers from the same communities who were not members of the FBO. In contrast to the intervention group which included all eligible women who wanted to participate, the comparison group participants were randomly selected from a community census. A male adult family member was invited to participate in the project in all households where women were enrolled. About 25% (n= 84) of our households did not have an adult male to enroll. Even though the woman was the main signatory of the loan, the

project was described as a household-level intervention. The majority (n=201) of the enrolled men were spouses/ cohabiting partners. Due to limited financial resources, the project was implemented in two phases (phase 1 [2019-2020] and phase 2 [2021-2022]). Each phase accounted for 50% of the participants in the project groups who were enrolled. Given that both intervention and comparison groups were in the same communities, the comparison participants may have been exposed to capacity-building activities and services that were delivered at the community level.

5.3.3 Intervention

The 12-month integrated intervention delivered to FBO member households consisted of agricultural loans (i.e., in-kind poultry input or vegetable input loan package), agricultural training, and nutrition education. Women in the intervention group received either of the two-loan packages; loan repayment was made through the local rural bank. The project adopted Heifer's Passing on the Gift® community development approach following a 12-mo repayment cycle with 5% interest, a reduced interest rate than what was typically charged by existing lending institutions. The repaid loans from phase 1 participants provided funds for the phase 2 participants.

The poultry loan package (estimated at 2672 Ghana cedis [Gh₵]; $474.36 USD) provided 50 point-of-lay chickens to each household for egg production, bags of feed for one month, and medications for the birds as part of the loan. To promote participant commitment, households were required to provide their own materials and tools for coop construction. Households then received intensive training on building the coop, poultry management as well as handling and marketing the eggs. Households were interacting with local agriculture extension agents (AEA) on a weekly basis throughout the project to receive technical assistance on poultry production

and management. In most cases, women FBO members bulked their eggs together for sale at markets.

The vegetable loan package (estimated at GhȻ 665; $118.05 USD) included 1 acre of rented land for a year for each participating household. Participants also received funds to support land clearing and preparation as well as fertilizer, pesticides, and intensive training related to farming practices and management. The FBO groups that selected this package chose a local egg plant variety garden eggs as their vegetable and received planting seeds. The district AEA interacted with the participants on a weekly basis to provide technical assistance. Like the poultry group, women bulked their garden eggs for sale at markets.

Agriculture, nutrition, and other capacity-building training were provided to households in the intervention group through existing government institutions and not directly by the project staff. In addition to interacting with the rural banks on a twice-monthly basis to repay the loans of the project, participants also received financial training (e.g., booking keeping, savings) from the institution. Participants also interacted with staff from the district Ghana Health Service, Ghana Education Service, and Department of Food and Agriculture to receive nutrition and health training as well as agriculture extension training. Communities differed in frequency and the lessons they received as this was dependent on the institutions' schedule. Training and services provided by district staff from the different institutions were in open areas and accessible to all residents of the community. The project FBO groups also met on a weekly or twice monthly basis to collaborate on different activities related to farmer support, finance, and agriculture.

5.3.4 Data Collection

The data for the study were collected by trained field staff using electronic tablets for the baseline (November 2019 [phase 1] and November 2020 [phase 2]) and endline (November 2020 [phase 1] and June 2022 [phase 2]).

Empowerment outcomes were measured using the Project-level Women's Empowerment in Agriculture Index (pro-WEAI). An overall score was derived from 11 equally weighted indicators: (1) autonomy in income, (2) self-efficacy, (3) attitudes about domestic violence, (4) control over the use of income, (5) input in productive decisions (participation in decisions for household agriculture activities), (6) asset ownership (land and household assets), (7) mobility, (8) access to and decisions on financial services, (9) work balance, (10) group membership, and (11) membership in influential groups (36). For households with a woman and a male family member, the tool was administered to both to calculate the household gender equality score from both of their empowerment scores.

Household food security was assessed using the 15-item Latin American and Caribbean Food Security Scale (37). Information on women's dietary diversity and daily dietary intakes was collected using three 24-hour recalls conducted on two weekdays and one weekend. Locally trained enumerators conducted face-to-face interviews asking respondents to recall all food and beverage consumed in the previous 24-hour period. Participants were asked to also estimate their actual intakes with the aid of food models and common household utensils provided by the enumerators. The conversion factors associated with the food items were obtained by the project team from the staff at the Department of Nutrition and Food Science, University of Ghana who had previously conducted research in the study districts. Food items that were missing conversion factors were purchased and weighed.The estimated intakes were then calculated in grams using the conversion factors. Sociodemographic characteristics (age, education, marital

status, ethnicity) and household characteristics (family composition, assets) were collected through the baseline surveys.

5.3.5. Data Analysis

The primary outcomes of the study include endline empowerment (women's empowerment and household gender equality), women's diet quality (minimum dietary diversity for WRA [MDD-W], and macronutrient and micronutrient intakes), and household food security.

The empowerment score was estimated as follows. First, the achievement (adequate = 1; inadequate = 0) based on the pro-WEAI pre-defined cut-offs for each of the 11 indicators was determined for each woman and man (36). Next, the overall empowerment score was calculated by multiplying the achievement (0 or 1) of each indicator by the weight (1/11) and summing the score. Finally, study participants were classified as empowered (score ≥ 0.80) or disempowered (score < 0.80).

Household gender equality was calculated by comparing women's and men's empowerment scores, only for households where both the woman and man were interviewed. A household was classified as gender equal if (1) the woman was empowered irrespective of the male family member's score, or (2) the woman was not empowered but her score was equal to or greater than the male family member's score. On the other hand, a household was classified as lacking gender equality if the woman was not empowered, and her score was less than the male family member's score.

The MDD-W was used to assess the micronutrient adequacy of women's daily diets (38). The MDD-W was estimated from the 3-day 24-hour dietary recall information to extract the number of food groups consumed within that period. The food groups included, (1) grains, white roots

and tubers, and plantains, (2) pulses (beans, peas, and lentils), (3) nuts and seeds, (4) dairy, (5) meat, poultry, and fish, (6) eggs, (7) dark green leafy vegetables, (8) other vitamin A-rich fruits and vegetables, (9) other vegetables, and (10) other fruits. Women were classified as adequate if they achieved a score greater than or equal to five food groups; otherwise, they were considered as having low dietary diversity.

With the same dietary information, the energy (kilocalories/day [kcal/d]) and nutrient intake [protein (gram/day [g/d]); fat (g/d); carbohydrates (g/d); zinc (mg/d); calcium (mg/d); iron (mg/d)] of women were estimated using a project nutrient database that is composed of commonly consumed food in Ghana (39). Food composition estimates were obtained from the West African Food Compositional Table (2019) or through a search for the nutrition information of the particular item online for food items with missing values in the nutrient database (40). The usual intakes for energy, macronutrients, and micronutrients based on the 3-day recall data were then estimated using the Multiple Source Method (MSM), a statistical package that estimates intakes based on short-term measurements (41). The MSM package employs a two-step regression approach to estimate the probability of consumption on a random day and the usual intake on consumption days from the observed food intake while adjusting for inter- and intra-individual variation in intake. Energy intake values were converted from kilocalories to kilojoules (kJ) using the conversion factor of 1 kcal equal to 4.184 kJ.

Household food security status was generated by classifying households based on the number of affirmative answers; this was different for households without children [food secure (0), mildly food insecure (1–3), moderately food insecure (4–6), and severely food insecure (7–8)] and households with children [food secure (0), mildly food insecure (1–5), moderately food insecure

(6–10), and severely food insecure (11– 15)]. Finally, a binary variable was created: food secure, and food insecure (including mildly, moderately, and severely).

Individual and household characteristics were used to describe the sample and as covariates in the analytical models. All covariates except for household size were used as categorical variables. Principal component analysis of 18 household assets (improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment, mechanized farm equipment, owns house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator) was used to generate the wealth variable. The first component was extracted and categorized into tertiles (low, middle, and high).

Group differences in descriptive statistics of women and households were tested using independent Student's *t* test for continuous variables and a chi-squared test of independence for categorical variables. The percent of protein, fat, and carbohydrate consumed from total energy intake were calculated by multiplying the mean population intake value (g/day) by 4 (i.e., protein and carbohydrate) or 9 (i.e., fat), then dividing by the total energy intake and multiplying by 100. The adequacy of the usual macronutrient intakes were evaluated by comparing the estimated percentages to the Food and Nutrition Board of the Institute of Medicine's Acceptable Macronutrient Distribution Ranges for women above 18 years (42). For micronutrients, usual intakes were compared to the Harmonized average requirements (H-AR) for different age categories (43). The H-AR are based on average requirement (AR) values for zinc, calcium, and iron derived from the European Food Safety Authority (EFSA). Iron AR assumes moderate

absorption (10%) from the diet. Zinc AR assumes a semi-refined diet (600 mg phytate/d). The adequacy of the usual macronutrient intakes was evaluated by classifying the population above and below the H-AR.

Mediation analysis

To develop the final models used in the analysis, a bivariate analysis between the outcome, mediator, and covariates was conducted using chi-square tests, Student's *t* test, and unadjusted logistic or linear regressions. Variables with a P value < 0.10 in the bivariate associations were included in the final models. Variables that were not significant in the bivariate analysis but have been shown to be associated with the outcome and mediator variables in published literature were also included as covariates.

Regression-based mediation models were used to test if a change in empowerment and household gender equality mediated the association between the *LinkINg Up* intervention and women's diet quality and household food security (44-46). In the mediation model, the independent variable was the intervention (X), the mediator change variables were endline empowerment and household gender equality (M); the dependent change variables were endline diet quality indicators and household food insecurity (Y) (Figure 5.2). All models adjusted for covariates, baseline values of the mediators and dependent variables, and cluster (i.e., community). For the analytical steps, first, a linear regression with the hypothesized mediators as outcomes and the independent variable was run to estimate the values for *path a* in the models (44). Then, a binary logistic regression with the study outcomes and both the hypothesized mediators and independent variable as explanatory were used to estimate the values for *path b* (i.e., the association between the hypothesized mediators and the outcomes) and *path c′* also

known as direct effect (i.e., the association between the intervention and outcomes in the presence of the hypothesized mediators). Finally, the indirect effect (i.e., the association of the intervention on the outcomes through the hypothesized mediators) which assesses the mediation was estimated from the values of the *paths a and b* (i.e., a*b) using bootstrapping (5000 repetitions). The 95% bootstrap confidence intervals were used to assess significance. The total effects, known as *path c*, was the sum of the direct and indirect effects and estimates of the relationship between the independent and outcome variables in the absence of the hypothesized mediators. A moderation-mediation model was also tested to investigate if covariates acted as moderators in the mediation analysis. However, none of the moderators were significant in the analysis. Mediation was considered present when both the total and indirect effects were significant at a P value < 0.05. The type of mediation, whether full or partial was determined by assessing the significance of the direct and indirect effects. The percentage mediated was calculated as the ratio of the indirect effect to the total effect. All analyses were conducted using PROCESS macro version 4.2 in SPSS version 29 (47).

Ethical Considerations

The ethical approval for this study was obtained from the institutional review boards of McGill University (# 377-0219) and the University of Ghana College of Basic and Applied Sciences (# 035/18-19). All participants provided informed written consent. The project is registered at ClinicalTrials.gov (NCT03869853).

5.4 Results

The study enrolled 166 households to participate in the intervention activities (Figure 5.1). In addition, 164 households were enrolled as the comparison group from the same communities. All women (n=330) in the project households completed the baseline surveys. In 84 households only a woman was interviewed. At the endline, 296 (women's empowerment), 297 (household food

security), 307 (diet quality), and 185 (men's empowerment) households completed the surveys. In the final analysis, 47 and 50 women had incomplete information and were excluded for household security and women's diet quality outcomes, respectively (missing information, not summative: age (n=11); household wealth (n=3); endline household food security (n=33), and baseline diet quality (n=13); endline diet quality (n=23)).

Individual and household characteristics

At baseline, the characteristics of women did not differ significantly between the intervention and comparison groups (Table 5.1). Overall, the mean age of the women was 44.8 ± 13.7 y. Over two-thirds of the women (69%; n = 228) had some formal education (i.e., either primary or secondary) and a large proportion (75%, n = 246) of the women were in a union. Households had on average 5 members. Over half (59%, n = 194) of the households were food insecure at baseline, with a higher proportion estimated in the intervention than comparison households. At the endline, the proportion of households experiencing food insecurity decreased in both groups (intervention: 55%, n = 87; comparison 39%, n =55), although the rates were still significantly ($P < 0.01$) higher among intervention households.

Diet quality of women

On average, the number of food groups consumed was 5.0 ± 1.1 out of 10 at baseline (Table 5.1). About 66% of women achieved adequate dietary diversity. Grains, roots, tubers, plantain, and fish were the most consumed foods in the study population. Meanwhile, the consumption of dairy (15.3%, n = 48) and egg (15.0%, n = 47) was uncommon. The number of food groups consumed among women stayed similar at the endline. However, the proportion of women consuming dairy tended to be higher in the intervention group (intervention: 25%, n = 40;

comparison: 17%, n = 24; *P* = 0.08). Furthermore, egg consumption was higher among the intervention group (intervention: 33%, n = 54; comparison: 23%, n = 33; *P* = 0.04). Also, a higher proportion of women in the second phase of the project consumed dairy (phase 1: 15%, n = 24; phase 2: 26%, n =40; *P* = 0.02) and eggs (phase 1: 22%, n = 35; phase 2: 34%, n = 52; *P* = 0.02) at endline. Baseline usual macronutrient intakes were within the recommended values among the study sample (Table 5.2). Over 30% of the women were below the requirement for zinc intake from the diet and the majority did not meet the average requirements for calcium from both groups (Table 5.3). More than 90% of the women had adequate intake of iron from the diet.

Empowerment and household gender equality

Women in the intervention group were more empowered than the comparison group at baseline (Table 5.1). The observed difference was similar among women in households with (intervention: 0.79 ± 1.13; comparison 0.73 ± 0.17; *P* < 0.001) and without (intervention: 0.84 ± 1.12; comparison 0.73 ± 0.15; *P* < 0.001) a male family member. Similarly, male family members of women in the intervention were more empowered. The household gender inequality score did not differ between study groups. At endline, the mean empowerment score was higher for women in the intervention vs the comparison group (0.83 ± 1.14 vs. 0.79 ± 0.16, respectively; *P* =0.01). Among all women, those in the second project phase had a higher mean empowerment score (phase 1: 0.80 ± 0.17; phase 2: 0.84 ± 1.13; *P* = 0.01). Men did not differ in their empowerment scores at the endline (intervention: 0.85 ± 1.13; comparison 0.86 ± 0.13; *P* = 0.67) but there was a tendency for household inequality to be smaller in the intervention group at the endline (intervention: 0.01 ± 1.18; comparison: 0.06 ± 0.18; *P* = 0.07).

Mediation analysis between intervention and household food insecurity

In the adjusted mediation models with women's empowerment, men's empowerment, and household gender equality, only women's empowerment was significant. The *path a* showed the intervention had a significant positive association with women's empowerment score at endline (aβ = 0.05; 95% CI [0.01, 0.08]) (Figure 5.3). *Path b* showed a unit change in women's empowerment was significantly associated with a 4.56 unit (95% CI [-6.70, -2.41]) decrease in household food insecurity.

The indirect effect coefficient was negative and significant showing that the intervention had an indirect negative association (aβ = -0.22; 95% CI [-0.51, -0.05]) with household food insecurity mediated by its positive association with women's empowerment (Table 5.4). *Path c′* (the direct effect) which estimated the association between the intervention and endline household food insecurity was also significant and showed that the intervention had a positive association with household food insecurity at endline (aβ = 0.82; 95% CI [0.24, 1.39]) (Table 5.4 & Figure 5.3). The coefficient of the total effects was also positive and significant (Table 5.4). The percentage mediated by endline women's empowerment was estimated as 37%.

Mediation analysis between intervention and women's diet quality.

None of the adjusted mediation models were significant with the diet quality outcomes. However, the intervention was positively associated with women's egg consumption at endline

based on the direct (aβ = 0.62; 95% CI [0.04, 1.21]) and total (aβ 0.65; 95% CI [0.07, 1.11]) effects (Table 5.4).

5.5 Discussion

Our results demonstrated that women's empowerment in agriculture partially mediated the association between a multisectoral NSA intervention and household food security. The analysis suggested that the intervention may have increased household insecurity, but the negative coefficient of the indirect effect showed a change in women's empowerment suppressed the negative effects of the intervention by 37%. The design of our study does not permit inferences on causality, nevertheless, the finding confirms the hypothesized women's empowerment pathway in the agriculture-nutrition linkage (18). The finding provides evidences for the pathway that links women's access and control of resources to food and non-food expenditures within the household (18, 19). To the best of our knowledge, this is the first study to unpack this pathway using longitudinal data from an NSA intervention.

Different studies have provided insights into how household food security may be improved through women's empowerment. Similar to our findings on the positive relationship with women's empowerment, a mixed-methods evaluation of an NSA cluster-randomized controlled trial that transferred assets to women increased overall women's empowerment score, the number and value of assets owned by women, and resulted in changes in men's perceptions in relation to the ownership and use of agricultural land by women (24, 48). While the authors of the aforementioned study did not analyze the linkages with household nutrition, economic theories have provided a framework for analyzing how resources within the household are allocated (49). Using intra-household models, they propose that resources in households have multiple decision-makers who have different preferences. Thus, how these resources in the

household are allocated is determined by the relative bargaining power of that individual within the household. Observational studies have shown that women with access to resources and ownership of land invest more in the nutrition of the household and allocate higher budget shares to food expenditures (50-53). Women's empowerment related to membership in groups, decision-making over credit, ownership and rights over assets were positively correlated with household per capita calorie availability and dietary diversity (54). The evidence suggests that increasing women's control over resources may translate into greater decision-making within the household which may result in better investments in the well-being of the household.

An interesting finding from our analysis was that the intervention was associated with a higher household food insecurity at endline. While this study cannot provide a clear justification for why this might have occurred, there may be some plausible explanations based on the study context. Firstly, the project was interrupted by the Coronavirus (COVID-19) pandemic and the associated directives implemented by the Ghanaian government (55). Similar to global findings, a national-level study conducted in Ghana revealed that the pandemic was associated with a 29 percentage point increase in household food insecurity and a 56 percentage point increase in household poverty, particularly for those in the rural areas (22 percentage points more than urban households) (56). Coupled with the pandemic, the pressure of repaying loans during times of uncertainty may have exacerbated the impacts on household food security. In the microfinance literature, loans taken by women have been linked with feelings of increased stress because of the pressure to repay loans on time (57). Furthermore, loans may allow women to make investments in small businesses but may have little impact on the overall income of the household (57, 58). In a study in Ethiopia, households participating in a credit program reported

increases in the number of months the household was food insecure (59). The finding highlights that loans alone may not be sufficient to address poverty and household food insecurity and the need for policies to complement loans with other sustainable services.

The intervention was not associated with women's diet quality score and nutrient intakes, nor did women's empowerment mediate the association. However, the likelihood of consuming eggs at the endline was greater in the intervention group perhaps due to the greater availability and accessibility to women. Our findings can be compared to those reported from a quasi-experimental study that delivered a 3-year nutrition behavior change communication (BCC) intervention through self-help groups to women in India (60). The intervention provided nutrition messages covering different topics through local volunteers monthly and did not find any significant association with women's diet diversity or nutritional status indicators. The authors of the study attributed the results to nutrition messaging that was designed for non-pregnant/lactating mothers as well as the exposure intensity since only 10% of women at the endline reported they heard the messages. We could say the same with our study given that the nutrition component of the intervention was delivered through the local institution staff who reported different challenges that may have affected the implementation of activities and engagements with participants (55). In addition, the nutrition and health messaging provided may have not been relevant to our study demographic given that the Ghana Health Service activities target younger women of reproductive age and with children. Nevertheless, evidence from a well-conducted NSA cluster randomized control trial with women's groups showed a positive impact on women's minimum dietary diversity particularly in the treatment group that met once every two weeks to view and discuss agriculture and nutrition participatory videos together with

a participatory learning action meeting and follow up visits (adjusted RR = 1.30, 95% CI [1.1, 1.153]) (61). Thus, there is a need to consider other strategies that could be utilized through existing institutions to achieve nutrition-related impacts through women's empowerment.

In the present study, there was no association between the intervention with other potential mediators, men's empowerment and household gender equality at the endline. Our findings are consistent with a 17-month longitudinal quasi-experimental intervention that did not find any significant association with men's empowerment or household gender equality at the endline. However, there is evidence from cluster randomized control trial with four treatment arms (agricultural production training; nutrition BCC; agriculture production training and nutrition BCC; agricultural production training, nutrition BCC, and gender sensitization) delivered to women and their husbands showing a positive impact on household gender equality in two study arms, specifically agriculture production training and nutrition BCC (increase by 8 percentage points) and agricultural production training, nutrition BCC, and gender sensitization (increase by13 percentage points) (62). Furthermore, the trial showed a positive impact on men's empowerment (increase by 0.03 percentage points) in the nutrition BCC arm. The contrasting findings perhaps highlight that different intervention modalities may impact intra-households gender dynamics which requires important consideration in the design and implementation of future NSA interventions in our study context.

Our assessment of the mediating role of empowerment and household gender equality on the study outcomes has some limitations. Firstly, our experimental design did not allow for isolating the effects of other factors in the environment that could have influenced the study outcomes. We

did test moderation-mediation models with covariates such as household wealth and education, but they were not significant in the analysis (44). However, the design does not allow us to establish causality. Next, our study focused on overall empowerment scores and did not look at the role of individual empowerment indicators. Perhaps a more targeted analysis with the individual indicators would have provided more insights on specific women's empowerment pathways to impact in the agriculture-nutrition linkage. Some studies have found that the individual empowerment indicators and not the overall score show better associations with women's nutritional outcomes and household food security (30). Finally, we did not conduct a process evaluation to assess how male family members were involved in the intervention activities. Nevertheless, data from qualitative interviews conducted after the intervention revealed men provided support to the women participants in their respective households and women reported better intra-household relationships after the intervention. A process evaluation would have also provided information on the type and intensity of nutrition training information provided by the local institutional staff. The amount of nutrition messages may have varied given that regional institutions were delivering the information directly to the participants.

Despite the limitations, the study contributes to limited studies that examined the mediating role of women's empowerment in the agriculture-nutrition linkage using pre-post assessments. Our results suggest that multisectoral NSA interventions delivered through the local institution and farmer groups have the potential to improve household food security outcomes through women's empowerment. However, additional complementary policy interventions are needed to maximize the benefits. Also, with the current nutrition transition and the double burden of malnutrition among women in Ghana, there is a need to strengthen capacity and integrate innovative and

targeted strategies within the existing district institutions to ensure the consumption of healthy diets.

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The author's responsibilities were as follows; GSM and EKC conceptualized the *LinkINg Up* study design. EKC oversaw project implementation and data collection. AA developed the research question around women's empowerment assessment; GSM, EKC, and AA developed the survey tools. AA and AMM conducted the literature review, cleaned, and performed the nutrient analysis with dietary data. AA performed the statistical analysis and drafted the manuscript. GSM supported the analysis and interpretation of the results. All authors contributed to and approved the final manuscript

Data Sharing

Data described in the manuscript, code book, and analytic code will be made available (in deidentified form) upon request pending application to the PI (Marquis) and approval.

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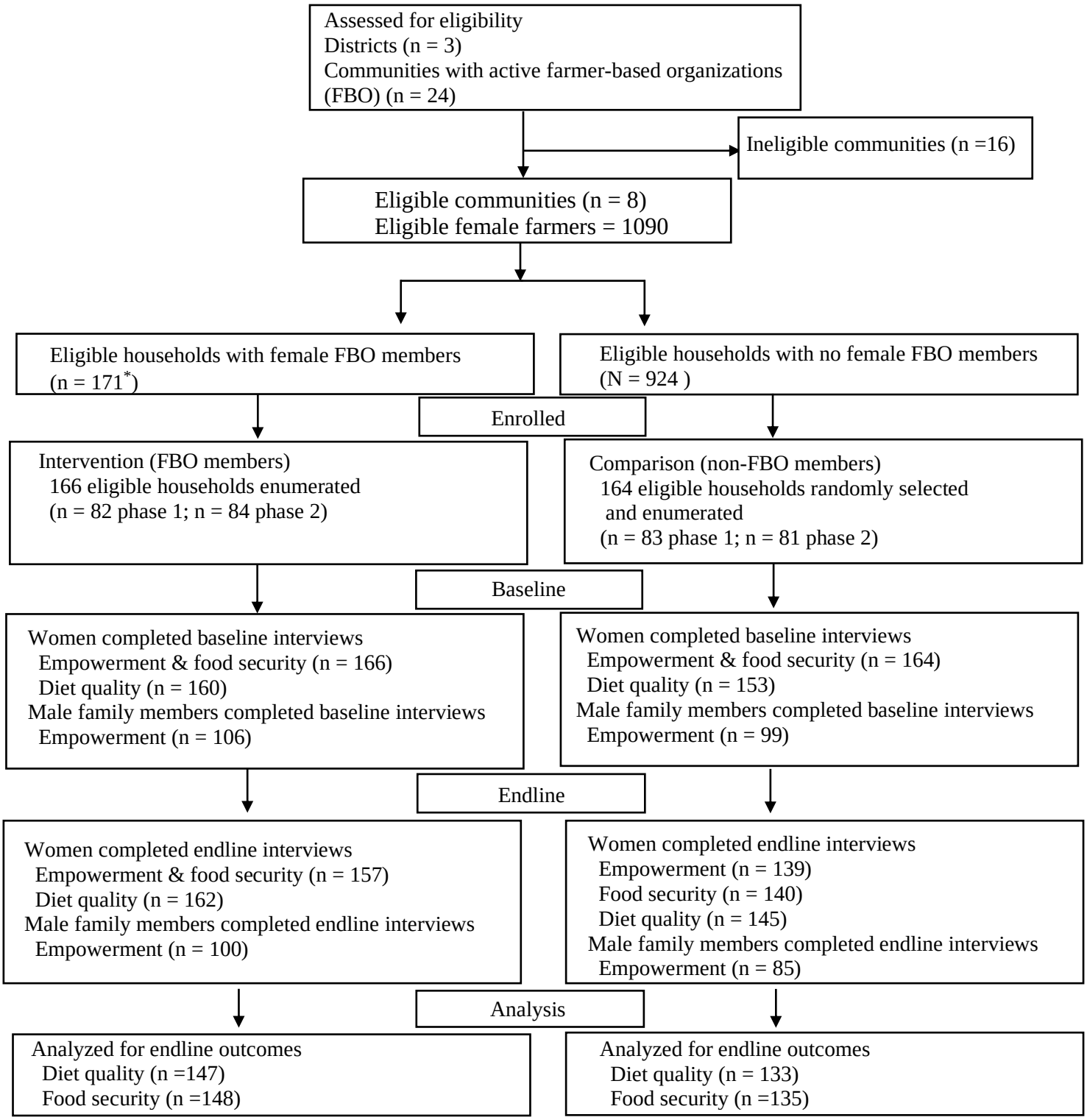
Figure 5.1 Participants flow through the quasi-experimental study in rural Ghana.



*Six women who were non-FBO members and in the comparison group in the phase 1 baseline became FBO members and part of the intervention group in the phase 2 baseline.

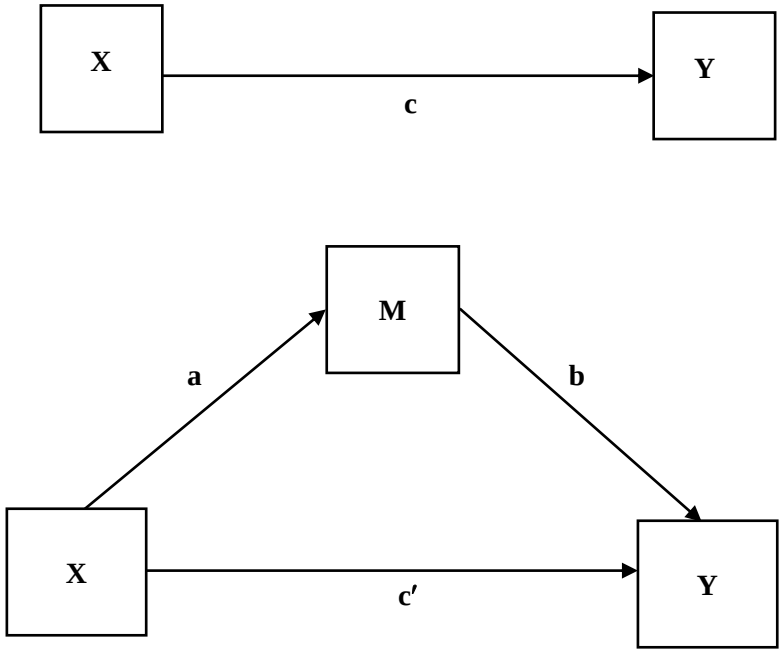


Figure 5.2 Path diagram for mediation analysis of nutrition outcomes among women farmers in rural Ghana

X is the independent variable (intervention), Y is the dependent variable (endline diet quality outcomes and household food security), and M is the mediator (endline empowerment score). Path a describes the association between X and M; path b describes the association between M and Y; path c′, also known as the direct effect, describes the association between X and Y in the presence of M; path c, also known as total effect, is the association between X and Y in the absence of M (43-44).

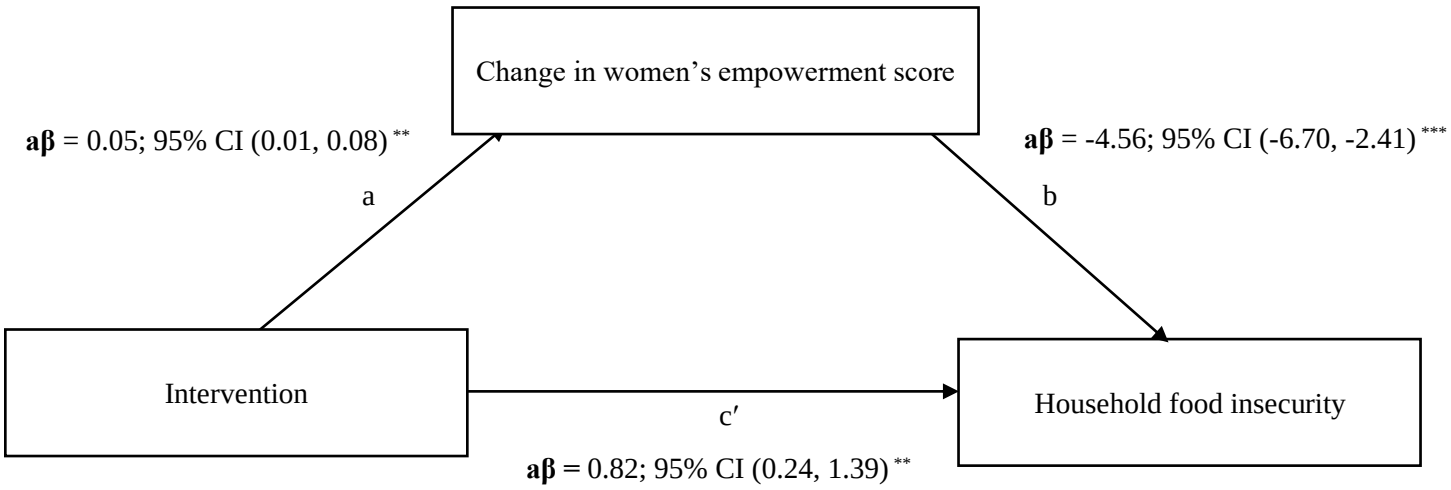


Figure 5.3 Mediation analysis diagram for women's empowerment and endline household food insecurity outcome in rural Ghana

Values shown are beta coefficients (95% Confidence Intervals) from regression-based mediation models adjusted for covariates (age group, ethnicity, marital status, education, household size, wealth, and project phase), baseline values (empowerment score and household food insecurity) and cluster (community). Path a is describing the association between the independent (intervention) and mediator (endline empowerment score) variables; path b is describing the association between the mediator (endline empowerment score) and dependent (endline diet quality actual intakes and household food security) variables; path c′ is describing the association between the independent variable (intervention) and the dependent variable (endline diet quality and actual intakes and household food security) in the presence of the mediator (endline empowerment score) (43-44). ** $p<0.01$, *** $p<0.001$

Table 5.1 Baseline individual and household characteristics of women farmers in the intervention and comparison groups in rural Ghana

Variables	Intervention n = 166[1]	Comparison n = 164[1]	P value[2]
Individual			
Age group, y			0.25
< 35	32 (20.1)	45 (28.1)	
35-44	44 (27.7)	38 (23.8)	
45-54	45 (28.3)	35 (21.9)	
≥ 55	38 (23.9)	42 (26.2)	
Ethnicity[3]			0.85
Krobo	136 (81.9)	133 (81.1)	
Education[4]			0.05
None	49 (29.5)	53 (32.3)	
Primary	65 (39.2)	44 (26.8)	
Secondary or higher	52 (31.3)	67 (40.9)	
Marital status[5]			
Married/cohabiting	124 (74.7)	122 (74.4)	0.95
Minimum dietary diversity[6]	5.0 ± 1.2	4.9±1.1	0.66
Food groups consumed[7]			
Grains, white roots and tubers, plantains	160 (100.0)	153 (100.0)	
Pulses	26 (16.3)	18 (11.8)	0.25
Nuts and seeds	54 (33.8)	44 (28.8)	0.34
Dairy	25 (15.6)	23 (15.0)	0.88
Meat, poultry, and fish	159 (99.4)	152 (99.4)	0.98
Eggs	20 (12.5)	27 (17.7)	0.20
Dark green leafy vegetables	53 (33.1)	53 (34.6)	0.78
Other vitamin A-rich fruits and vegetables	116 (72.5)	114 (74.5)	0.69
Other vegetables	159 (99.4)	152 (99.4)	0.98
Other fruits	34 (21.3)	26 (16.9)	0.34
Household			
Size, #	5.1 ± 1.9	5.2 ± 2.0	0.71
Wealth[8]			0.25
Low	50 (30.7)	59 (36.2)	
Medium	52 (31.9)	57 (35.0)	
High	61 (37.4)	47 (28.8)	
Food security[9]			0.04
Food insecure	107 (64.5)	87 (53.1)	
Phase of enrollment			
Phase 1	82 (49.4)	83 (50.6)	
Phase 2	84 (50.6)	81 (49.4)	
Empowerment[10]			
Women's empowerment score[11]	0.81 ± 0.13	0.73 ± 0.16	< 0.001
Men's empowerment score[11]	0.83 ± 0.13	0.79 ± 0. 14	0.03
Household inequality score[12]	0.04 ± 0.17	0.07 ± 0.19	0.24

Data shown are n (%) or mean ± standard deviation

[1]Total n = 330 for all but age (n = 319), wealth (n =326), minimum dietary diversity and individual food groups (n = 313), and men's empowerment and household gender equality (n = 205). Includes all participants with baseline data for these variables. [2]Independent Student's *t* test for continuous variables; Chi-Squared test of independence for categorical variables.[3]Krobo, the local ethnic group, was compared to others (Akan, Ewe, Ga, among others). [4]Highest level of education completed. [5]Married/cohabiting compared to not married or cohabiting. [6] Mean number

of food groups consumed out of 10 [(1) grains, white roots and tubers, and plantains, (2) pulses, (3) nuts and seeds, (4) dairy, (5) meat, poultry, and fish, (6) eggs, (7) dark green leafy vegetables, (8) other vitamin A-rich fruits and vegetables, (9) other vegetables, and (10) other fruits] (38). [7]Includes persons who consumed food group in the previous 24 hr. [8]Wealth: tertiles for the first component of a principal components analysis of 18 household assets [improved water source, floor materials, wall materials, roof materials, toilet facility, cooking fuel, ownership of agricultural land, small livestock, non-mechanized farm equipment (i.e., hand tools), mechanized farm equipment (i.e., tractor), house or building, electricity, motorcycle, bicycle, cellphone, radio, television, and refrigerator].[9]Food security: classification based on the 15-item Food Insecurity Experience Scale (37). Food secure and food insecure (included mildly, moderately, and severely food insecure). [10]Empowerment outcomes measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (36). [11]Mean population score based on 11 empowerment indicators. [12]Calculated only for the households where a woman and a male adult family member were interviewed.

Table 5.2 Baseline usual energy and macronutrient intakes of women farmers in the intervention and comparison groups in rural Ghana

		Treatment		Comparison	
		n = 160		n = 153	
	AMDR[1]	Intake	Percentage of energy intake	Intake	Percentage of energy intake
Energy, kJ/d[2]	–	7460.0 (6327.1, 8610.3)	–	7259.1 (5934.1, 8765.1)	–
Protein, g/d	10-35%	57.4 (47.3, 68.3)	12.0 ± 2.2	57.1 (45.5, 68.7)	13.0 ± 2.1
Fat, g/d	20-35%	50.8 (40.4, 65.6)	26.0 ± 6.0	54.4 (40.6, 70.4)	27.0 ± 6.7
Carbohydrates, g/d	45-65%	277.5 (237.7, 318.4)	62.0 ± 6.0	263.5 (224.1, 318.1)	60.0 ± 6.9

Data shown are median (IQR: Interquartile range) or mean ± standard deviation. There were no significant group differences.
AMDR; Acceptable Macronutrient Distribution Ranges.[1]Percentage of energy intake (42). [2]1 kcal = 4.184 KJ

Table 5.3 Baseline usual micronutrient intakes of women farmers in the intervention and comparison groups in rural Ghana

Baseline usual micronutrient intakes of women farmers in the intervention and comparison groups in rural Ghana

			Treatment n = 160			Comparison n = 153		
Micronutrient	Age	H-AR[1]	Intake	Percentage above H-AR	Percentage below H-AR	Intake	Percentage above H-AR	Percentage below H-AR
Zinc, mg/d	≥ 18 y	7.6	8.5 (7.0, 9.9)	102 (63.7)	58 (36.3)	8.4 (7.2, 9.9)	101 (66.0)	52 (34.0)
Calcium, mg/d	18-24 y	860	711.6 (440.7, 786.2)	1 (16.7)	5 (83.3)	577.0 (551.2, 772.6)	2 (20.0)	8 (80.0)
	≥ 25 y	750	558.5 (469.4, 682.0)	32 (21.8)	115 (78.2)	584.7 (452.3, 754.2)	35 (25.2)	104 (74.8)
Iron, mg/d	18-50 y	11.2	20.2 (17.5, 23.6)	106 (100.0)	–	20.8 (16.8, 24.0)	101 (99.0)	1 (1.0)
	≥ 51 y	9.6	18.1 (15.8, 21.8)	45 (95.7)	2 (4.3)	18.0 (13.7, 22.3)	46 (97.9)	1 (2.1)

Data shown are median (IQR: Interquartile range) or n (%). There were no significant group differences.
H-AR: Harmonized average requirement. [1]Requirements are based on average requirement (AR) values for zinc, calcium, and iron derived from the European Food Safety Authority (EFSA; 43). Iron AR assumes moderate absorption (10%) from the diet. Zinc AR assumes a semi-refined diet (600 mg phytate/d).

Table 5.4 Association between intervention with endline household food insecurity and diet quality, as mediated by empowerment among women's farmers in rural Ghana

Outcome[1]	Total effect[2]	Direct effect[3]	Indirect effect[4]	Percentage mediated[4]
Individual				
Diet diversity				
MDD-W	0.11 (-0.19, 0.41)	0.08 (-0.23, 0.39)	0.03 (-0.01, 0.10)	No mediation
Eggs consumed	0.65 (0.07, 1.11) *	0.62 (0.04, 1.21) *	0.05 (-0.04, 0.19)	No mediation
Energy and Macronutrients				
Energy	-620.73 (-1571.26, 329.81)	-647.03 (-1609.56, 315.49)	26.31 (-103.25, 190.40)	No mediation
Protein	-2.69 (-11.20, 5.82)	-3.18 (-11.79, 5.43)	0.49 (-0.62, 2.03)	No mediation
Fat	-4.10 (-10.81, 2.62)	-4.40 (-11.20, 2.40)	0.30 (-0.64, 1.57)	No mediation
Carbohydrates	-24.76 (-66.84, 17.30)	-25.05 (-67.65, 17.54)	0.29 (-5.95, 6.97)	No mediation
Micronutrients				
Zinc	-0.48 (-1.83, 0.87)	-0.57 (-1.93, 0.80)	0.08 (-0.09, 0.34)	No mediation
Calcium	-31.00 (-170.05, 108.05)	-43.01 (-183.58, 97.55)	12.01 (-5.43, 38.95)	No mediation
Iron	-1.08 (-3.63, 1.47)	-1.16 (-3.74, 1.42)	0.07 (-0.28, 0.50)	No mediation
Household				
Food insecurity	0.60 (0.05, 1.12) *	0.82 (0.24, 1.39) **	-0.22 (-0.51, -0.05) *	37%

* $p<0.05$, ** $p<0.01$

Values shown are beta coefficients (95% Confidence Intervals or 95% Percentile Bootstrap Confidence Intervals) from regression-based mediation models. [1]Each outcome represents a single model adjusted for covariates (age group, ethnicity, marital status, education, household size, wealth, and project phase), baseline values (empowerment score and household food insecurity) and cluster (community). [2]The association between the independent variable (intervention) and the dependent variable (endline diet quality and actual intakes and household food security) in the absence of the mediator (endline empowerment score) (43-44). [3]The association between the independent variable (intervention) and the dependent variable (endline diet quality and actual intakes and household food security) in the presence of the mediator (endline empowerment score). [4]The association between independent variable (intervention) and the dependent variable (endline diet quality and actual intakes and household food security) through the mediator (endline empowerment score). [5]Ratio of indirect effect to the total effect; mediation was considered present when both the total and indirect effects were statistically significant.

Chapter 6: General discussion, conclusion, and recommendations

The overall goal of this dissertation was to investigate measures of women's empowerment and intra-household gender dynamics among farmers and their relationship with women's nutritional outcomes and household food security. The first study used qualitative methods to explore local meanings and perceptions of empowerment among women farmers and their male partners. The second study used cross-sectional data and the novel Project-level Women's Empowerment in Agriculture Index (pro-WEAI) to assess the relationship between women's empowerment, men's empowerment, and household gender equality with women's participation in farmer-based organizations (FBO), women's and men's nutritional status, and household food security. The final study within a quasi-experimental design (i) examined the association between a nutrition-sensitive agricultural (NSA) intervention and endline women's and men's empowerment and household gender equality and (ii) investigated if a change in empowerment and household gender equality mediated the association between the NSA intervention and women's diet quality and household food security. The key findings of the individual studies will be discussed in this chapter.

6.1 Overall discussion

6.1.1 Understandings of women's empowerment are relational

A key finding from the qualitative study was that women's empowerment is relational in our study context. Manuscript 1 revealed that local meanings of women's empowerment were focused more on interdependence rather than independence. Women's social ties, relationships, and participation in groups were key to their empowerment. Aggregated, the findings suggested that a woman's level of empowerment was a product of her own attributes and capabilities but

largely shaped by her interactions with others (i.e., family members, community members, local institutional staff, market actors) and the environment (i.e., social, cultural, and economic context) (Appendix 1). A recent qualitative study conducted in Cambodia showed that empowerment for women in a socially cohesive context resulted from social connections (e.g., interpersonal relationships and community ties) and group formation (Doneys et al., 2020). This is also true in Ghana where communal collectivism is a common practice in society (LeFebvre & Franke, 2013). Thus, the study findings do not support Western discourses that focus on individualism as opposed to collectivism to achieve women's empowerment (Chant, 2016; Pigg, 2002).

In a follow-up study (manuscript 2), we hypothesized that women participating in farmer groups would have higher levels of empowerment. Interestingly, the study found that women participating in FBO compared to non-participants had a significantly higher likelihood of overall women's empowerment and household gender equality measured using the pro-WEAI. Furthermore, women participating in FBO had higher empowerment related to attitudes about domestic violence, access to and decisions on financial services, mobility, group membership, and membership in influential groups. In manuscript 3, a household-level multisectoral NSA intervention was delivered to women who were part of FBO. Women FBO members who made up the intervention group had higher levels of empowerment at the endline compared to non-FBO-participating female farmers in the comparison group.

The thesis empowerment frameworks (Chapter 2) provide insights into how FBO participation and leveraging women's existing resources and capabilities within an NSA intervention could

influence women's empowerment. Kabeer (1999) in her framework highlighted the importance of social resources (e.g., access to social networks and participation in organizations) as enabling factors that allow individuals and groups to expand their ability to exercise choice (Kabeer, 1999). This is consistent with the results in manuscript 1; women farmers with good relationships and social networks were described as having better access to material resources, support, and opportunities that allowed them to reach their goals and achieve empowerment.

Alsop et al. (2006) and Narayan (2005) in their frameworks have theorized the benefits of enabling formal and informal institutions as they promote women's empowerment by creating an inclusive environment for women to access services and information as well as participate in decision-making processes. In the qualitative interviews (manuscript 1), participants reported that government institutional support (i.e., financial, agricultural services) and familial support could act as facilitators as well as barriers to women's empowerment. A woman achieved empowerment when she interacted with agriculture extension agents and bank officials to access training, input support, and loans as well as when she received male partner support with her farming activities. However, when she faced difficulties in accessing agricultural inputs or the household financial burden shifted to her it prevented the woman from achieving her set goals. The thesis findings highlight the importance of a relational approach to women's empowerment.

6.1.2 The role of intra-household relations and women's empowerment on household food security

My thesis results indicate that relational empowerment may be linked with food security. An interesting finding from manuscript 2 was that an empowerment indicator that captured intra-household relationships was important for household food security. Women's empowerment related to attitudes about domestic violence (i.e., a woman did not believe intimate partner

violence was justified under any condition) had a strong negative association with household food insecurity; that is, more empowerment was linked to better food security. My analysis in manuscript 2 found that women participating in FBO had a higher likelihood of empowerment in this same indicator. Brody et al. (2017) in a systematic review have noted decreases in experiences of domestic violence among women who were members of groups. Furthermore, the review reported that participating in groups promoted social recognition and respect for women from their husbands and other household members. In the qualitative interviews conducted in manuscript 1, participants reported that mutual respect within the households of empowered women farmers allowed them to participate in household decision-making as well as achieve their goals such as those related to farming and building assets. Furthermore, an empowered woman was described as having autonomy over the spending of her money. In the literature, women's decision-making and ownership of assets have been positively associated with household dietary diversity as well as energy and nutrient availability (Sraboni et al., 2014; Tsiboe et al., 2018).

Manuscript 3 showed that women's empowerment associated with participating in the FBO-based NSA intervention was negatively associated with household food insecurity. A plausible pathway to improve food security may be women's improved access to resources and services through government institutions (manuscript 1). Women participants interacted with the district agriculture extension agent on a twice-monthly basis to receive technical assistance with their loan assets and farming activities (Colecraft et al., 2022). Kassie et al. (2012) have found that women's access to quality services from extension agents and agricultural assets was positively associated with household food security (Kassie et al., 2012). In this thesis, empowered women

were described as contributing financially to the household unit (manuscript 1). Evidence suggests that women allocate higher budget shares to household food expenditures (Haddad, 1999; Quisumbing & Maluccio, 2000)

6.1.3 The role of FBO participation and access to credit on household food security

The thesis findings have highlighted the important role of context in the assessments of groups and empowerment and their role in household food security outcomes. Manuscript 2 found that women's FBO participation was positively associated with household insecurity, suggesting a potential negative influence of farmer groups on household nutrition or perhaps households that are food insecure join FBO. Interestingly, the analysis in the study found that in households where a woman participated in FBO, both the women and men had a higher likelihood of empowerment in the indicator related to access to and decisions on financial services. Descriptive statistics showed that households with female FBO members borrowed credit from more sources compared to non-FBO member households. In the same study, empowerment in access to and decisions on financial services was positively associated with household food insecurity among women and men.

There are different plausible explanations for these findings. While the Women in Agriculture Development Directorate (WIAD) is tasked with promoting production diversity and providing nutrition education to rural women farmers, there is little evidence that WIAD staff actually deliver food-based nutrition education through FBO in the study communities (Food and Agriculture Organization of the United Nations, 2018). Secondly, the key function of farmer groups in rural areas is to increase farmer income and productivity through increasing access to credit, market, and extension services (Bizikova et al., 2020; Salifu et al., 2012). Limited studies have reported on the relationship between farmer group membership and food security, however,

Bizikova et al. (2020) have noted the lack of a clear targeted focus on improving food security through farmer groups. Higher productivity may not necessarily translate to household food security as there is evidence suggesting that small-scale farmer households sell farm produce to address other competing household needs (Bizikova et al., 2020; Ochieng et al., 2017). In addition, small-scale farmers including women may not derive complete advantages from farmer organizations as a result of their fluctuating income and limited resources (Bizikova et al., 2020).

In Ghana, FBO rely on government services and local institutions to access resources and technical support in agriculture (Salifu et al., 2012). Participants of the focus group discussions (manuscript 1) shared that the lack of timely delivery of agricultural inputs (e.g., seeds), difficulty in accessing bank loans, and high-interest loans were common obstacles they faced in their interactions with local agricultural and financial institutions. In a scoping review of farmer organization services in Sub-Saharan Africa and India, it was highlighted that farmer groups had little influence on crop yield and production quality attributed to poor access to extension services and capacity-building training activities (Bizikova et al., 2020). In manuscript 1, our findings suggested the potential benefits of improved government services. The participants mentioned it contributed to achieving higher yields and quality agricultural products which facilitated access to markets and wholesale buyers and improved profits from the sale of the commodities.

6.1.5 Women's nutritional outcomes, FBO participation, and women's empowerment

The thesis identified nutritional issues among the study population. Manuscript 2 found a higher risk of overweight and obesity among women who were FBO members compared to non-members. A 43% prevalence of overweight and obesity has been reported among this same study sample (Arnouk et al., 2023). The rising rates of non-communicable diseases such as

cardiovascular disease (i.e., hypertension, stroke) and diabetes associated with overweight and obesity in Ghana have been documented (Coomson & Aryeetey, 2022; Lartey et al., 2020). In 2016, an estimated 37% of all deaths in Ghana were attributed to non-communicable diseases. In manuscript 3, the analysis of dietary data also found that intakes of zinc and calcium were below the requirements for a large proportion of the women. Previous work conducted in the same study context found that diets did not meet the requirement for calcium (Nti, 2008). The findings emphasize the need to intensify nutrition education among the rural population.

The thesis did not confirm the hypothesis in manuscripts 2 and 3 that women's empowerment and intra-household gender dynamics were associated with women's nutritional status and diet quality indicators. Similarly, in a cross-sectional study, Malapit et al. (2015) did not find any association between women's empowerment and Body Mass Index (BMI). Nevertheless, the authors found that the overall empowerment score of women in the Women's Empowerment in Agriculture Index (WEAI) domains and participation in credit decisions were significantly associated with women's diet diversity. In another study in Nepal, overall women's empowerment was associated with women's BMI and dietary diversity (Malapit et al., 2015) Women had a higher likelihood of diet diversity in households where they participated in decision-making and when they were part of a social or economic group. Furthermore, women's control over income and reduced workload were positively associated with women's BMI.

A recent cross-country analysis of WEAI data may explain the nutrition-related findings in manuscripts 2 and 3 (Quisumbing et al., 2021). Comparing analysis of studies conducted with data from South Asian and African countries, Quisumbing et al. (2021) noted fewer significant

associations between women's empowerment and intra-household equality with women's BMI and women's dietary diversity with data from African countries (Ghana, Mozambique, and Tanzania). The authors indicated these measures had a stronger relationship with women's nutritional status and diets among data from South Asian countries as well as with child nutritional outcomes. Furthermore, household level and contextual factors such as wealth and underlying gender norms explained more the variance in women's dietary diversity than women's empowerment. A study found that lower-income households were less likely to purchase diverse food groups and consumed higher energy-based foods (French et al., 2019). Also, social norms have been linked with intra-household food allocation where women were found to consume fewer nutrients (Behrman, 1992). Social norms also influence dietary behaviour and food choices. For instance, in Ghanaian culture, monotonous meals that are based on cereals and starchy roots dominate diets (Amugsi et al., 2016; Galbete et al., 2017). Manuscript 3 showed that egg consumption was higher among women in the NSA intervention group compared to the comparison. The finding highlights the role of the food environment such as the availability of nutrient-rich food as well as the importance of targeted NSA interventions to improve women's diets.

6.1.4 The role of men's empowerment on household food security and women's nutritional outcomes

Men played an important role in women's empowerment and household food security. In the qualitative interviews (manuscript 1), men were key contributors to the empowerment of women when they provided support (e.g., financial, labour) and facilitated access to land that allowed women to achieve higher farm productivity, sell more products at the local markets, and make higher profits. In manuscript 2, men's empowerment was negatively associated with household food insecurity. While no published studies have reported on this relationship, there is evidence

showing that male-headed farming households are less likely to be food insecure compared to female-headed households (Jung et al., 2017; Kassie et al., 2012). Qualitative evidence from Tanzania suggested male financial support within the household may result in higher purchases of food for consumption, thus improving household food security (Ochieng et al., 2017). Furthermore, women in male-headed households were more likely to have higher diet diversity. However, the thesis did not find evidence that male empowerment was associated with women's nutritional status or diet quality indicators.

6.2 Strengths and limitations

The thesis helped to improve our understanding of women's empowerment and intra-household gender dynamics and their role in women's nutritional outcomes and household food security among rural Ghanaian farming communities. This was achieved through three unique studies that provided supporting empirical evidence. The dissertation had several strengths.

First, the thesis began with a thorough review of the literature (Chapter 2) on existing empowerment frameworks which guided and shaped the philosophical and methodological choices made to unravel the thesis research questions. Next, the use of a mixed-methods approach allowed for obtaining comprehensive information to understand women's empowerment and gender dynamics in the study context. The use of qualitative methods, particularly focus group discussions, allowed for the engagement of participants in collective discussions to uncover the nuances, experiences, and perceptions of the concept of women's empowerment from women and men farmers. The quantitative data were collected using the novel pro-WEAI, a multidimensional tool that provided rich information on different dimensions of empowerment in agriculture, sex-disaggregated information on women's and men's empowerment, and women's empowerment relative to that of men from the same households

(Malapit et al., 2019). Integrating the results from the qualitative and quantitative studies helped me to contextualize and gain a more complete picture of the findings as well as explain some of the discrepancies observed between empowerment and group participation with individual and household nutrition. The qualitative information also helped to confirm the dimensions of empowerment that were important to the study population. The interpretations of the final qualitative results were verified by research assistants who were familiar with the local dialect and culture of the participants.

Another strength of the thesis was the assessment of the role of FBO on women's empowerment using gender disaggregated tools. While the need to utilize gender indicators to track the gender mainstreaming effort in agriculture has been noted in policy reports from Ghana to the best of my knowledge this thesis published the first study that provided evidence (Food and Agriculture Organization of the United Nations, 2018). The thesis examined the role of FBO in intra-household gender dynamics. Next, the thesis empirically demonstrated the theorized women's empowerment pathway in the agriculture-nutrition linkage (Ruel et al., 2013). To the best of my knowledge, this is the first study to unpack this pathway using longitudinal data from an NSA intervention.

Other strengths concern the sample population of the thesis. First, the inclusion of men's data in the analysis from the Ghanaian context provided richer information related to gender dynamics. There is a paucity of studies investigating women's empowerment that have included men in their analysis (Johnson et al., 2018b). Also, the research focused on women across the life cycle,

not only on mothers of young children who are often the focus of NSA interventions aiming at empowering women (Ruel et al., 2018; Sharma et al., 2021).

Assessing empowerment comes with a set of limitations. In the qualitative study, the translation of the concept of empowerment to the local dialect by the local translators may have been influenced by their own cultural biases and life experiences. Some important nuances associated with empowerment may have been lost in the translation as a result of the concepts or phrases not having equivalent words in the English language (Glennerster et al., 2018). Also, I, a female Nigerian national, coded the interviews independently, thus my cultural differences and bias may have influenced the interpretations of the results. In the empowerment surveys, questions on decision-making may have been subject to reporting bias (Glennerster et al., 2018). It is worth mentioning that project surveys took approximately two hours which may have contributed to respondent fatigue and led to response bias. Moreover, women's empowerment and gender dynamics may be sensitive topics in some communities leading to people not expressing their actual views on the subject.

The thesis cannot claim causality in the assessment of the relationship between women's FBO membership and empowerment indicators. Women who joined groups may have been empowered before joining the group or vice versa. Perhaps an analysis of the years of membership would have provided insights into the role of these farmer groups in women's empowerment. Also, the quasi-experimental design used in the third study did not allow for the establishment of a cause-and-effect relationship between the intervention and empowerment since extraneous variables were not controlled through randomization. Finally, the thesis did not

assess the nutrition knowledge of both the participants and institutional staff, accessibility to markets, and the broader food environment. This would have helped explain better the findings related to women's diets and household food security.

6.3 Policy implications and future directions

There is a global recognition of the importance of women's empowerment and gender equality (Goal 5) in achieving the United Nations Sustainable Development Goals (SDG), particularly the eradication of poverty (Goal 1) and hunger (Goal 2) by 2030. With only seven years remaining, the most recent Global Gender Gap report (2022) has highlighted that no country is on track to achieve SDG Goal 5 (World Economic Forum, 2022). In the Sub-Saharan African region, even though Ghana is doing better than other countries, the country ranks low at a position of 110 out of 163 United Nations member countries in relation to progress toward achieving SDG 5 (Sachs et al., 2022). Thus, there is a need for individual countries to consider different strategies to accelerate progress toward meeting the goals of women's empowerment and gender equality.

In Ghana, the agriculture sector is one area where gender gaps exist. The present president of Ghana, Nana Akufo-Addo, has announced that the government's goal is to raise the WEAI score of the country by 20% (Myers, 2022). The Ghanaian government, as part of its agricultural policies, is promoting FBO for agriculture and rural development as they find that providing resources and technical services to groups is more efficient and effective for reaching rural farmers. The thesis findings demonstrate that rural women farmers have a strong presence in these groups since they recognize the value of these groups in building relationships, and gaining access to resources and support from government agencies that allow them to reach their agriculture-related goals. Thus, there is an opportunity for the Ghana government to leverage and

strengthen these existing resources (i.e., farmer's associations and service institutions) to allow rural women farmers to increase their empowerment and close the gaps between men and women in agriculture.

Strengthening multisectoral collaboration, integrating gender-transformative strategies, and promoting women farmers' access to loans and markets may be key to achieving the desired empowerment outcomes. Farmer-based organizations can be used in Ghana as a platform to implement more targeted NSA interventions to strengthen the influence of women's empowerment on diet quality and food security. However, future research should prioritize investigating the added benefits of involving male family members and delivering innovative nutrition education approaches that are designed to target women across the life cycle through these groups in Ghana.

6.4 Conclusions

Groups, relationships, and the environment are important for women's empowerment in rural Ghana. Furthermore, the role of women's empowerment in household food security is shaped by these factors. Thus, policies and programs that strengthen networks and relationships for women have the potential to contribute to women's empowerment and consequently household food security. However, delivering more targeted NSA interventions through FBO may be more promising to improve women's nutritional outcomes and diet.

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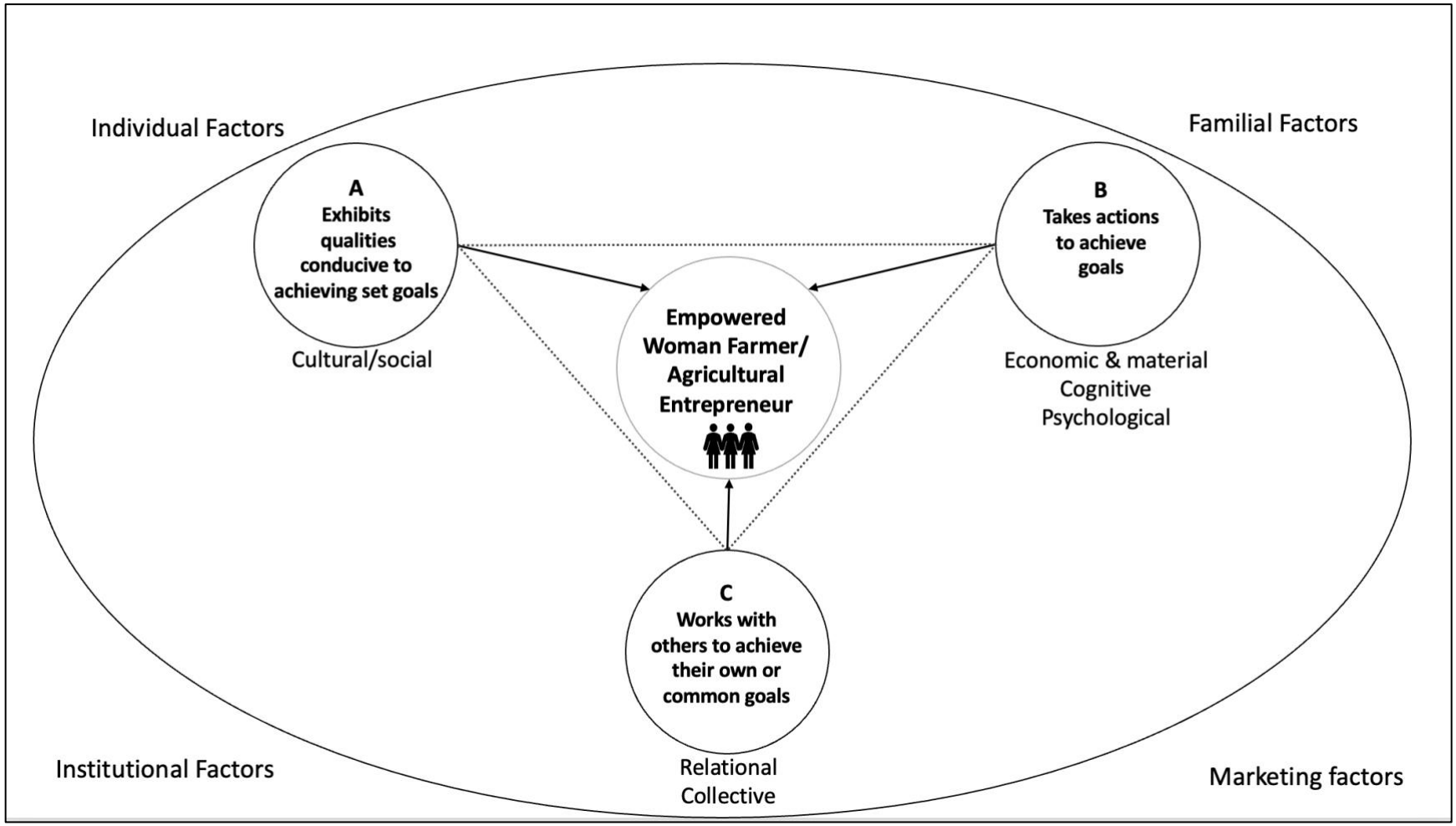
Appendices

Appendix 1 Descriptions of women's empowerment by women and men farmers in rural Ghana



The figure describes nuances associated with being an empowered woman farmer/agricultural entrepreneur in focus group discussions with women and men farmers. The diagram is composed of three main themes (A-C) that are composed of different dimensions (cultural/social; economic and material; cognitive; psychological; relational; collective) of women's empowerment. The three themes interact with each other, and a woman's level of empowerment is dependent on how many dimensions of empowerment she can achieve in all themes combined. Factors in the environment may either promote or inhibit women's empowerment and these four factors are present at different levels (individual; familial; institutional; market).

Appendix 2 Focus group guide

Local understandings of empowerment

Part 1:

1. How would you describe an empowered person in your community? [**general question**; **probe responses**]

Now, I am interested in knowing your views on empowerment in your community with regard to women farmers/agricultural entrepreneurs

Part 2:

2. How would you describe a woman farmer/agricultural entrepreneur who is empowered in your community?
   Probes
   a) What is this woman like? **[Probe characteristics and how others see her]**
   b) How do you expect her life to be?
   c) What factors contribute to her life being like this? **[Probe for conditions of empowerment at different levels – self, family/household, community, markets, farm, institutions]**
   d) What factors prevent her life from being like this? **[Probe at different levels – self, family/household, community, markets, farm, institutions]**
   e) What resources does this person have?
      Probe:
      Material, human, social,
      Decision-making power does she have? [at household level and community level]
      Other kinds of power she may have
      Achievements does she have? (at individual, family, community levels)

3. How would you describe a man farmer/agricultural entrepreneur who is empowered in your community? **[probe as question 2]**

4. How is the empowered woman farmer/agricultural entrepreneur similar/different from the empowered man in your community

Thank you for sharing your views about an empowered woman and man farmer/agricultural entrepreneur. Now, we would like to talk to you about the opposite of what we have discussed

5. How would you describe a woman farmer/agricultural entrepreneur who is not empowered **[probe as question 2]**

6. How would describe a man farmer/agricultural entrepreneur who is not empowered **[probe as question 2]**

7. How is the disempowered woman farmer/agricultural entrepreneur similar/different from the disempowered man in your community

Thank you for sharing your views on empowerment. Is there anything I didn't ask you that you think I should have asked? Thank you!

Appendix 3 Project-level Women's Empowerment in Agriculture Index pilot version[1]

MODULE G1. INDIVIDUAL IDENTIFICATION

G1.01. HOUSEHOLD IDENTIFICATION:		**G1.04 TYPE OF HOUSEHOLD**	MALE AND FEMALE ADULT ..... 1 FEMALE ADULT ONLY 2
G1.02. NAME OF RESPONDENT CURRENTLY BEING INTERVIEWED (ID CODE GENERATED FROM HOUSEHOLD ROSTER):		**G1.05. OUTCOME OF INTERVIEW:** **CIRCLE ONE**	COMPLETED ..... 1 HOUSEHOLD MEMBER TOO ILL TO RESPOND/COGNITIVELY IMPAIRED ... 2 RESPONDENT NOT AT HOME/TEMPORARILY UNAVAILABLE ..... 3 RESPONDENT NOT AT HOME/EXTENDED ABSENCE ..... 4 REFUSED ..... 5 COULD NOT LOCATE 6
SURNAME, OTHER NAME: _____			
G1.03. SEX OF RESPONDENT:	MALE ..... 1 FEMALE 2	**G1.06. ABILITY TO BE INTERVIEWED ALONE:** **CIRCLE ONE**	ALONE ..... 1 WITH ADULT FEMALES PRESENT ..... 2 WITH ADULT MALES PRESENT ..... 3 WITH ADULTS OF BOTH SEX PRESENT ..... 4 WITH CHILDREN PRESENT ..... 5 WITH ADULTS OF BOTH SEX AND CHILDREN PRESENT 6

[1] Malapit H, Quisumbing A, Meinzen-Dick R, Seymour G, Martinez EM, Heckert J, Rubin D, Vaz A, Yount KM. Development of the project-level Women's Empowerment in Agriculture Index (pro-WEAI). *World Dev.* 2019;122:675-92

MODULE G2: ROLE IN HOUSEHOLD DECISION-MAKING AROUND PRODUCTION AND INCOME

Now I'd like to ask you some questions about your participationin certain types of work activities and on making decisions on various aspects of household life.		Did you [NAME] participate in [ACTIVITY] in the past 12 months (thatis, during the last [one/two] cropping seasons), from [PRESENT MONTH] last year to [PRESENT MONTH] this year?	When decisions are made regarding [ACTIVITY], who is it that normally takes the decision? **ENTER UP TO THREE (3) MEMBER IDs** **IF RESPONSE IS MEMBER ID (SELF) ONLY → *G2.05*** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE.....98 → ***NEXT ACTIVITY***			How much input did you have in making decisions about [ACTIVITY]? **USE CODE G2↓**	To what extent do you feel you can participate in decisions regarding [ACTIVITY] if you want(ed) to? **CIRCLE ONE**	To what extent are you able to access information that you feel is important for making informed decisions regarding [ACTIVITY]? **CIRCLE ONE**	How much input did you have in decisions about how much of the outputs of [ACTIVITY] to keep for consumption at home rather than selling? **USE CODE G2↓**	How much input did you have in decisions about how to use income generated from [ACTIVITY]? **USE CODE G2↓**
ACTIVITY		**G2.01**	**G2.02**			**G2.03**	**G2.04**	**G2.05**	**G2.06**	**G2.07**
			ID #1	**ID #2**	**ID #3**					
A	Staple grain farming and processing of the harvest: grains that are grown primarilyfor food consumption (rice, maize, wheat, millet)	YES.....1 NO .....2 → ***ACTIVITY B***					NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
B	Horticultural (gardens) or high value crop farming and processing of the harvest	YES.....1 NO .....2 → ***ACTIVITY C***					NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
C	Large livestock raising (cattle, buffaloes) and processing of milk and/or meat	YES.....1 NO .....2 → ***ACTIVITY D***					NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
D	Small livestock raising (sheep, goats, pigs) and processing of milk and/or meat	YES.....1 NO .....2 → ***ACTIVITY E***					NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
E	Poultry and other small animals raising (chickens, ducks, turkeys) and processing of eggs and/or meat	YES.....1 NO .....2 → ***ACTIVITY F***					NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		

		Did you [NAME] participate in [ACTIVITY] in the past 12 months (thatis, during the last [one/two] cropping seasons), from [PRESENT MONTH] last year to [PRESENT MONTH] this year?	When decisions are made regarding [ACTIVITY], who is it that normally takes the decision? **ENTER UP TO THREE (3) MEMBER IDs** **IF RESPONSE IS MEMBER ID (SELF) ONLY →** ***G2.05*** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE.....98 → NEXT ***ACTIVITY***			How much input did you have in making decisions about [ACTIVITY]? **USE CODE G2↓**	To what extent do you feel you can participate in decisions regarding [ACTIVITY] if you want(ed) to? **CIRCLE ONE**	To what extent are you able to access information that you feel is important for making informed decisions regarding [ACTIVITY]? **CIRCLE ONE**	How much input did you have in decisions about how much of the outputs of [ACTIVITY] to keep for consumption at home rather than selling? **USE CODE G2↓**	How much input did you have in decisions about how to use income generated from [ACTIVITY]? **USE CODE G2↓**
ACTIVITY		**G2.01**	**G2.02**			**G2.03**	**G2.04**	**G2.05**	**G2.06**	**G2.07**
			ID #1	**ID #2**	**ID #3**					
F	Fishpond culture	YES .....1 NO..... 2 → ***ACTIVITY G***					NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
G	Non-farm economic activities (running a small business, self-employment, buy-and-sell)	YES .....1 NO..... 2 → ***ACTIVITY H***					NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
H	Wage and salary employment (work that is paid for in cash or in-kind, including both agriculture and other wagework)	YES .....1 NO..... → ***ACTIVITY I***					NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
I	Large, occasional household purchases (bicycles, land, transport vehicles)						NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		
J	Routine household purchases (food for daily consumption or other household needs)						NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4	NOT AT ALL .....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 TO A HIGH EXTENT. 4		

CODE G2
LITTLE TO NO INPUT IN DECISIONS 1
INPUT INTO SOME DECISIONS 2
INPUT INTO MOST OR ALL DECISIONS 3
NOT APPLICABLE / NO DECISION MADE 98

MODULE G3(A): ACCESS TO PRODUCTIVE CAPITAL

Now I'd like to ask you specifically about your household's land.

QUESTION		RESPONSE
G3.01. Does anyone in your household currently own or cultivate land?		YES.....1 NO .....2 → ***G3.06, ITEM A***
G3.02. Who generally makes decisions about what to plant on this land?	**ENTER UP TO THREE (3) MEMBER IDs** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE.....98	**ID #1** | **ID #2** | **ID #3**
G3.03. Do you [NAME] solely or jointly cultivate any land?	**CIRCLE <u>ONE</u>**	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
G3.04. Who generally makes decisions about what to plant on the land that you yourself cultivate?	**ENTER UP TO THREE (3) MEMBER IDs** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE.....98	**ID #1** | **ID #2** | **ID #3**
G3.05. Do you own any of the land owned or cultivated by your household?	**CIRCLE <u>ONE</u>**	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4

Now I'd like to ask you about a number of items that could be used to generate income.		Does anyone in your householdcurrently have any [ITEM]?	Do you [NAME] own any [ITEM]? **CIRCLE ONE**
ITEM		**G3.06**	**G3.07**
A	Large livestock (cattle, buffaloes)	YES ..... 1 NO.....2 →***ITEM B***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
B	Small livestock (sheep, goats, pigs)	YES ..... 1 NO.....2 → ***ITEM C***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
C	Poultry and other small animals (chickens, ducks, turkeys)	YES ..... 1 NO.....2 →***ITEM D***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
D	Fishpond or fishing equipment	YES ..... 1 NO.....2 →***ITEM E***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
E	Non-mechanized farm equipment (hand tools, animal-drawn plough)	YES ..... 1 NO.....2 → ***ITEM F***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
F	Mechanized farm equipment (tractor-plough, power tiller, treadle pump)	YES ..... 1 NO.....2 → ***ITEM G***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
G	Non-farm business equipment (solar panels used for recharging, sewing machine, brewing equipment, fryers)	YES ..... 1 NO.....2 →***ITEM H***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
H	House or building	YES ..... 1 NO.....2 →***ITEM I***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4
I	Large consumer durables (refrigerator, TV, sofa)	YES ..... 1 NO.....2 → ***ITEM J***	YES, SOLELY .....1 YES, JOINTLY .....2 YES, SOLELY AND JOINTLY .....3 NO.....4

		Does anyone in your householdcurrently own any [ITEM]?	Do you [NAME] own any [ITEM]? **CIRCLE ONE**
ITEM		**G3.06**	**G3.07**
J	Small consumer durables (radio, cookware)	YES .....1 NO.....2 → ***ITEM K***	YES, SOLELY.....1 YES, JOINTLY.....2 YES, SOLELY AND JOINTLY .....3 NO 4
K	Cell phone	YES .....1 NO.....2 → ***ITEM L***	YES, SOLELY.....1 YES, JOINTLY.....2 YES, SOLELY AND JOINTLY .....3 NO 4
L	Other land not used for agricultural purposes (pieces/plots, residential or commercial land)	YES .....1 NO.....2 →***ITEM M***	YES, SOLELY.....1 YES, JOINTLY.....2 YES, SOLELY AND JOINTLY .....3 NO 4
M	Means of transportation (bicycle, motorcycle, car)	YES .....1 NO.....2 →***MODULE G3(B)***	YES, SOLELY.....1 YES, JOINTLY.....2 YES, SOLELY AND JOINTLY .....3 NO 4

MODULE G3(B): ACCESS TO FINANCIAL SERVICES

		Next I'd like to ask about your household's experience with borrowing money or other items(in-kind) in the past 12 months.	Would you or anyone in your household be able to take a loan or borrow cash/in-kind from [SOURCE] if you wanted to?	Has anyone in your household taken anyloans or borrowed cash/in-kind from [SOURCE] in the past 12 months? **CIRCLE ONE**		Who made the decision to borrow from [SOURCE] most of the time? **ENTER UP TO THREE (3) MEMBER IDs** **OTHER CODES:** NON-HH MEMBER .....94 NOT APPLICABLE.....98			Who makes the decision about what to do with the money or item borrowed from [SOURCE] most of thetime? **ENTER UP TO THREE (3) MEMBER IDs** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE 98			Who is responsible for repaying the money or item borrowed from [SOURCE]? **ENTER UP TO THREE (3) MEMBER IDs** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE 98		
LENDING SOURCES		**G3.08**	**G3.09**			**G3.10**			**G3.11**			**G3.12**		
						ID #1	**ID #2**	**ID #3**	**ID #1**	**ID #2**	**ID #3**	**ID #1**	**ID #2**	**ID #3**
A	Non-governmental organization (NGO)	YES.....1 NO… .....2 → ***SOURCE B*** MAYBE....3	YES, CASH .....1 YES, IN-KIND.....2 YES, CASH AND IN-KIND.....3 NO.....4 DON'T KNOW.....97	→ ***SOURCE B***										
B	Formal lender (bank/financial institution)	YES.....1 NO… .....2 → ***SOURCE C*** MAYBE....3	YES, CASH .....1 YES, IN-KIND.....2 YES, CASH AND IN-KIND.....3 NO.....4 DON'T KNOW.....97	→ ***SOURCE C***										
C	Informal lender	YES.....1 NO… .....2 →***SOURCE D*** MAYBE....3	YES, CASH .....1 YES, IN-KIND.....2 YES, CASH AND IN-KIND.....3 NO.....4 DON'T KNOW.....97	→ ***SOURCE D***										
D	Friends or relatives	YES.....1 NO… .....2 →***SOURCE E*** MAYBE....3	YES, CASH .....1 YES, IN-KIND.....2 YES, CASH AND IN-KIND.....3 NO.....4 DON'T KNOW.....97	→ ***SOURCE E***										
E	Group based micro-financeor lending including VSLAs / SACCOs	YES.....1 NO… .....2 →***SOURCE F*** MAYBE....3	YES, CASH .....1 YES, IN-KIND.....2 YES, CASH AND IN-KIND.....3 NO.....4 DON'T KNOW.....97	→ ***SOURCE F***										
F	Informal credit / savings groups (.e.g., merry-go-rounds, tontines, funeral societies, etc.)	YES.....1 NO .....2 →***G3.13*** MAYBE....3	YES, CASH .....1 YES, IN-KIND.....2 YES, CASH AND IN-KIND.....3 NO.....4 DON'T KNOW.....97	→ ***G3.13***										

G3-.13	An account can be used to save money, to make or receive payments, or to receive wages or financial help. Do you, either by yourself or together with someone else, currently have an account at any of the following places: a bank or other formal institution (e.g., post office)?	YES.....1 NO.....2 DON'T KNOW 97

MODULE G4: TIME ALLOCATION

G4.01: PLEASE RECORD A LOG OF THE ACTIVITIES FOR THE INDIVIDUAL IN THE LAST COMPLETE 24 HOURS (STARTING YESTERDAY MORNING AT 4 AM, FINISHING 3:59 AM OF THE CURRENT DAY). THE TIME INTERVALS ARE MARKED IN 15 MIN INTERVALS. MARK ONE ACTIVITY FOR EACH TIME PERIOD BY ENTERING THE CORRESPONDING ACTIVITY CODE IN THE BOX.

G4.02: CHECK THE BOX BELOW IF THE RESPONDENT WAS CARING FOR CHILDREN WHILE PERFORMING EACH ACTIVITY

Now I'd like to ask you about how you spent your time during the past 24 hours. We'll begin from yesterday morning, and continue through to this morning. This will be a detailed accounting. I'm interested in everything you did (i.e. resting, eating, personal care, work inside and outside the home, caring for children, cooking, shopping, socializing, etc.), even if it didn't take you much time. I'm particularly interested in agricultural activities such as farming, gardening, and livestock raising whether in the field or on the homestead. I'm also interested in how much time you spent caring for children, especially if it happened while you did some other activity (e.g., collecting water while carrying a child or cooking while watching after a sleeping child).

		Night		**Morning**	**Day**									
		4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	
G4.01 Activity **(WRITE ACTIVITY CODE)**														
G4.02 Did you also care for children?	YES.....CHECK BOX NO.....LEAVE BLANK	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

		Day		**Evening**	**Night**									
		16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	1:00	2:00	3:00	
G4.01 Activity **(WRITE ACTIVITY CODE)**														
G4.02 Did you also care for children?	YES.....CHECK BOX NO.....LEAVE BLANK	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ACTIVITY CODES FOR G4.01

A	Sleeping and resting	H	Horticultural (gardens) or high value crop farming	N	Shopping/getting service (incl. health services)	U	Exercising
B	Eating and drinking	I	Large livestock raising (cattle, buffaloes)	O	Weaving/sewing/textile care	V	Social activities and hobbies
C	Personal care	J	Small livestock raising (sheep, goats, pigs)	P	Cooking	W	Religious activities
D	School (incl. homework)	K	Poultry and other small animals raising (chickens, ducks, turkeys)	Q	Domestic work (incl. fetching water and fuel)	X	Other (specify)
E	Work as employed	L	Fishpond culture	R	Caring for children		
F	Own business work	M	Commuting (to/from work or school)	S	Caring for adults (sick, elderly)		
G	Staple grainfarming			T	Travelling (not for work or school)		

G4.03. In the last 24 hours did you work (at home or outside of thehome including chores or other domestic activities) less than usual, about the same as usual, or more than usual?	**FOR <u>FEMALES</u> ONLY:DOES RESPONDENT HAVE A CHILD UNDER 5 YEARS OLD?**	**G4.04.** If you wanted to do something (livelihood-related, training-related, self-care) and could not take your child with you, is there someone who could care for your child in your absence?	**G4.05.** Who?	**ID #1**	**ID #2**	**ID #3**
LESS THAN USUAL ..... 1 ABOUT THE SAME AS USUAL..... 2 MORE THAN USUAL ..... 3 **IF RESPONDENT IS <u>MALE</u> → MODULE G5**	YES ..... 1 → G4.04 NO… .....2 → MODULE G5	YES .....1 →G4.05 NO…..... 2 →MODULE G5	**ENTER UP TO THREE (3) MEMBER IDs** **OTHER CODES:** NON-HH MEMBER.....94 NOT APPLICABLE 98			

MODULE G5: GROUP MEMBERSHIP

Now I'm going to ask you about groups in the community. These can be either formal or informal and customary groups.		Is there a [GROUP] in your community?	Is this group composed of all male or female or mixed-sex members?	Are you an activemember of this [GROUP]?	To what extent do you feel like you can influence decisions in this [GROUP]?	To what extent does this [GROUP] influence life in the community beyond the group activities?
GROUP CATEGORIES		**G5.01**	**G5.02**	**G5.03**	**G5.04**	**G5.05**
A	Agricultural / livestock / fisheries producer's group (including marketing groups)	YES .....1 NO .....2 → ***GROUP B*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP B***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
B	Water users' group	YES .....1 NO .....2 → ***GROUP C*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP C***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
C	Forest users' group	YES .....1 NO .....2 → ***GROUP D*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP D***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
D	Credit or microfinance group (including SACCOs / merry-go-rounds / VSLAs)	YES .....1 NO .....2 → ***GROUP E*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP E***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
E	Mutual help or insurance group (including burial societies)	YES .....1 NO .....2 → ***GROUP F*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP F***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
F	Trade and business association group	YES .....1 NO .....2 → ***GROUP G*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP G***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
G	Civic group (improving community) or charitable group (helping others)	YES .....1 NO .....2 → ***GROUP H*** DON'T KNOW.....97	ALL MALE.....1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW.....97	YES.....1 NO.....2 → ***GROUP H***	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL .....1 SMALL EXTENT .....2 MEDIUM EXTENT.....3 HIGH EXTENT 4

	Religious group	YES .....1 NO .....2 → ***GROUP I*** DON'T KNOW.....97	ALL MALE..... 1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW... 97	YES.....1 NO ..... → ***GROUP I***	NOT AT ALL.....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL.....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 HIGH EXTENT 4
	Other (specify): _____	YES .....1 NO .....2 → ***MODULE G6*** DON'T KNOW.....97	ALL MALE..... 1 ALL FEMALE.....2 MIXED SEX.....3 DON'T KNOW... 97	YES.....1 NO.....2 → ***MODULE G6***	NOT AT ALL.....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 HIGH EXTENT 4	NOT AT ALL.....1 SMALL EXTENT.....2 MEDIUM EXTENT.....3 HIGH EXTENT 4

MODULE G6. PHYSICAL MOBILITY

QUESTION	RESPONSE FOR G6.01 - G6.06: USE CODE G6↓
G6.01 How often do you visit an urban center?	
G6.02 How often do you go to the market / haat / bazaar?	
G6.03 How often do you go to visit family or relatives?	
G6.04 How often do you go to visit a friend / neighbor's house?	
G6.05 How often do you go to the hospital / clinic / doctor (seek health service)?	
G6.06 How often do you go to a public village gathering / community meeting / training for NGO or programs?	
G6.07. In the last 12 months, how many times have you been away from home for one or more nights (in other words, sleeping somewhere else for the night)?	
G6.08. In the last 12 months, have you been away from home for more than one month at a time?	YES.....1 NO .....2 ***IF RESPONDENT IS MALE →MODULE G7***

CODE G6
EVERYDAY..... 1
EVERY WEEK AT LEAST ONCE..... 2
EVERY 2 WEEKS AT LEAST ONCE..... 3
EVERY MONTH AT LEAST ONCE..... 4
LESS THAN ONCE A MONTH..... 5
NEVER..... 6

MODULE G7: INTRAHOUSEHOLD RELATIONSHIPS

Now I'd like to ask you some questions abouthow you feel about some of other people in your household or family group and how you think they feel about you. **ENTER MEMBER ID FOR EACH RELATION** **OTHER CODES:** NON-HH MEMBER.....94			Do you [NAME] respect your [RELATION]?	Does your [RELATION] respect you?	Do you trust your [RELATION] to do things that are in your best interest?	When you disagree with your [RELATION], do you feel comfortable telling him/her that you disagree?	**IS [RELATION] THE OTHER RESPONDENT WITHIN THIS HOUSEHOLD?**
RELATION			**G7.02**	**G7.03**	**G7.04**	**G7.05**	**G7.06**
A	Husband / wife	**ID #**	MOST OF THE TIME.....1 SOMETIMES .....2 RARELY.....3 NEVER 4	MOST OF THE TIME .....1 SOMETIMES.....2 RARELY .....3 NEVER 4	MOST OF THE TIME.....1 SOMETIMES.....2 RARELY .....3 NEVER.....4	MOST OF THE TIME.....1 SOMETIMES .....2 RARELY .....3 NEVER..... 4	YES……1 NO 2
B	Other respondent within the household	**ID #**	MOST OF THE TIME.....1 SOMETIMES .....2 RARELY.....3 NEVER 4	MOST OF THE TIME .....1 SOMETIMES.....2 RARELY .....3 NEVER 4	MOST OF THE TIME.....1 SOMETIMES.....2 RARELY .....3 NEVER.....4	MOST OF THE TIME.....1 SOMETIMES .....2 RARELY .....3 NEVER..... 4	

MODULE G8(A): AUTONOMY IN DECISION-MAKING

Now I am going to read you some stories about different farmers and their situations regarding different agricultural activities. This question format is different from the rest so take your time in answering. For each I will then ask you how much you are like or not like each of these people. We would like to know if you are completely different from them, similar to them, or somewhere in between. There are no right or wrong answers to these questions. **READ ALOUD EACH STORY, SUBSEQUENT QUESTIONs, AND RESPONSE CODES. NAMES SHOULD BE ADOPTED TO LOCAL CONTEXT AND BE MALE/FEMALE DEPENDING ON THE SEX OF THE REPONDENT. THE ORDER OF STORIES 1-4 SHOULD BE RANDOMIZED.**	Are you like this person? **CIRCLE ONE**	Are you completely the sameor somewhat the same? **CIRCLE ONE**	Are you completely different or somewhatdifferent? **CIRCLE ONE**

		STORY	**G8.01**	**G8.02**	**G8.03**
How to use income generated from agricultural and non-agricultural activities	**D1**	*"There is no alternative to how [PERSON'S NAME] uses her income. How she uses her income is determined by necessity."*	YES...1 NO ...2 →***G8.03***	COMPLETELY THE SAME….1 → ***D2*** SOMEWHAT THE SAME.....2 →***D2***	COMPLETELY DIFFERENT .....1 SOMEWHAT DIFFERENT.....2
	D2	*"[PERSON'S NAME] uses her income how her spouse, or another person or group in her community tell her she must use it there. She does what they tell her to do."*	YES...1 NO ...2 → ***G8.03***	COMPLETELY THE SAME….1 → ***D3*** SOMEWHAT THE SAME.....2 →***D3***	COMPLETELY DIFFERENT .....1 SOMEWHAT DIFFERENT.....2
	D3	*"[PERSON'S NAME] uses her income in the way that her family or community expect. She wants them to approve of her."*	YES...1 NO ...2 → ***G8.03***	COMPLETELY THE SAME….1 → ***D4*** SOMEWHAT THE SAME.....2 →***D4***	COMPLETELY DIFFERENT .....1 SOMEWHAT DIFFERENT.....2
	D4	*"[PERSON'S NAME] chooses to use her income how she personally wants to, and thinks is best for herself and her family. She values using her income in this way. If she changed her mind, she could act differently."*	YES...1 NO ...2 →***G8.03***	COMPLETELY THE SAME...1 →***G8.04*** SOMEWHAT THE SAME….2 →***G8.04***	COMPLETELY DIFFERENT .....1 SOMEWHAT DIFFERENT.....2

MODULE G8(B): NEW GENERAL SELF-EFFICACY SCALE

Now I'm going to ask you some questions about different feelings you might have. Please listen to each of the following statements. Think about how each statement relates to your life, and then tell me how much you agree or disagree with the statement on a scale of 1 to 5, where 1 means you "strongly disagree" and 5 means you "strongly agree." **Note: randomize order of statements**

	STATEMENTS	**G8.04**
A	I will be able to achieve most of the goals that I have set for myself.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
B	When facing difficult tasks, I am certain that I will accomplish them.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
C	In general, I think that I can obtain outcomes that are important to me.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
D	I believe I can succeed at most any endeavor to which I set my mind	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
E	I will be able to successfully overcome many challenges.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
F	I am confident that I can perform effectively on many different tasks.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
G	Compared to other people, I can do most tasks very well.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5
H	Even when things are tough, I can perform quite well.	STRONGLY DISAGREE.....1 DISAGREE.....2 NEITHER AGREE NOR DISAGREE.....3 AGREE.....4 STRONGLY AGREE.....5

MODULE G9. ATTITUDES ABOUT DOMESTIC VIOLENCE

Now I would like to ask about your opinion on the following issues. Please keep in mind that I am not asking about your personal experience or whether the following scenarios have happened to you. I would only like to know whether you think the following issues are acceptable.		In your opinion, is a husband justified in hitting or beating his wife in the following situations?
SITUATION		**G9.01**
A	If she goes out without telling him?	YES.....1 NO.....2 DON'T KNOW.....97
B	If she neglects the children?	YES.....1 NO.....2 DON'T KNOW.....97
C	If she argues with him?	YES.....1 NO.....2 DON'T KNOW.....97
D	If she refuses to have sex with him?	YES.....1 NO.....2 DON'T KNOW.....97
E	If she burns the food?	YES.....1 NO.....2 DON'T KNOW.....97

Appendix 4 Project-level Women's Empowerment in Agriculture Index indicators and definitions of adequacy[2]

Indicator	Definition of adequacy
Input in productive decisions [Module G2]	Meets at least ONE of the following conditions for ALL of the agricultural activities they participate in *1) Makes related decision solely,* *2) Makes the decision jointly and has at least some input into the decisions* *3) Feels could make decision if wanted to (to at least a MEDIUM extent)*
Ownership of land and other assets [Module G3(A)]	Owns, either solely or jointly, at least ONE of the following: *1) At least THREE small assets (poultry, nonmechanized equipment, or small consumer durables)* *2) At least TWO large assets* *3) Land*
Access to and decisions on financial services [Module G3 (B)]	Meets at least ONE of the following conditions: *1) Belongs to a household that used a source of credit in the past year AND participated in at least ONE sole or joint decision about it* *2) Belongs to a household that did not use credit in the past year but could have if wanted to from at least ONE source* *3) Has access, solely or jointly, to a financial account*
Control over use of income [Module G2 (G2.06 & G2.07)]	Has input in decisions related to how to use BOTH income and output from ALL of the agricultural activities they participate in AND has input in decisions related to income from ALL non-agricultural activities they participate in, unless no decision was made
Work balance [Module G4]	Works less than 10.5 hours per day: *Workload = time spent in primary activity + (1/2) time spent in childcare as a secondary activity*
Visiting important locations [Module G6]	Meets at least ONE of the following conditions: *1) Visits at least TWO locations at least ONCE PER WEEK of [city, market, family/relative], or* *2) Visits least ONE location at least ONCE PER MONTH of [health facility, public meeting]*
Group membership [Module G5]	Active member of at least ONE group

[2] Malapit H, Quisumbing A, Meinzen-Dick R, Seymour G, Martinez EM, Heckert J, Rubin D, Vaz A, Yount KM. Development of the project-level Women's Empowerment in Agriculture Index (pro-WEAI). *World Dev.* 2019;122:675-92

Membership in influential group [Module G5]	Active member of at least ONE group that can influence the community to at least a MEDIUM extent
Respect among household members [Module G7]	Meets ALL of the following conditions related to another household member: *1) Respondent respects relation (MOST of the time) AND* *2) Relation respects respondent (MOST of the time) AND* *3) Respondent trusts relation (MOST of the time) AND* *4) Respondent is comfortable disagreeing with relation (MOST of the time)*
Autonomy in income [Module G8(A)]	Uses the relative autonomy index approach ("based on self-motivation theory and is a measure of internal and external motivations that determine a person's decisions") More motivated by own values than by coercion or fear of others' disapproval: Relative Autonomy Index score>=1 RAI score is calculated by summing responses to the three vignettes (yes=1; no=0), using the following weighting scheme: -2 for vignette 2 (external motivation), -1 for vignette 3 (introjected motivation), and +3 for vignette 4 (autonomous motivation)
Self-efficacy [Module G8]	"Agree" or greater on average with self-efficacy questions: New General Self-Efficacy Scale score>=32
Attitudes about intimate partner violence against women [Module G9]	Believes husband is NOT justified in hitting or beating his wife in all 5 scenarios: *1) She goes out without telling him* *2) She neglects the children* *3) She argues with him* *4) She refuses to have sex with him* *5) She burns the food*

Appendix 5 24-hr dietary recall questionnaire

VISIT INFORMATION

1.1. Respondent ID ..... ……...

1.2. Date of visit: .....|___|___| |___|___| 20 |___|___ dd/ mo./yr.

1.3. Day Food Eaten .....…… |___|

[1] Monday [2] Tuesday [3] Wednesday [4] Thursday [5] Friday [6] Saturday [7] Sunday

"I am now going to start the 24-hour dietary recall. Could you please tell me everything you ate and drank yesterday including main meals, snacks, things shared by friends or other members of the community, and anything eaten during the night. Remember by starting from the first thing you ate or drank in the morning and continue through the day until the last thing you ate in the evening or night. It may also help you to remember if you think about activities, you did yesterday starting in the morning until the end of the day. Give as much detail as possible, more detail is better"

Mealtime	**Description of Food/beverage consumed (List all foods or a combination food)**	**Source of food**	**Preparation method**	**Estimated quantity (Food models, measure)**	**Estimated quantity (g)**

Mealtime	**Description of Food (List all foods or a combination food)**	**Source of food**	**Preparation method**	**Estimated quantity (Food models, measure)**	**Estimated quantity (g)**

Mealtime	Description of Food (List all foods or a combination food)	Source of food	Preparation method	Estimated quantity (Food models, measure)	Estimated quantity (g)

Is what he/she has eaten in the past day similar to what he/she normally eats?

[ ] No [ ] Yes

If NO, why not?.....

Appendix 6 Food Insecurity Experience Scale[3]

The questions ask about food for your household. This information will help researchers, community and health leaders have a better understanding of problems facing families in this community and to develop approaches to improve food security. This information is confidential.

Response options	**Yes**	**No**	**Don't know**

During the last month….

1. …….were you worried that your household would run out of food because of lack of money or other resource to get food?

2. …did your household run out of food because of lack of money or other resource to get food?

3. …did your household lack enough money or other resource to get healthy and nutritious food?

4. …did you or any adult in your household have to consume a diet based on only few kinds of foods because of lack of money or other resources to get food?

5. … did you or any adult in your household not eat breakfast, lunch or dinner [or skip a meal] because of lack of money or other resources to get food?

6. … did you or any adult in your household eat less than you thought you should because of lack of money or other resources to get food?

7. … did you or any adult in your household feel hungry but did not eat because of lack of money or other resources to get food?

8. … did you or any adult in your household eat only one meal in a day or go without eating for a whole day because of lack of money or other resources to get food?

The following questions are for households with children five years of age or younger

9. … did any child, aged 5 or younger, in your household not eat healthy foods because of lack of money or other resources to get healthy and nutritious food?

10. … did any child, aged 5 or younger, in your household have to consume a diet based on only few kinds of foods because of lack of money or other resources to get food?

[3] ELCSA Scientific Committee. Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA): Manual de Uso y Aplicaciones. Rome: Food and Agriculture Organization. 2012.

11. … did any child aged 5 or younger in your household not eat breakfast, lunch or dinner because of lack of money or other resources to get food?

12. ... did any child, aged 5 or younger, in your household eat less than you thought he/she should because of lack of money or other resources to get food?

13. ... did you have to serve less food to any child aged 5 or younger in your household because of lack of money or other resources to get food?
14. ... did any child aged 5 or younger in your household feel hungry but did not eat because of lack of money or other resources to get food?

15. ... did any child aged 5 or younger in your household eat only one meal in a day or go without eating for a whole day because of lack of money or other resources to get food?

Appendix 7 Consent forms for focus group and survey participants

a. Informed consent (female focus group participants)
b. Informed consent (female survey participants -FBO members)
c. Informed consent (female survey participants -non-FBO members)
d. Informed consent (male focus group and survey participants

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COLLEGE OF BASIC AND APPLIED SCIENCES

Ethics Committee for Basic and Applied Sciences (ECBAS)

Official Use only Protocol number

PROTOCOL CONSENT FORM – **Focus Groups and In-depth Interviews with all categories of study participants**

Section A- BACKGROUND INFORMATION

Title of Study:	Scaling up women's Agripreneurship through public-private linkages to improve rural women's income, nutrition, and the effectiveness of institutions in rural Ghana
Principal Investigator:	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com
Co-Investigators:	University of Ghana: Naa Dodoo
	McGill University: Grace Marquis and Nii Addy
Funder:	International Development Research Centre (IDRC)
Certified Protocol Number	

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

This research activity is being undertaken to identify opportunities for improving the well-being of women in agricultural livelihoods and their households. Recently, our project staff may have interviewed you and you may have participated in a focus group discussion about women's livelihoods. If you did not previously participate in our project, you are being invited because you live or work in rural communities. Today, we would like to invite you to participate in interviews and/or focus group discussions that will help us to have a more thorough understanding about women's lives in rural Ghana and issues of concern about gender.

If you agree to participate, members of our research team will interact with you individually or in a group with other residents like yourself for up to a maximum of four times over the next two years of the project. You will be asked to give your perceptions about women's roles, gender equity, and experiences of empowerment throughout your life and in your community. Each discussion will take at most two hours of your time. So that we do not miss anything from the discussion we will tape record the discussion.

Benefits/of the study

There is no direct benefit to you for participating in the study. However, by participating, you will help us better understand how to work with local institutions to better support women in agriculture-based livelihoods.

Risk of the study

There are no foreseeable risks to you.

Confidentiality
All information from the discussions will be confidential, which means that we will not tell anyone what you say or give out any information about you. Only the research team will have access to this information; this includes the field workers who collect the information from you, translators when needed, and the staff who analyze the data. Data sets will be shared for analysis only if all personal identifiers have been removed. You will not be named in any of the oral or written reports and no reference will be made that could be linked to your information.

Compensation
You will receive a small token of appreciation, such as a cake of bathing soap for your participation.

Withdrawal from Study
You are invited to participate in this part of the research project and your participation is voluntary. You may refuse to answer any of the questions, and you may withdraw from the project at any time without any consequences. Please feel free to ask questions at any time regarding this study. You will be given a copy of this consent form.

Contact for Additional Information
If you have any questions, at any time, about the research project or procedures used in this part of the project, you may contact any of the following individuals.

University of Ghana	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com	Naa Dodoo, PhD, Regional Institute of Population Studies, University of Ghana, Legon Tel:+233-244574434 Email: ndodoo@ug.edu.gh
McGill University	Grace S. Marquis, PhD, School of Dietetics and Human Nutrition, CINE Building, Macdonald Campus of McGill University, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, H9X 3V9, Canada Tel: +1 514-398-7839, Fax: +1 514-398-1020 Email: grace.marquis@mcgill.ca	Nii Addy, PhD, McGill University Tel: +233-262800401 Email: nii.addy@.mcgill.ca

If you have any issues about your rights as a participant, you can contact the address below: Administrator, Ethics Committee for Basic and Applied Sciences, College of Basic and Applied Sciences, University of Ghana, P. O. Box LG 68, Legon – Accra, Tel: + 233 277493259, Email: ekacquaah@ug.edu.gh
In addition, if you have any ethical concerns or complaints about your participation in this study and want to speak with someone not on the research team, please contact the McGill Ethics Manager at 514-398-6831 or lynda.mcneil@mcgill.ca".

Section C- VOLUNTEER AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____
Name of Volunteer

_____ _____
Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:
I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered, and the volunteer has agreed to take part in the research.

_____
Name of witness

_____ _____
Signature of witness Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____
Name of Person who obtained Consent

_____ _____
Signature of Person who obtained Consent Date

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COLLEGE OF BASIC AND APPLIED SCIENCES

Ethics Committee for Basic and Applied Sciences (ECBAS)

Official Use only Protocol number

PROTOCOL CONSENT FORM: **Members of selected farmer-based associations**

Section A- BACKGROUND INFORMATION

Title of Study:	Scaling up women's Agripreneurship through public-private linkages to improve rural women's income, nutrition, and the effectiveness of institutions in rural Ghana
Principal Investigator:	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com
Co-investigators	University of Ghana: Naa Dodoo, PhD
	McGill University: Grace Marquis, PhD and Nii Addy, PhD
Certified Protocol Number	

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

The University of Ghana is working with local institutions to identify ways of supporting women in agriculture-based livelihoods (agriprenuers) to better manage their farming activities as a business enterprise. To do this, we need to better understand the factors that help or hinder women farmers to achieve good results in their work. We are also interested in understanding the differences between women agriprenuers who are members of farmer-based associations/organizations (FBOs) and those who are not members. As part of our engagement with women agriprenuers, we are offering women who are members of farmer-based associations/organizations in Upper Manya Krobo District, Lower Manya Krobo and Yilo Krobo Municipalities, the opportunity to participate in a poultry or vegetable inputs loan package that has been fully explained to you at information sessions recently held with your FBO. Whether you have opted for the package or not, we are inviting your participation in data collection activities that will help us to access differences and similarities between those who opted in or out of the package as well as women agriprenuers who are not members of FBOs. The findings from these data collection activities will help us make recommendations on how local institutions can better support women agriprenuers such as yourself.

If you agree to participate, members of our research team (including students associated with the University of Ghana) will interview you about yourself (e.g., your education, marital status etc.) and your family (e.g., household size, food security etc.), your livelihood activities and decision-making about your livelihood, your access to and use of services in the municipality, your on-farm and off-farm activities and details about your food intake that will be recorded on electronic tablets. We will also weigh you and take your weight,

height, waist and hip measurements to help as determine your weight status. After completing this first interview, we will visit you again in about 12 months and collect similar information from you. As part of the first interview session, you will be visited in your home on two (2) additional occasions where we will collect information on your food intake the previous day. Completing the questionnaire for the first interview session will take about one hour and a half while the two (2) additional food intake assessment days will take about 30 minutes each. In all you will be visited on two weekdays and one weekend for the first round of interactions.

Benefits/of the study

There is no direct benefit to you for participating in the study. However, by participating, you will help us better understand how to work with local institutions to better support women in agriculture-based livelihoods.

Risk of the study

There are no foreseeable risks for you for participating in this study.

Confidentiality

All information from the discussions will be confidential, which means that we will not tell anyone what you say or give out any information about you. Only the research team will have access to this information; this includes the field workers who collect the information from you, translators when needed, and the staff who analyze the data. Data sets will be shared for analysis only if all personal identifiers have been removed. You will not be named in any of the oral or written reports and no reference will be made that could linked to your information.

Compensation

You will receive a small token of appreciation (e.g., harvest basket for the farm, laundry or bathing soap, kitchen towel) for your participation in two different interview sessions.

Withdrawal from Study

Your decision participate in this research activity is completely voluntary. You may refuse to answer any of the questions we ask, and you may withdraw from this research activity at any time without any consequences. Please feel free to ask questions at any time regarding what we are doing. You will be given a copy of this consent form.

Contact for Additional Information

If you have any questions, at any time, about the research project or procedures used in this part of the project, you may contact any of the following individuals.

University of Ghana	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com	Naa Dodoo, PhD, Regional Institute of Population Studies, University of Ghana, Legon Tel:+233-244574434 Email: ndodoo@ug.edu.gh
McGill University	Grace S. Marquis, PhD, School of Dietetics and Human Nutrition, CINE Building, Macdonald Campus of McGill	Nii Addy, PhD, McGill University Tel: +233-262800401

	University, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, H9X 3V9, Canada Tel: +1 514-398-7839, Fax: +1 514-398-1020 Email: grace.marquis@mcgill.ca	Email: nii.addy@.mcgill.ca

If you have any issues on your rights as a participant you can contact the address below:
Administrator, Ethics Committee for Basic and Applied Sciences, College of Basic and Applied Sciences, University of Ghana, P. O. Box LG 68, Legon – Accra, Tel: + 233 277493259, Email: ekacquaah@ug.edu.gh

Section C- VOLUNTEER AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent for me, my child/ward to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____
Name of Volunteer

_____ _____
Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:
I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered, and the volunteer has agreed to take part in the research.

_____
Name of witness

_____ _____
Signature of witness Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____
Name of Person who obtained Consent

_____ _____
Signature of Person who obtained Consent Date

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COLLEGE OF BASIC AND APPLIED SCIENCES

Ethics Committee for Basic and Applied Sciences (ECBAS)

Official Use only Protocol number

PROTOCOL CONSENT FORM: **Women who are NOT members of famer-based associations/organizations**

Section A- BACKGROUND INFORMATION

Title of Study:	Scaling up women's agripreneurship through public-private linkages to improve rural women's income, nutrition, and the effectiveness of institutions in rural Ghana
Principal Investigator:	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com
Co-investigators	University of Ghana: Naa Dodoo, PhD
	McGill University: Grace Marquis, PhD and Nii Addy, PhD
Certified Protocol Number	

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

The University of Ghana is working with local institutions as research to identify ways of supporting women in agriculture-based livelihoods (agripreneurs) to better manage their faming activities as a business enterprise. To do this, we need to better understand the factors that help or hinder women farmers in their work. To this end we are carrying out some interactions with women agriprenuers, living in Upper Manya Krobo District, Lower Manya Krobo and Yilo Krobo Municipalities, to learn from them about their work, the challenges they face and the institutional-level supports available to them. We are also interested in understanding the differences between women agriprenuers who are members of farmer-based associations/organizations (FBOs) and those who are not members. You may have participated in discussions with someone from our team about women's livelihoods recently.

If you agree to participate, members of our research team (including students associated with the University of Ghana) will interview you about yourself (e.g., your education, marital status etc.) and your family (e.g., household size, food security etc.), your livelihood activities and decision-making about your livelihood, your access to and use of services in the municipality, your on-farm and off-farm activities and details about your food intake that will be recorded on electronic tablets. We will also weigh you and take your weight, height, waist and hip measurements to help as determine your weight status. After completing this first interview we will visit you again in about 12 months and collect similar information from you. As part of the first interview session, you will be visited in your home on two (2) additional occasions where we will collect information on your food intake the previous day. Completing the questionnaire for the first interview session will

take about one hour and a half while the two (2) additional food intake assessment days will take about 30 minutes each. In all you will be visited on two weekdays and one weekend for the first round of interactions. We will compare the information we collect from women agripreneurs who are not members of associations, such as yourself, with that of those in associations to understand differences and similarities between them.

Benefits/of the study
There is no direct benefit to you for participating in the study. However, by participating, you will help us better understand how to work with local institutions to better support women in agriculture-based livelihoods.

Risk of the study
There are no foreseeable risks for you for participating in this study.

Confidentiality
All information from the discussions will be confidential, which means that we will not tell anyone what you say or give out any information about you. Only the research team will have access to this information; this includes the field workers who collect the information from you, translators when needed, and the staff who analyze the data. Data sets will be shared for analysis only if all personal identifiers have been removed. You will not be named in any of the oral or written reports and no reference will be made that could linked to your information.

Compensation
You will receive a small token of appreciation (e.g., harvest basket for the farm, laundry or bathing soap, kitchen towel) for your participation.

Withdrawal from Study

Your decision to participate in this research activity is completely voluntary. You may refuse to answer any of the questions we ask and you may withdraw from this research activity at any time without any consequences. Please feel free to ask questions at any time regarding what we are doing. You will be given a copy of this consent form.

Contact for Additional Information
If you have any questions, at any time, about the research project or procedures used in this part of the project, you may contact any of the following individuals.

University of Ghana	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com	Naa Dodoo, PhD, Regional Institute of Population Studies, University of Ghana, Legon Tel:+233-244574434 Email: ndodoo@ug.edu.gh
McGill University	Grace S. Marquis, PhD, School of Dietetics and Human Nutrition, CINE Building, Macdonald Campus of McGill University, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, H9X 3V9, Canada	Nii Addy, PhD, McGill University Tel: +233-262800401 Email: nii.addy@.mcgill.ca

	Tel: +1 514-398-7839, Email: grace.marquis@mcgill.ca	

If you have any issues on your rights as a participant, you can contact the address below: **Administrator, Ethics Committee for Basic and Applied Sciences, College of Basic and Applied Sciences, University of Ghana, P. O. Box LG 68, Legon – Accra, Tel: + 233 277493259, Email ekacquaah@ug.edu.gh**

In addition, if you have any ethical concerns or complaints about your participation in this study and want to speak with someone not on the research team, please contact the McGill Ethics Manager at 514-398-6831 or lynda.mcneil@mcgill.ca".

Section C- VOLUNTEER AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent for me to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____
Name of Volunteer

_____ _____
Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:
I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered, and the volunteer has agreed to take part in the research.

_____
Name of witness

_____ _____
Signature of witness Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____
Name of Person who obtained Consent

_____ _____
Signature of Person who obtained Consent Date

UNIVERSITY OF GHANA

COLLEGE OF BASIC AND APPLIED SCIENCES

Ethics Committee for Basic and Applied Sciences (ECBAS)

Official Use only Protocol number

PROTOCOL CONSENT FORM – **Additional Interviews & Focus Group Discussions**

Section A- BACKGROUND INFORMATION

Title of Study:	Scaling up women's agripreneurship through public-private linkages to improve rural women's income, nutrition, and the effectiveness of institutions in rural Ghana
Principal Investigator:	Esi Colecraft, PhD, Department of Nutrition and Food Science, University of Ghana, Legon Tel: +233- 244-107633 Email: colecraft_s@hotmail.com
Co-Investigators:	University of Ghana: Naa Dodoo
	McGill University: Grace Marquis and Nii Addy
Funder:	International Development Research Centre (IDRC)
Certified Protocol Number	

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

This research activity is being undertaken to identify opportunities for improving the well-being of women in agricultural livelihoods and their households. Recently, our project staff may have interviewed you and you may have participated in a focus group discussion about women's livelihoods. If you did not previously participate in our project, you are being invited because you live or work in rural communities. Today, we would like to invite you to participate in interviews and/or focus group discussions that will help us to have a more thorough understanding about women's lives in rural Ghana and issues of concern about gender.

If you agree to participate, members of our research team will interact with you individually or in a group with other residents like yourself for up to a maximum of four times over the next two years of the project. You will be asked to give your perceptions about women's roles, gender equity, and experiences of empowerment throughout your life and in your community. Each discussion will take at most two hours of your time. So that we do not miss anything from the discussion we will tape record the discussion.

Benefits/of the study

There is no direct benefit to you for participating in the study. However, by participating, you will help us better understand how to work with local institutions to better support women in agriculture-based livelihoods.

Risk of the study

There are no foreseeable risks for you.

Confidentiality
All information from the discussions will be confidential, which means that we will not tell anyone what you say or give out any information about you. Only the research team will have access to this information; this includes the field workers who collect the information from you, translators when needed, and the staff who analyze the data. Data sets will be shared for analysis only if all personal identifiers have been removed. You will not be named in any of the oral or written reports and no reference will be made that could linked to your information.
During the focus group, all participants will be asked not to talk to others about anything in the discussions. By agreeing to participate you agree to not to talk to others about anything said. Nevertheless, we cannot assure you about the confidentiality held by other participants of the group discussions.
Written copies and the tape recordings will be stored in a protected computer and a locked cabinet in the project office until the data entering is completed. Data will be reported as a summary, no names will be used. Selected codes may be used but without names. We will assure that nothing that is published can be linked to you.

Compensation
You will receive a small token of appreciation, such as cake of bathing soap, for your participation.

Withdrawal from Study
You are invited to participate in this part of the research project and your participation is voluntary. You may refuse to answer any of the questions and you may withdraw from the project at any time without any consequences. Please feel free to ask questions at any time regarding this study. You will be given a copy of this consent form.

Contact for Additional Information
If you have any questions, at any time, about the research project or procedures used in this part of the project, you may contact any of the following individuals.

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Name of Person who obtained Consent

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Signature of Person who obtained Consent Date