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Bridging the gap in plant health systems: The role of gender-transformational advisory models in enhancing women's empowerment in agriculture

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Abstract

Background: Empowering women in agriculture is critical for enhancing productivity, improving food and nutrition security, and ensuring equitable food systems for sustainable development. However, studies have shown that social norms define gender roles in agriculture and determine who benefits from participation in agricultural activities. While gender transformative approaches target to tackle the social norms that disproportionately affect women in agriculture, the effectiveness of these in extension services is underexplored. This study examined the effectiveness of plant clinics and community conversations in empowering women in agriculture. **Methods:** The study used mixed methods to assess the effectiveness of plant clinics and community conversations in addressing social norms and contributing to women's empowerment and intra-household equality in Burundi. Content analysis, summary statistics (means and percentages) of project-level women's empowerment in agriculture index indicators, and tests of significance were employed to measure and analyse qualitative and quantitative data. **Results:** Findings showed that community conversations contributed to increased self-efficacy among women, alongside notable reductions in gender disparities and intra-household inequality. Gender parity in project households increased by approximately 71%, while intra-household inequality decreased by 41% – both improvements being nearly twice as much as those observed in control households. The interventions also significantly increased the proportion of empowered women. In project households, the percentage of empowered women more than doubled, rising from 19% at baseline to 46% at endline – a 150% increase. In comparison, the control group saw a 75% increase over the same period. Additionally, the pro-WEAI score for women in the project group improved by 15%, compared to an 8% increase among women in the control group. Despite these encouraging gains, the project had limited contribution on reducing the intensity of disempowerment among the most marginalized women. This is reflected in the disempowerment score, which remained unchanged over the two periods. Qualitative findings further revealed that persistent social norms – particularly those governing women's mobility and division of labour – continue to restrict their access to extension services, participation in training sessions, and the ability to apply new knowledge on the farm. **Conclusions:** The study underscores the importance of promoting gender-transformative approaches within agricultural extension services. Women's empowerment programs should integrate a multi-dimensional strategy that promotes gender-transformative outcomes by actively engaging both men and women in extension services. This approach should address not only visible inequalities but also the invisible architecture of gender norms.

Keywords: gender, plant clinics, equality, community conversations, extension services, gender transformative approaches

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Introduction

Extension and advisory systems in developing countries are criticized for being less gender sensitive (Ragasa *et al.*, 2013). Specifically, women farmers experience barriers in accessing agricultural information and knowledge about pests and pest control measures (Akter *et al.*, 2016). Some scholars report that technical information and communication efforts in rural areas are shaped by social norms that favour men over women's needs, resulting in gaps in women's access to extension information (Mudege *et al.*, 2015; Lamontagne-Godwin *et al.*, 2019).

The gender imbalances in access to extension information are attributed to social and cultural constructions that create inequalities in access to opportunities in agricultural education and practices (Quaye *et al.*, 2017). In sub-Saharan Africa, socially ascribed roles limit women's mobility and constrain their time, restricting them from engaging fully in activities outside their homes (Bergman Lodin *et al.*, 2019). Additionally, division of labour is deeply rooted in traditional gender roles that relegate domestic responsibilities, unpaid labour, and roles considered less critical to agricultural production to women (Evans, 2014; Bikketi *et al.*, 2016). Because of these socially constructed divisions of labour, men are more likely to access and use extension information than women (Elias *et al.*, 2014). This systemic bias limits women's access to opportunities to enhance their agricultural knowledge and diminishes their decision making power within households (Mudege *et al.*, 2017). These factors perpetuate a cycle of women's disempowerment and marginalization in agricultural development.

Gender transformative approaches (GTAs) are critical in tackling the influence of social norms on access to extension. GTAs aim to fundamentally alter normative constraints that dictate what women can and cannot do and perceptions of men's and women's roles, power, and control over household resources (Kantor *et al.*, 2015). GTAs have gained traction in agricultural extension services. The gender-transformative extension and advisory facilitation system (GT-EAFS) has emerged to ensure that the delivery of extension services benefits both men and women (Lamontagne-Godwin *et al.*, 2019). GT-EAFS is designed to systematically identify, integrate, and scale up proven positive women empowerment approaches in delivering extension services for equitable access and outcomes (Lamontagne-Godwin *et al.*, 2019). The hypothesis is that GT-EAFS would lead to a gradual socio-cultural change, resulting in gender equality and empowerment in agriculture.

Access to extension is highly gendered in Burundi, with women having disproportionately lower access than men (Nchanji *et al.*, 2023). These differences are shaped by the social construction of men's and women's roles in agriculture. While women play a crucial role in securing resources for their families, their primary responsibilities often lie in household duties and agricultural labour. Men and women differ in their objectives of seeking information from extension agents due to social expectations. These norms impede women's empowerment in agriculture in Burundian society (Basse and Kwizera, 2017).

In response to gender inequalities in extension services in Burundi, CAB International (CABI) and Institut des Sciences Agronomiques du Burundi (ISABU) deployed the plant clinic extension model to address the social norms impeding women's access to agricultural services. Plant clinics is an extension approach "where farmers who are experiencing plant health problems can take samples of their ailing crops to trained plant health extension officers (referred to as plant doctors) for free diagnosis and recommendations on how to manage the problem" (Tambo *et al.*, 2021, p. 98). Through the Plantwise program, the model integrates a gender strategy that mainstreams gender in extension services to ensure that women farmers can access plant doctors (Tambo *et al.*, 2021).

The Plantwise project also piloted community conversation (CCs) as a gender transformational approach to tackle social norms that impede women's engagement in agricultural extension activities

and empowerment in agriculture. CC was grounded in social transformative principles, bringing together diverse community members, including local administrators, religious leaders, men, women, and various age groups (Tambo *et al.*, 2021). Structured dialogues on specific challenges hindering women's empowerment in agriculture were conducted. The topics covered included issues related to unequal distribution of unpaid care work, gender-based social norms regarding women's participation in public spheres, and decision making processes in agricultural activities. Plantwise uses CC as a structured dialogue platform where both men and women participate. These conversations are held at convenient times and in accessible locations to ensure inclusivity.

The GTA had been integrated in Burundi's extension and advisory services for almost 2 years. Yet, limited empirical evidence exists on how effective plant clinics and CCs have contributed towards women's empowerment and gender relations at household level. The study explored effectiveness of CC and plant clinics on women's empowerment in Burundi.

Methods

DATA SOURCES

This empirical research uses two sets of panel quantitative data collected from Burundi in 2022 and 2023 to assess the status of women's empowerment in agriculture after 1 year of implementing CC through the Plantwise project. The study was conducted in two provinces of Burundi – Kayanza and Mwaro. In Kayanza, the selected communes were Muhanga and Matongo; in Mwaro, they were Kayokwe and Bisoro. Data collection took place at baseline in 2022 and at endline in 2023. Muhanga and Kayokwe served as intervention sites for the Plantwise project, while Matongo and Bisoro acted as control group communes.

Burundi has five agro-ecological zones – the western plains of Imbo, the steep region of Mumurwa, the Congo-Nile Divide, the Central Highlands, and the depressions of Kumoso to the east and Bugesera basin to the northeast (Baramburiye *et al.*, 2013). Kayanza and Mwaro provinces are in the Central Highlands of Burundi. These locations are increasingly experiencing pest and disease outbreaks, largely driven by climate change and farmers' limited access to research and extension services. In the selected study sites, access to plant health services is constrained not only by limited resources but also by socio-cultural practices and traditions that particularly restrict women's access. Piloting plant clinics and CC interventions is, therefore, essential to strengthen farmers' capacity in managing crop pests and diseases and to begin addressing entrenched socio-cultural barriers.

SAMPLING PROCEDURE

A multi-stage stratified sampling approach was used in 2022 to select participants for the Plantwise project, focusing on Kayokwe commune in Mwaro province and Muhanga commune in Kayanza province. The control sites were Matongo in Kayanza and Bisoro in Mwaro. This sampling method involved organizing study sites and subjects into homogeneous subgroups before selecting the final sample, allowing for adequate representation and reducing the risk of sampling bias (Kamalu *et al.*, 2024). Its flexibility enabled the use of different sampling techniques at each stage based on the specific context. The selected provinces were chosen considering their diverse agricultural conditions and the active implementation of the Plantwise project, supporting the generalization of findings to a broader range of settings in Burundi.

In the second stage, communes were purposively selected to represent both Plantwise project and control sites. Kayokwe and Muhanga were chosen as intervention areas, while Bisoro and Matongo served as controls. Stratification was applied to capture variation in agricultural practices, socio-cultural contexts, and access to agricultural services, ensuring a diverse and representative sample across the selected communes (Kamalu

et al., 2024). The stratified multi-stage sampling approach resulted in baseline (2022) sample of 385 farmers (228 in project sites and 157 in control sites). This sample size was determined to ensure sufficient statistical power to detect differences in key outcomes between project and control groups. Due to attrition, the follow-up survey in 2023 included a total of 365 farmers (186 in project sites and 179 in control sites) to assess changes between baseline and endline.

DATA COLLECTION

A quasi-experimental impact evaluation with pre- and post-assessments and involving mixed methods research design was employed to collect data from Plantwise and non-Plantwise farmers. Qualitative methods involved key informant interviews (KIIs) with plant doctors who operated plant clinics at the community level and CCs facilitators. The interview guide covered various aspects, including how technical information was communicated within villages, the functioning of plant clinics, the participation of both men and women in these plant clinics, and the social norms that prevent women from attending, along with strategies employed to address these barriers. The interview guide for the CC collected information regarding the participation of both women and men in the sessions, the themes covered, and the prevailing social norms. A total of 4 key informant interviews were conducted in Kayokwe and Muhanga communes – 2 with CC facilitators and 2 with plant doctors.

Gender disaggregated focus group discussions (FGDs) were conducted in Bisoro, Kayokwe, Matongo, and Muhanga communes. Young married individuals aged 35 years and below, as well as adult participants over 35 years old, and both men and women, participated in FGDs. At endline, eight FGDs were conducted to gather information on the gendered division of roles and to explore social norms related to unpaid care work.

The project-level women's empowerment in agriculture index (Pro-WEAI) survey tool was administered to both adult men and women in the selected households. According to Pro-WEAI guidelines, data should be collected from both dual-adult and female-only households. Female-only households consist of a single adult woman with no adult man present, while dual-adult households include both an adult man and an adult woman, each responding separately to the Pro-WEAI survey. In total, 162 dual-adult households and 41 female-only households participated in the study at both baseline and endline. This included 159 male and 206 female respondents. Approximately 89% of participants had completed primary education or lower.

The WEAI calculates three main indices – three domains of empowerment (3DE) score, gender parity index (GPI), and the Pro-WEAI score, which is the weighted sum of two sub-indices. While 3DE is calculated based on the entire sample regardless of whether women belong to a dual-adult or a female-only household, the GPI is calculated based on dual-adult households only because of the absence of an adult man against which woman's disempowerment can be compared (Seymour *et al.*, 2023). Following pro-WEAI recommendation, at least 20% of female-only households were included in the sample. This approach is grounded on the need for a sufficient sample of women-headed households to provide robust information on gender parity and empowerment.

The Pro-WEA tool collects data on three domains of women's empowerment in agriculture – intrinsic agency or power within, instrumental agency or power to, and collective agency or power with (Malapit *et al.*, 2019). A total of 10 indicators are used to measure the three domains and to calculate the pro-WEAI score (Malapit *et al.*, 2019; Seymour *et al.*, 2023). The must-have indicators for calculation of the Pro-WEAI are autonomy in income, self-efficacy, and attitude towards intimate partner violence (IPV) for intrinsic agency, input in livelihood decisions, ownership of land and other assets, access to and decisions on financial services,

control over the use of income, time use (work balance), and visiting important locations for instrumental agency, and group membership for collective agency (Malapit *et al.*, 2019; Seymour *et al.*, 2023).

DATA ANALYSIS

Content analysis was used to generate insights from qualitative data collected from FGDs and key informant interviews. Notes, transcriptions, and other textual material captured during FGDs and interviews with CC facilitators and plant doctors were systematically categorized. This process facilitated the extraction of themes and patterns from the data. Underlying meanings and a comprehensive understanding of views, perspectives, and experiences of key informants and focus group participants were generated, providing a broader picture of changes in social norms at baseline and endline. This provided a broader picture of how the CC and plant clinics contributed to women's empowerment. The pro-WEAI score, along with the 3DE, GPI, and adequacy levels across the ten empowerment indicators, were calculated using Stata statistical software. Descriptive statistics involved both summary measures (means) and percentages of pro-WEAI individual and household level empowerment indicators and indices. We also performed t-tests to test for systematic differences in empowerment and intra-household gender equality between project and control households.

Results

ADEQUACY IN PRO-WEAI INDICATORS

Table 1 presents adequacy levels in the ten pro-WEAI indicators. The results show that individuals in project households were significantly more adequate in input in livelihood decisions and access to and decisions on financial services than individuals in the control group. In contrast, individuals in control group were significantly more adequate in control over the use of income than those in project.

A particularly notable trend was observed in autonomy over income, which declined significantly ($p < 0.01$) from 76% to 48% (–28 percentage points) among individual in the project. This suggests that the project may have reshaped intra-household negotiation spaces in ways that reduced individual autonomy, reflecting either a transitional effect of the project on joint agency or new constraints (e.g., increased male oversight over women's economic activities) unintentionally introduced by plant clinics and community conversations.

Self-efficacy adequacy increased significantly ($p < 0.05$) among project households, rising from 53% at baseline to 67% at endline, but remained unchanged (45%) in the control group. The positive change in self-efficacy among project households reflects the participatory and dialogic elements of project interventions, which may have enhanced women's confidence in their own capacities to achieve agricultural and personal goals.

No statistically significant change was observed in proportions of project households with individuals adequate in attitude towards intimate partner violence (IPV) at baseline (40%) and endline (48%) and difference between control and project was marginally significant. This suggests that transforming deeply internalized social norms around IPV may require more intensive, longer-term interventions than what the current project could provide over its time frame.

Adequacy in input into livelihood decisions remained relatively unchanged among individuals in project households, with 99% adequacy at both baseline and endline. In the control group, this indicator increased slightly from 94% to 98%. However, there was no statistically significant difference between project and control households, likely because this domain was already nearing saturation. In contrast, project households saw significant

Table 1. Adequacy levels of women farmers in pro-WEAI indicators at baseline and endline for project and control groups.

	Baseline		(a–b)	Endline		(c–d)	(a–c)
	Project (a)	Control (b)		Project (c)	Control (d)		
Autonomy in income	0.76	0.79	–0.02	0.48	0.50	–0.02	0.28***
Self-efficacy	0.53	0.45	0.08	0.67	0.45	0.22***	–0.14**
Attitude about IPV	0.40	0.46	–0.06	0.48	0.35	0.13*	–0.08
Input in livelihood decisions	0.99	0.94	0.05*	0.99	0.98	0.01	0.00
Ownership of land and other assets	0.92	0.91	0.01	0.98	0.91	0.06**	–0.06*
Access to and decisions on financial services	0.70	0.55	0.15**	0.87	0.82	0.05	–0.16***
Control over the use of income	0.07	0.17	–0.10**	0.29	0.26	0.03	–0.22***
Work balance	0.84	0.79	0.05	0.92	0.94	–0.02	–0.08*
Visiting important locations	0.88	0.90	–0.02	0.95	0.83	0.12***	–0.07*
Group membership	0.85	0.75	0.09	0.80	0.74	0.06	0.04

***Difference statistically significant at $p < 0.01$.

**Difference statistically significant at $p < 0.05$.

*Difference statistically significant at $p < 0.1$.

improvements across several other empowerment domains. Adequacy in ownership of land and other assets rose from 92% to 98%; access to and decision making on financial services increased from 70% to 87%; control over the use of income improved from 7% to 29%; work balance rose from 84% to 92%; and the ability to visit important places increased from 88% to 95%. These gains suggest the project effectively addressed key barriers to women's mobility, financial inclusion, and control over productive assets.

At endline, individuals in project households were significantly more adequate than those in control households in two domains: ownership of land and other assets (98% vs 91%) and the ability to visit important places (95% vs 83%). For other domains, no significant differences were observed between the two groups.

Adequacy in group membership declined slightly in both groups – from 85% to 80% in the project households and from 75% to 74% in the control group. However, these changes were not statistically significant, suggesting relatively stable levels of collective participation over time.

AGGREGATE INDICES

Table 2 shows a significant improvement in women's empowerment, as measured by the Three Domains of Empowerment (3DE), with scores increasing from 0.661 at baseline to 0.745. In contrast, men's empowerment – reflecting power within, power to, and power with – increased more modestly, from 0.808 to 0.826. Gender equity within households also improved over the study period. The GPI rose from 0.858 at baseline to 0.898 at endline, and the proportion of households not achieving gender parity (HGPI) reduced from 59% to 39%. However, the mean empowerment gap (IGPI) among households that remained unequal widened slightly, from 0.241 in 2022 to 0.257 in 2023, indicating that while more households achieved parity, those still lagging behind experienced a slightly greater disparity in empowerment between men and women.

The overall pro-WEAI score increased from 0.681 at baseline to 0.760 at endline, reflecting a broad enhancement in empowerment. This was reinforced by a notable decline in the percentage of women not achieving empowerment – from 83% to 62%. However, the intensity of disempowerment among those still below the empowerment threshold did not change, as the mean disempowerment score (A), which “reflects the intensity of (dis)empowerment among women/men in the sample population” (Dione *et al.*, 2024), remained

Table 2. Aggregate level women empowerment indices.

Index	Baseline		Endline	
	Women	Men	Women	Men
Pro-WEAI	0.681		0.760	
5/3DE Index	0.661	0.808	0.745	0.826
Gender Parity Index (GPI)	0.858		0.898	
% Not achieving empowerment (H)	82.524	54.217	62.136	43.421
Mean disempowerment score (A)*	0.411	0.353	0.411	0.400
% Without gender parity (HGPI)	59.036		39.474	
Mean empowerment gap (IGPI)	0.241		0.257	
Number of dual households	83		76	
Number of observations	103	83	103	76

*Refers to the mean disempowerment score among only women/men who are disempowered. $5/3DE = 1 - (H^*A)$; $GPI = 1 - (HGPI^*IGPI)$.

constant at 0.411. This suggests that although more women crossed the empowerment threshold, those who remained disempowered continued to experience the same level of constraints. For men, the proportion not achieving empowerment decreased from 54% to 43%, but the change was less substantial than for women. Moreover, the mean disempowerment score for men increased slightly, from 0.353 to 0.400, indicating a small rise in the intensity of disempowerment among those not yet empowered.

Disaggregated project metrics presented in Table 3 further highlight the effectiveness of the intervention. At baseline, women in both the project and control groups had similar Pro-WEAI scores (0.699 and 0.661, respectively). By endline, empowerment among women in the project group had increased by approximately 15%, reaching a score of 0.804, compared to an 8% increase to 0.711 in the control group. Similarly, the 3DE score among project women improved from 0.680 to 0.791 – a 16% increase – while control

Table 3. Aggregate level women empowerment indices disaggregated by project participation status.

	Baseline				Endline			
	Project		Control		Project		Control	
	Women	Men	Women	Men	Women	Men	Women	Men
Pro-WEAI	0.699		0.661		0.804		0.711	
5/3DE Index	0.680	0.809	0.641	0.807	0.791	0.853	0.694	0.791
Gender Parity Index (GPI)	0.871		0.844		0.925		0.864	
% Not achieving empowerment (H)	81.481	53.488	83.673	55	53.704	37.209	71.429	51.515
Mean disempowerment score (A) [*]	0.393	0.357	0.429	0.35	0.39	0.394	0.429	0.406
% Without gender parity (HGPI)	60.465		57.5		32.558		48.485	
Mean empowerment gap (IGPI)	0.214		0.272		0.231		0.28	
Number of dual households	43		40		43		33	
Number of observations	54	43	49	40	54	43	49	33

^{*}Refers to the mean disempowerment score among only women/men who are disempowered. 5/3DE = 1 – (H*A); GPI = 1 – (HGPI*IGPI).

group women saw a more modest increase from 0.641 to 0.694 (about 8%). These improvements in both 3DE and Pro-WEAI scores among the project group suggest that interventions, such as community conversations and plant clinics, played a meaningful role in advancing women's empowerment.

Table 2 also shows a considerable reduction in the proportion of women not achieving empowerment, with a 33% decrease in the project group compared to a 15% decrease in the control group. This suggests that interventions such as plant clinics and community conversations may have helped a significant number of previously disempowered women reach the empowerment threshold. However, the project's impact on the intensity of disempowerment was minimal. In the project group, the mean disempowerment score declined only slightly – from 0.393 at baseline to 0.390 at endline (a 1% decrease). Among the control group, the mean disempowerment score remained unchanged at 0.429 across both time points. This indicates that women who remained disempowered continued to face deep-rooted challenges, highlighting persistent structural barriers to empowerment in agriculture in Burundi. Gender parity also improved more substantially in project households compared to control households. In the project group, the GPI increased by 6%, from 0.871 at baseline to 0.925 at endline, whereas the control group saw a smaller 2% improvement (from 0.844 to 0.864). Moreover, the percentage of project households without gender parity dropped from 60% to 33% compared to the control group (from 58% to 48%). These findings suggest a greater reduction in gender inequality within project households, particularly in terms of women's participation in decision making related to economic and productive activities.

INDIVIDUAL AND HOUSEHOLD-LEVEL INDICATORS

Table 3 presents changes in empowerment indicators between baseline and endline, showing significant improvements among project households. At baseline, the average empowerment scores of individuals in project households (0.693) and control households (0.671) were relatively similar and not statistically different. By endline, however, individuals in project households had significantly higher empowerment scores (0.743) compared to those in control households (0.678), with a statistically significant difference ($p < 0.01$). This improvement is likely attributable to the project's interventions. Participation in project activities also appears to have accelerated empowerment. The proportion of empowered individuals in the project group rose from 30.9% at baseline to 53.6% at endline – a 23 percentage point increase. In comparison, the control group saw a more modest rise of 7.4 percentage points

(from 29.2% to 36.6%). This suggests that interventions such as community conversations and plant clinics may have enhanced participants' influence over agricultural and household decisions, self-confidence, and participation in collective action.

Table 3 also provides indicators of gender equality and parity. These include the intra-household inequality score, which measures the difference in empowerment scores between men and women within the same household, and gender parity status, which reflects whether a household has achieved gender parity (Dione *et al.*, 2024). At baseline, project and control households had similar intra-household inequality scores (0.095 vs. 0.118). By endline, the score for project households had declined significantly to 0.056, representing a 41% reduction in gender disparity. In contrast, the control group only saw a 20% reduction (from 0.118 to 0.094). The percentage of project households achieving gender parity increased by approximately 71%, from 39.5% at baseline to 67.4% at endline. For control households, this figure rose by 21% (from 42.5% to 51.5%). The significant differences in both inequality scores and gender parity rates between project and control groups at endline suggest that the project effectively contributed to improved gender equality within households – likely by challenging and reshaping norms that historically disadvantaged women.

Table 4 highlights the project's potential effects specifically on women's empowerment. At baseline, there were no statistically significant differences between women in the project and control groups in terms of empowerment scores, intra-household inequality, or the percentage of empowered individuals and households achieving gender parity. However, by endline, significant differences emerged. Women in the project group experienced a 10% increase in their average empowerment score (from 0.656 to 0.722), compared to a 5% increase among women in the control group (from 0.618 to 0.651). The proportion of empowered women in the project group rose dramatically from 18.5% to 46.3% – a 150% increase. In contrast, the control group saw a smaller increase from 16.3% to 28.6% (a 75% improvement). The intra-household inequality score for project households (Table 5) decreased by 71% (from 0.095 to 0.056), compared to a 21% reduction in the control group (from 0.118 to 0.094). Gender parity among project households (Table 5) nearly doubled, rising from 0.395 to 0.674, while in control households it increased more modestly, from 0.425 to 0.515. These findings strongly suggest that the project positively influenced intra-household power dynamics, gender relations, and the empowerment of women, contributing to more equitable decision-making and resource access within participating households.

Table 4. Individual and household-level empowerment indicators disaggregated by participation status in the project.

	Baseline			Endline			(a–c)
	Project (a)	Control (b)	Diff (a–b)	Project (c)	Control (d)	(c–d)	
Empowerment score (average)	0.693	0.671	0.022	0.743	0.678	0.065***	–0.051**
Empowered (%)	0.309	0.292	0.017	0.536	0.366	0.170**	–0.227***
Intra-household inequality score (average)	0.095	0.118	–0.022	0.056	0.094	–0.038*	0.040**
Household achieves gender parity (%)	0.395	0.425	–0.030	0.674	0.515	0.159**	–0.279***

***Difference statistically significant at $p < 0.01$.**Difference statistically significant at $p < 0.05$.*Difference statistically significant at $p < 0.1$.**Table 5.** Individual and household-level empowerment indicators of project-participating women and non-participating women (control group).

	Baseline			Endline		
	Project	Control	Diff	Project	Control	Diff
Empowerment score (average)	0.656	0.618	0.037	0.722	0.651	0.071**
Empowered (%)	0.185	0.163	0.022	0.463	0.286	0.177*
Intra-household inequality score (average)	0.095	0.118	–0.022	0.056	0.094	–0.038
Household achieves gender parity (%)	0.395	0.425	–0.030	0.674	0.515	0.159

**Difference statistically significant at $p < 0.05$.*Difference statistically significant at $p < 0.1$.

QUALITATIVE FINDINGS: GENDERED EXPERIENCES AND SOCIAL NORMS

We also present insights derived from interviews with plant doctors and CCs facilitators, and discussions with men and women farmers in project communes to complement the pro-WEAI results. The qualitative results illustrate socio-cultural mechanisms that underpin empowerment dynamics and gender disparities in the study communes. We present themes that provide contextual depth on how project interventions influenced women's agency, participation, and gender relations within project households.

Gender dynamics in extension outreach

Extension services adopted multi-channel strategies to enhance inclusivity and reach. Yet, gendered patterns in participation and access emerged. Data collected from plant doctors and CCs facilitators provided insights into the operational aspects of plant clinics in Kayokwe and Muhanga communes and gender dynamics in farmers' participation in this extension model. Plant doctors employed a multi-channel approach as a communication and outreach effort for disseminating extension information. These efforts involved weekly meetings, church announcements, and visually engaging posters in communal areas. The rationale for the multi-channel approach was for a wider reach and inclusivity. However, there was a notably higher attendance by men than women, with plant doctors attributing it to societal norms, self-confidence levels, decision-making power in households, and perception of agriculture as a male-dominated field, especially when it is market-oriented, as noted in one of the interviews:

“Men's attendance is high for many reasons: They have the last say in the household and are self-confident. They are doing agriculture as a business, and they invest seriously with their money, so they must monitor and find solutions to any problems to succeed in their business.” – Plant Doctor, Muhanga commune.

Community conversation facilitators also utilized a broad outreach communication strategy to ensure a wider reach to the community about meetings and activities. Unlike plant clinics, CC meetings

were held fortnightly in alignment with community preferences and schedules. Additionally, there was a balanced and active participation of men and women farmers, with the CC facilitator noting that female household heads actively participated. This reflects a potentially empowering aspect of CC gatherings.

Social norms and gendered constraints in extension participation

Plant clinics and CC were designed with inclusivity in mind. However, gendered barriers persisted in terms of extension outreach and the application of knowledge. Information gathered from key informant interviews was compared to the discussions held during separate focus groups with men and women. Participants in men's and women's FGDs indicated awareness and accessibility challenges of plant clinics and agricultural advisory services in their communes. Ineffective communication and outreach and access to plant clinic locations were barriers to both men and women but felt differently based on social roles and mobility freedoms. Interestingly, the focus groups revealed that extension agents mainly relied on formal meetings convened by the local administration and direct communication to reach farmers. This focus on official channels suggests a potential gap in reaching individuals not regularly engaged with these systems, including those with limited mobility or those not involved in formal community structures.

“Men will attend because they have transport money. Women do not have the ticket money and must stay with their children. Sometimes, she could be pregnant or have a baby, and it is not good to go far away.”

Cultural norms, access to resources, and the division of labour and decision making power within households were identified as barriers to applying advice from CC meetings and plant clinics. According to the CC facilitator in the Kayokwe commune, cultural norms and household dynamics challenge the application of gender advice received from CC meetings for both men and women farmers. The CC facilitator explained that it is difficult for one spouse to apply or discuss gender-related advice if their

partner did not attend the CC meetings. In Muhanga commune, established cultural norms have been identified as a source of resistance to gender-responsive changes at the household level following men's or women's attendance at CC meetings.

"There are differences between the types of crops that men and women usually bring to the clinic. Men bring Irish potato, cassava, banana, and avocado, and women bring legumes, especially beans. Men like to bring crops that are normally sold and bring money. Women like to bring crops for consumption at home ... Because of culture and norms (around these crops and who is responsible), when it is about pesticides, it is a matter of men. Women are poorer than men; they do not have the last say in the household and in terms of time use. If the pharmacy is far, it becomes more difficult for women to go there." – Plant doctor, Kayokwe commune

Transformation of social norms and gender empowerment: *Changing gender norms and empowerment pathways*

The most pronounced qualitative shifts observed relate to evolving social norms and behavioural change concerning gender roles in agricultural decision making. Discussions with both men and women FGDs indicated an increased awareness of gender disparities in agriculture and the importance of women's participation in decision making processes.

"Before, we thought farming was just men's work, but now we see it is for us too. We discuss what crops to plant and how to manage our fields together." – Woman FGD, Muhanga commune

"I never knew I could have a say in selling our crops. The CC meetings showed me that my opinion matters in our household decisions." – Woman FGD, Kayokwe commune

"The CC sessions have opened up new conversations in our community. Men and women are starting to see each other as equal partners in agriculture." – Plant Doctor, Muhanga commune

These qualitative narratives reflect gradual normative shifts aligned with the observed quantitative improvements in women's empowerment, particularly in domains such as self-efficacy, joint decision-making, and control over productive assets.

Discussion

The study assessed the contribution of plant clinics and CCs to women empowerment. Findings showed improvements in self-efficacy alongside a reduction in gender parity gaps and intra-household inequality. The positive change in these indicators suggests that the dialogic and participatory elements of the project interventions possibly enhanced individual confidence and self-perception of agency. This aligns with earlier findings of Ghosh *et al.* (2019) and Turyasingura and Chavula (2022) who found that interventions that focus on collective, rights-based, and inclusive engagement approaches have higher propensity to shift internalized beliefs and enhance women's participation in agriculture. This observation was further supported by qualitative finding that participation of men and women CCs enabled them to start acknowledging their roles in agriculture and recognizing the importance of collaborative decision making. Such normative changes are critical enablers of empowerment and gender equality.

Findings also show that gender interventions in the delivery of extension and advisory services increased the proportion of women achieving empowerment, significantly contributed to improvements in 3DE, and enhanced the overall women's empowerment. Specifically, plant clinics and CCs were effective in increasing proportion of empowered women and the extent to which they (individuals) were adequate in indicators of intrinsic, instrumental, and collective agency. Despite these improvements, the disempowerment score remained unchanged over the two period, suggesting that a large percentage of disempowered individuals, especially women, continued to experience high intensity of disempowerment. This finding indicates that although project interventions were effective in lifting some women above the empowerment threshold, the contribution to reduction of

disempowerment intensity among the most marginalized was limited. This could be attributed to structural constraints that remain deeply embedded in the study context as highlighted in the qualitative results. According to Cornwall and Rivas (2015) multi-dimensional and sustained interventions are required to achieve deeper, lasting empowerment among the most marginalized.

Third, although the interventions improved individual adequacies in instrumental agency indicators its effect on intrinsic agency was mixed. While the intervention positively impacted self-efficacy, there was a 28% decline in autonomy over income among project participants. This suggests gains in one indicator or domain of empowerment may trigger renegotiations in household dynamics that potentially constrain gains in other areas, an observation documented by past studies. Significant increase in self-efficacy and in favour of project participants suggests that the interventions model improved women's confidence in their agricultural skills and knowledge through direct access to information, training, and resources, possibly empowering them to make more informed decisions about crop production and plant health issues (Tambo *et al.*, 2021).

Nonetheless, the mixed findings with respect to project participants being better off or adequate than the comparison group (e.g., self-efficacy, input in livelihood decisions, ownership of land and other assets, access to and decisions on financial services, and work balance/time use) or worse-off in some indicators than non-participant (autonomy in income and control over the use of income) at endline suggests that increased visibility of women's economic participation could have led to increased male oversight or appropriation of income (Cornwall and Edwards, 2010; Ragasa *et al.*, 2019). This underscores the importance of designing empowerment programs with attention to household power asymmetries and the potential for backlash.

Fourth, adequacies in group membership and attitudes towards IPV were relatively stable between baseline and endline. This suggests that improvements in these indicators require longer timeframes and more intensive social norm change interventions to address the deeply internalized beliefs, particularly around violence and collective action. These indicators possibly remained resilient to change over short-term program cycle of measuring the effectiveness of the project interventions (Edström *et al.*, 2015). The quantitative finding was also underpinned by qualitative narratives that highlighted persistent social expectations around women's mobility and division of labour that potentially restricted their ability to access extension and training sessions or apply what they learned.

Furthermore, gender parity among project households increased by approximately 71% while intra-household inequality declined by 41%. The project may have reconfigured gender power relations through plant clinics extension session or CCs that were effective in promoting inclusive decision making and reducing gender-based disparities within households. These findings support the argument made by Kabeer and Natali (2013), van den Bold *et al.* (2015) that promoting inclusive decision making and reducing gender-based disparities requires well-targeted community interventions that actively engage both men and women in reshaping household norms and responsibilities. However, the slight increase in the empowerment gap among households that remained unequal reveals that gender disparities at the household level may even intensify when empowerment and gender equality programs adequately promote active participation of both men and women (from the same household) in the interventions.

The study also confirms findings of previous studies on the effects of social norms on women's access to extension and advisory services and participation in decision making (Bergman Lodin *et al.*, 2019; Elias *et al.*, 2014; Mudege *et al.*, 2017; Quaye *et al.*, 2017) and the rationale of mainstreaming gender in delivery of extension services to challenge the norms (Kantor *et al.*, 2015; Lamontagne-Godwin *et al.*, 2019). We found that although both men and women

farmers recognize the effect of gendered social norms on women's well-being, rigid social norms prevent them from taking active steps towards change. Additionally, our results indicate that social norms influence the types of crops that men and women engage in, with men controlling cash crops. In contrast, women's role is limited to food crops for home consumption.

While the study demonstrates the effectiveness of inclusive extension and CCs approaches for women's empowerment and gender equality within households, future studies should consider its limitations to ensure that gender equality and social inclusion programs addresses both visible inequalities and the invisible architecture of gender norms. First, the study was primarily based on the pro-WEAI framework that quantifies visible dimensions of gender inequality but less equipped to detect subtle and latent changes that underlie power relations and gender asymmetries and shape empowerment pathways.

The effectiveness of CCs and plant clinics was measured over a relatively short implementation period. This possibly prevented detection of normative shifts and determining of whether the realized positive empowerment and gender equality outcomes were sustained over time. This possibly explains why indicators such as attitude toward IPV, autonomy in income, group membership, or control over the use of income remained unchanged between baseline and endline. Additionally, the study did not systematically assess intersectional vulnerabilities (e.g., socio-economic characteristics of individuals) highlighted in literature (Garutsa, 2021; Tavenner *et al.*, 2022; Rao *et al.*, 2025) as being critical in shaping constraints to empowerment and gender equality. Thus, future studies must consider complementing pro-WEAI indicator with gender transformative indicators for deeper assessments of the impacts of GTA on temporal changes in empowerment and gender equality outcomes.

CONCLUSION

The study provides evidence on how combining innovative extension service models (e.g., plant clinics) and GTA (e.g., community conversations) can advance women's empowerment in agriculture and gender equality. Findings show that plant clinics and CCs contributed to significant improvements in individual and household-level empowerment outcomes, enhanced gender parity within households, and reduced intra-household inequality.

The contribution of the project on intrinsic agency indicators was mixed. While adequacy in self-efficacy significantly improved, attitude towards IPV remained relatively stable and autonomy in income declined. Additionally, the intensity of disempowerment among individual who remained below empowerment cutoff did not improve. Qualitative findings identified entrenched social and gender norms as explainers of the persisting constraints to women's access to agricultural extension services and promotion of women's empowerment while mitigating unintended reinforcement of traditional hierarchies. Notwithstanding, there were reported indications of gradual changes in norms, shifts towards collaborative decision making, and increasing recognition of women's contributions to agriculture. Therefore, GTA should integrate a multi-dimensional strategy to promote gender-transformative outcomes. This could be achieved by actively engaging both men and women in CCs and extension services to address visible inequalities and the invisible architecture of gender norms.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

ETHICS STATEMENT

A consent statement was read to all participants prior to completing the survey and subsequent interviews were only completed with those who gave their consent.

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AUTHOR CONTRIBUTIONS

BT conceived and designed the study. WNO, CN, EH, PN, and IM all contributed to critical early stage thinking, design, and development of the survey tools. BT, EH, LN, IM, FM, MB, and MBH conducted field survey work and trained enumerators. IM, FM, MB, SP, and BM contributed late stage thinking. OIA led data analysis with inputs from AO and CL. EN provided logistical support for the study. JV, WNO and CN supervised the entire process and provided guidance. OIA with inputs from AO and CL drafted the initial manuscript. All authors checked and edited the final manuscript.

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DATA AVAILABILITY

All data generated or analysed during this study are included in this published article.

CONSENT FOR PUBLICATION

Not applicable.

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