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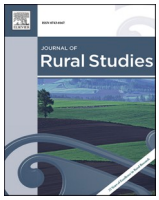

Empowerment unveiled: Gender dynamics and the impact of nutrition-sensitive agriculture interventions among ethnic minority groups in northern Vietnam

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ABSTRACT

Gender equality and women's empowerment are key global agendas, yet women often face marginalization compared to men. Nutrition-sensitive agriculture interventions (NSAs) often aim to benefit women but their impacts on women's empowerment remain unclear. This study focuses on: 1) assessing the empowerment levels of women and men from three ethnic minorities in rural northern Vietnam (Thai, H'Mong and Dao) with the Project-level women's empowerment in agriculture index (Pro-WEAI); 2) examining the potential of NSA to improve women's empowerment during COVID-19 pandemic; and 3) applying an intersectional lens by analyzing how empowerment and treatment effects vary by ethnic subgroups. We conducted a Randomized controlled trial (RCT) involving around 600 rural households from 36 clusters that were randomly assigned to one of the following three treatment arms: receiving agriculture and nutrition training; receiving seed provision on top of the training; and a control group. We found that both men and women experienced disempowerment, due to ethnicity and systemic ethnical marginalization. While no significant gender discrimination in resource access was found, women faced limited mobility, overburdened workload and diminished agencies. Empowerment experiences varied across ethnicities. The NSAs improved women's mobility and group membership, yet carried different implications across ethnicities, potentially due to the interaction between the intervention, initial contextual conditions and the COVID-19 pandemic. Nevertheless, NSAs alone cannot achieve structural empowerment. Meaningful and lasting empowerment requires integrated approaches that address interconnected social, political, and cultural factors.

1. Introduction

Despite their important roles in agricultural production and caregiving within the family, women in rural area tend to encounter more systematic marginalization than men. They lack access to education and training, constraining them contributing to livelihood decisions and voicing their needs and aspirations (UNICEF, 2022). Women in farming communities also face gender discrimination in land ownership, land access, and financial access (Adekola et al., 2013; Muli, 2018). Consequently, these women often experience lower agricultural productivity than their male counterparts (Ali et al., 2016). Evidences in Vietnam shows that, controlling for other factors, men can obtain 2 % more credit than women, indicating gender discrimination in credit markets (Tran et al., 2018); and that rice productivity of male-headed households is 10 % higher than female-headed households (Van Tran et al., 2019). These inequalities contribute to women's greater vulnerability to poverty and

Abbreviations: Pro-WEAI, Project-level women's empowerment in agriculture index; A-WEAI, Abbreviated women's empowerment in agriculture index; NSA, Nutrition-sensitive agriculture Intervention; 3DE, Three domains of empowerment; GPI, Gender parity index; HN, Health and nutrition module; ITT, Intent to treat treatment effect; LATE, Local average treatment effect.

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food insecurity (Tibesigwa and Visser, 2016).

Given this context, rural development projects increasingly integrate gender objectives, particularly within nutrition – sensitive agriculture interventions (NSAs) (Santoso et al., 2019). NSAs are designed for rural households that rely on farming for both food and income. They include projects such as nutrition education, promoting agrobiodiverse farming systems, including homestead gardening or agroecology, or promoting biofortified crops. By changing women's nutrition knowledge or foods available for consumption within the household, these projects could enhance women's bargaining power in intra-household resource allocation, which in turn could lead to larger investments in family health and nutrition (Waid et al., 2022).

In this study, we used data from an experimental evaluation of an NSA implemented among ethnic minority groups in rural northern Vietnam to increase our understanding of, how, and under which conditions NSAs can contribute to women's empowerment. Specifically, this paper aims to address the following three main objectives: 1) to assess women's and men's empowerment status; 2) to estimate the impact of an NSA on women's empowerment, which mainly targeted women but did not have a specific empowerment component; and 3) to examine heterogeneity of empowerment and treatment effects across ethnicities. While the heterogeneity analysis of treatment effects is not intended to establish causality, it helps to unpack the mechanisms of impact and illustrate how program outcomes may differ depending on social and cultural contexts.

To capture empowerment, we applied the Project-based women's empowerment in agriculture index (Pro-WEAI). Measuring empowerment is challenging, as past studies have used more than 200 different indicators across 69 papers in NSAs context alone, complicating the synthesis and impeding the development of a comprehensive understanding on empowerment (Santoso et al., 2019). The International Food Policy Research Institute (IFPRI) developed the Pro-WEAI offering a standardized and culturally adaptable approach. The index was developed based on Kabeer's definition of empowerment as 'the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them' and comprises 10 main and two optional sub-indicators covering three domains of agency: intrinsic (power within), instrumental (power to), and collective agency (power with) (Kabeer, 1999; Malapit et al., 2019). The index is constructed using individual-level data collected from male and female household members. The tool has been used and validated in thirteen projects spanning South Asia and Africa (Malapit et al., 2019). By measuring men's and women's empowerment simultaneously, Pro-WEAI enables us to distinguish gender-specific disempowerment from broader community – level disempowerment.

We make three contributions to the literature. First, we improve the understanding of empowerment among rural ethnic minorities, a group underrepresented in empowerment research (Santoso et al., 2019). In rural northern Vietnam, ethnic minorities continue to face chronic poverty and undernutrition, social and economic exclusion (World Bank, 2009). Women in these communities are further disadvantaged by a strongly patriarchal culture rooted in Confucian ideology, which frames them as 'low value', while men are seen as breadwinners (Thi et al., 2022). On the other hand, another body of literature challenges this narrative, proposing that in various ethnic minority and indigenous settings, women hold 'separate but equal' status (Long, 2008; Mikell, 1997; Sarah, 2017). Therefore, further analysis is necessary to deepen our understanding of empowerment among these groups, suggesting a more nuanced view of their societal roles and contributions.

Second, we enrich the knowledge of how rural development interventions can empower women, which vary across empowerment dimensions and context. NSAs may enhance agency in productive activities (Bushamuka et al., 2005; Waid et al., 2022), but show limited impacts on health care, family planning, or perception of gender equality (Heckert et al., 2019; Olney et al., 2016), and some cases increase women's workloads (Margolies et al., 2023). Outcomes are highly context-dependent, shaped by factors such as baseline empowerment level, local perception of empowerment, and intervention design (Santoso et al., 2019). The COVID-19 pandemic adds another layer, offering a unique lens on how women's empowerment may shift under external shock, interacting with the interventions. Therefore, it is important to investigate the effects of NSAs in the relatively unexplored context of Vietnam's minority groups during this special time.

Third, we contribute to the growing literature highlighting the importance of intersectionality in shaping outcomes of rural development projects (Banerjee et al., 2023; Nichols, 2021). Intersectionality underscores how overlapping social identities create distinct experiences of privilege and disadvantage (Yuval-Davis, 2006). Yet, many studies treat ethnic minorities as a single homogeneous category, which risks masking important variations in intervention impacts (Cuong et al., 2015; C. D. Nguyen and Tran, 2024). By disaggregating NSA effects by ethnicity, we show how outcomes carry different implications across social and cultural contexts, revealing the specific conditions under which empowerment is (not) achieved.

In the remainder of this manuscript, we start by describing the methods used and explaining the possible mechanisms through which our NSA can change women's agency. We then present the characteristics of respondents and test whether observable characteristics are balanced between treatment and control groups, followed by an analysis of men's and women's empowerment in our sample, and the treatment effects of the NSA on empowerment. The final section concludes.

2. Background and the nutrition-sensitive agriculture intervention (NSA)

2.1. Background

Vietnam is home to 54 ethnic groups with distinct languages and cultural traditions. The majority group, the Kinh, makes up about 85 % of the population, and is concentrated in lowland and coastal areas (GSO, 2019). Ethnic minorities typically reside in upland and mountainous areas, with less access to infrastructure, health services, and education compared to the Kinh. In 2020, one-third of ethnic minorities lived in poverty compared to just 1.3 % of the Kinh (World Bank, 2022). They are less likely to have wage jobs and earn lower incomes in both agriculture and other sectors (Demombynes and Testaverde, 2018; Tuyen, 2016). They also have weaker positions in agricultural markets, where Kinh traders dominate market linkages even for niche commodities like high-value exotic crops (World Bank, 2019). These disadvantages are compounded by low formal education, language barriers, inadequate infrastructure, and pervasive ethnic prejudices from the Kinh population exacerbate these challenges (Imai et al., 2011). Gender issues are also a challenge. A study conducted by UN Women (2021) highlighted that ethnic minority women are less likely to enter the labor market and more likely to engage in unstable and vulnerable jobs. This study also reported widespread violence against women within these communities. Child marriage is widespread, with severe consequences for women's economic opportunities and wellbeing (Kawarazuka et al., 2019; Trang and Ngoc, 2024).

Our study took place in rural area of two mountainous districts in Vietnam, Mai Son in the Son La province, and Sa Pa in the Lao Cai province (Fig. 1). These two regions were chosen because they have favorable conditions for horticulture and are rich in agrobiodiversity, which suggests high potential benefits of implementing NSAs to promote dietary diversity through crop diversity. Agriculture underpins the key livelihoods in the study areas, with vegetables and legumes playing a central role in farming systems and diets. Ethnic minorities are considered custodians of Vietnam's agrobiodiversity, maintaining diverse landraces alongside new varieties. Favorable climatic and agronomic conditions allow year-round cultivation of vegetables and legumes, though seasonal variation persists. Production is primarily for household consumption, while any surplus is sold in local markets, making

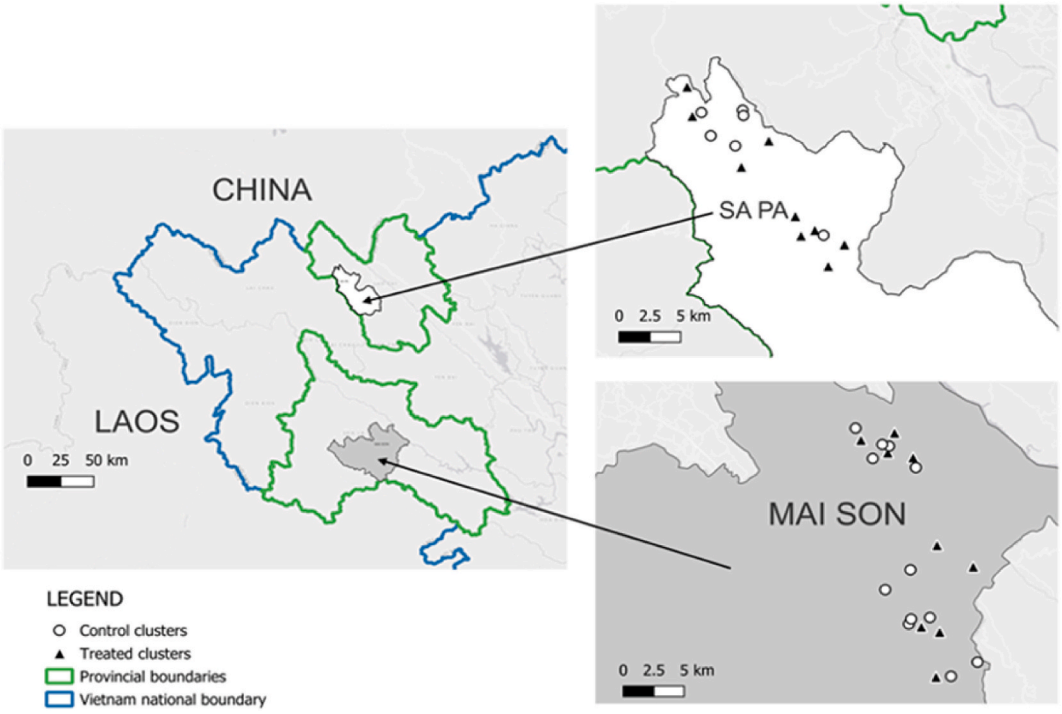

Fig. 1. Study area, and treated and control clusters.

small-scale commercial horticulture an important rural livelihood strategy.

We focused on three ethnic groups: the H'Mong, Thai, and Dao, who form the majority in these regions. The Thai reside in Mai Son, the Dao exclusively in Sa Pa, while the H'Mong reside in both districts. Although all three groups share common challenges as ethnic minorities, their socio-economic trajectories and cultural dynamics differ. The Thai are often considered the most economically successful minority group (World Bank, 2019). Their advantage stems from long-standing integration with the Kinh majority, shared linguistic roots, and adaptive strategies that improved their economic standing and reduced ethnic prejudice (Hiwasaki and Minh, 2022). The Dao and H'Mong, by contrast, migrated later from Southern China, and share the same language family. Both south to preserve their cultural identity, but with different approaches. The Dao gradually compromised and integrated with the majority, improving their economic position in recent years (UNDP, 2018). The H'Mong, however, maintain a strong ethnic identity and relative isolation, which has persisted which has persisted despite government investment in physical and economic integration (Michaud, 2012; Turner, 2012).

Gender norms also vary across groups, but consistently disadvantage women. The issue is especially pronounced among the H'Mong, with high rates of child marriage, around 60 % compared to 26 % among ethnic minorities. Overall (UN Women, 2021). Women's participation in livelihood projects is limited, and household decision-making is strongly male-dominated (DeJaeghere et al., 2024). Thai households display comparatively the most gender-balanced across the three groups, at least instrumentally (DeJaeghere et al., 2022). The Dao occupy an intermediate position regarding instrumental empowerment, and women show greater participation in community activities than the H'Mong (DeJaeghere et al., 2024). Regarding mobility, Thai women generally enjoyed greater freedom of movement, particularly within their communities, while Dao and H'Mong women faced more restrictions. Among the H'Mong, for instance, women need to seek their husband's permission before traveling anywhere (L. T. T. Nguyen et al., 2025a).

The Women's union, the Communist youth league, and the Peasants' union are the most active at the village level. While official missions of these organizations are to ensure political alignment, they also foster collective identity and implement poverty reduction initiatives (London, 2022). Among them, the Women's Union appears to have a lighter political agenda, acting more like a non-governmental organization (H. T. Nguyen and Rydstrom, 2022). They are highly active in implementing various poverty reduction programs for their members and occasionally provide additional access to preferential credit programs or microcredit schemes when funding is available.

2.2. *The Nutrition-sensitive agriculture intervention (NSA)*

This study draws on quantitative data from a clustered Randomized Controlled Trial (RCT) originally designed to evaluate the impact of a Nutrition-Sensitive Agriculture intervention (NSA) on crop and dietary diversity among ethnic minorities in two regions (L. T. T. Nguyen et al., 2025b). The NSA centered on the establishment of Community dietary diversity clubs, which promoted the consumption of diverse diets through increased intake of vegetables and legumes.

The intervention was suggested to local government after a 2018 mixed-methods study confirmed challenges in achieving dietary diversity in the region. The intervention was further refined through consultations with district and commune authorities throughout the first months of 2020. It aims at encouraging diversifying consumption of vegetables and legumes, as well as applying some simple environmentally friendly vegetable cultivation techniques and self-seed saving. Club members participated in eight monthly agricultural and nutrition training sessions (60–90 min each), covering dietary diversity, food groups, micronutrients, participatory cooking, vegetable and seed production, food budgeting, and food shopping. Sessions were interactive, led by field assistants from the Alliance of Bioversity and CIAT, and local facilitators. Participants received travel allowances, and training frequency was planned as once per month.

Training materials were designed by the researchers and one field consultant, who ran a similar intervention among the Thai. Given that literacy could be a significant barrier to knowledge acquisition among club members, training materials were tailored for accessibility. These included podcasts in native languages, visual posters summarizing

agricultural and nutrition messages, and illustrated booklets with culturally relevant layouts, ethnic imagery, and minimal text. Training materials were refined throughout the implementation upon feedback from participants and facilitators. Each participant received booklets and posters to display at home and participants were encouraged to discuss them with literate peers or family members to reinforce learning.

Facilitators were selected by the local Women's union, resulting in 16 female facilitators who are heads of village women's unions, and two male village chiefs. These facilitators were trained by the researchers through a three-day district-level Training of trainers (TOT) session, followed by a one-day refresher at the commune level. Facilitators received reimbursements equivalent to one daily local wage for their time and phone usage for each training session.

A second treatment aimed to improve access to diverse seeds. The vegetable and legume types were selected using baseline data, which the research team used to identify nine under-consumed vegetable and legume types in each study region. The selected crops were validated with communal leaders to ensure farmers would be able to grow them in their respective commune. While this approach may not fully reflect farmers' preferences as a participatory method would, it streamlined the process by reducing the time and effort needed to consolidate diverse demands across villages given our resource constraints. Moreover, farmers still had a choice, as they were allowed to select seeds of five crop types from the given list of nine. This strategy not only enabled some degree of preference expression but also increased the perceived value of the seeds by making opportunity costs more salient. In turn, this helped mitigate potential spillover effects from seed sharing between recipients and non-recipients, which endline data confirm to be rare (Makarina et al., 2019; L. T. T. Nguyen et al., 2025b). Seed recipients received individual supervision and assistance through phone calls or home visits from field assistants.

Interventions spanned 10 months from March 2021 to January 2022, amidst Vietnam's COVID-19 pandemic (Fig. 2). In response to the pandemic, the national government applied a unique track and trace policy, targeting confirmed cases, and high risk individuals, including close contacts of the infected individuals and travelers from high risk areas. These individuals were either mandated to self-quarantine or enter centralized quarantine (Van Nguyen et al., 2021). This policy minimized national locked downs by focusing on high-risk communities, enabling economic activities to continue. However, it also created substantial social stigma, as those labeled high-risk often judged and discriminated, leading many refrained from attending social gatherings or traveling (Trinh et al., 2022). Stigma eased over time as infections rose, more information about the virus became available, and the health effects proved less severe than feared. Amid this shifting context, the team adapted training schedules in coordination with local authorities and facilitators, and provided online support when needed (Fig. 2).

The NSA was well received by the participants, as demonstrated by relatively high participation rates, with 86 % of eligible households joining at least one training session, and 74 % joining at least three training sessions. These rates were equivalent to those among H'Mong and Thai communities (Table D.1, Appendix D). Despite these efforts, the interventions demonstrated limited meaningful impact on dietary diversity and crop diversity, the two primary outcome variables. The underlying factors contributing to these results are complex and are analyzed in detail in a companion paper (L. T. T. Nguyen et al., 2025b).

2.3. Expected mechanisms of impact

It is essential to note that the intervention was not explicitly designed with a primary focus on capacity building in women's empowerment or gender equality. Rather, its central objective was to benefit women, who formed the majority of club members, by providing training and agriculture and nutrition, as well as seed access. We conceptualize women's empowerment as a dynamic process, in which resources enable women to have agency, or the ability to make decisions, and through this agency, women can achieve desirable outcomes (Kabeer, 1999). We thereby focus on three domains of agency: intrinsic agency (power within), instrumental agency (power to), and collective agency (power with). Defined in this way, the intervention could enhance women's empowerment through several pathways.

By equipping women with practical knowledge, skills, and resources, the intervention can strengthen their instrumental agency, enabling greater participation in decision-making processes, especially the production decisions (Kumar et al., 2021; Ragasa et al., 2023). Group-based trainings foster collective agency, as women learn and work together in club settings, providing opportunities to share experiences and support one another, creating opportunities for collective action (Nichols, 2021). Moreover, the intervention may improve women's self-efficacy, as skill development and peer support can boost their confidence and belief in their capabilities (Mathur and Agarwal, 2017).

However, NSAs can also have adverse effects on women's empowerment. For example, they may increase women's workload, adding strain to their daily responsibilities (Gerber et al., 2024). Furthermore, participation in such interventions, especially in conservative gender contexts, can provoke backlash from spouses or other community members (Alemu et al., 2018). This resistance can undermine their intrinsic agency, reducing their sense of autonomy and self-determination.

We apply an intersectional lens as NSAs may produce different impacts across ethnicities, depending on their social and cultural context. Uptake and participation are not uniform but vary across communities, shaping the extent to which interventions translate into empowerment (Di Prima et al., 2022). Even when NSAs generate similar measurable outcomes, these results can carry different meanings and implications. For instance, a group-based approach may strengthen collective agency in communities with traditions of communal labor, but could be exclusionary in settings where social hierarchies and structural inequities are deeply entrenched (Nichols, 2020). Likewise, what appears as a modest gain in women's public participation may be highly significant in contexts where women's voices are traditionally restricted (DeJaeghere et al., 2024). Such variations risk being overlooked without an intersectional perspective.

3. Methodology

3.1. Sampling

We stratified 36 clusters by ethnicity and distance to urban markets, factors likely to influence dietary diversity and women's empowerment. Half of the clusters in each stratum were randomly assigned to treatment and half to control. Community diet diversity clubs were established in 18 treatment clusters. We randomly invited 20–30 households in treatment clusters, and 10–12 households in control clusters to send a member with knowledge of vegetable production and food preparation to join the survey (Fig. 2). Those in treatment clusters also received the invitation to join the clubs. Randomization was based on residence lists provided by village chiefs. At baseline, 584 respondents in 36 villages[1] were recruited.

For the second treatment, we selected half of the club members to be the seed recipients by a lottery game. The game was organized in the first meeting session. Other club members received cooking spices and soap with equal value (approximately US $5, about 75 % of average

[1] The chosen villages should have favorable conditions for horticulture, not have similar projects aiming at promoting either nutrition or crop diversity in the past two years, and not be considered politically sensitive by the local government. 38 villages qualified, we initially randomly selected 36 due to available funding. However, due to the changes in the administration border and the potential risk of spill-over effect, we finally included all 38 qualified villages.

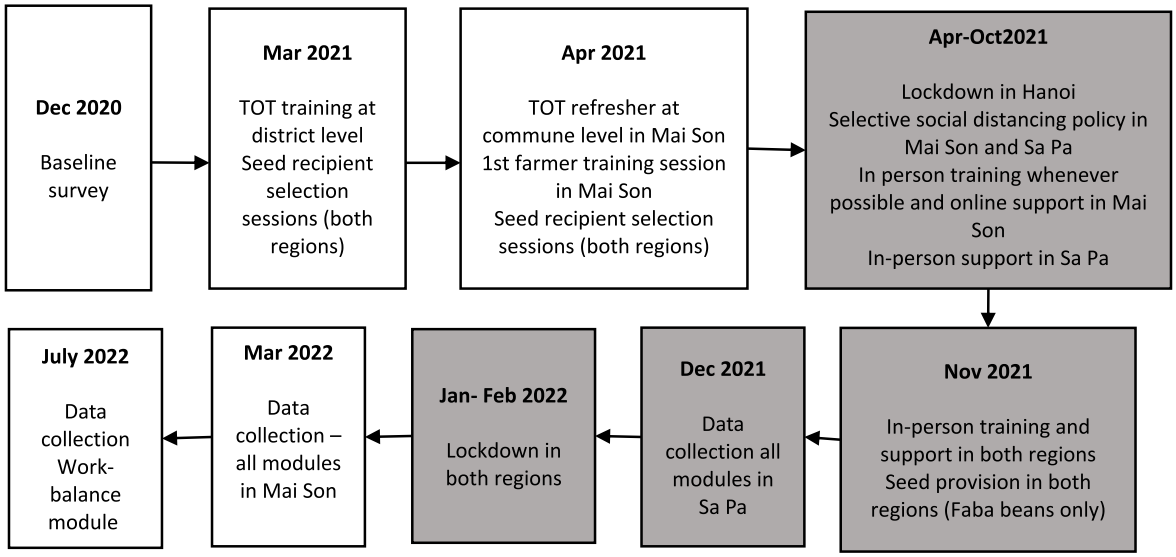

Fig. 2. Implementation timeline of the Randomized Controlled Trial, including major Covid-19 pandemic related restrictions and events and related changes of meetings from in-person to online etc.

daily wage).

However, after baseline survey, we found that the proximity of certain villages raised concerns about potential spillover effects. We grouped adjacent villages within the same treatment into one cluster, and added two villages. As a result, the study included 38 villages, grouped into 36 clusters. During the project, administrative boundary changed displacing 23 households from three villages outside their designated village areas. To maintain sample size, 58 additional households were randomly recruited. Both displaced and replaced households were invited for treatment and were included in the endline sample.

3.2. Data collection and questionnaire

Data collection occurred before and after the intervention. Baseline data were collected in December 2020, and endline data were gathered in December 2021 in Sa Pa and between March and April 2022 in Mai Son. An additional survey in July 2022 collected data on work-life balance from the Pro-WEAI for all female respondents and a randomly selected half of all male respondents who completed the first round of our endline survey, due to budget constraints. This decision accounted for expected seasonal variation in the indicator.

The endline survey schedule was adapted to comply with provincial COVID-19 social distancing regulations. At baseline, we interviewed one household member per household, preferably the individual most knowledgeable about food production and preparation. At the endline, we interviewed the baseline respondent and their spouse. If the spouses were unavailable during the visit, we recruited another adult in the household with the same gender as the unavailable spouse. If there were multiple eligible and available, we let the households decide, and typically, they selected the oldest household member. Although empowerment data were not collected at baseline, this does not affect the validity of impact estimates of the NSA on women's empowerment. A randomized trial does not require baseline data because random assignment ensures that treatment and control groups are comparable on average before the intervention, so any differences observed at endline can be attributed to the intervention rather than potential selection bias. Baseline data are useful for improving precision, checking balance, and addressing issues like attrition, but they are not required to obtain an unbiased impact estimate (White, 2013).

The response rate was high, with a non-response of less than six percent compared to the intended sample, and we successfully administered 1149 interviews (with 602 women and 547 men). Men were more difficult to reach. Of all those who are absent, 32 % refused to participate in the interviews, and 44 % travelled for off-farm jobs or forestry work. In the second endline round (July 2022), we reached 503 women and 271 men. For those interviewed only once, we used the single round available. For respondents interviewed twice, we used both rounds to calculate work-life balance; otherwise, we used the single available round and used it as imputation for missing values. To test the robustness of this approach, we estimated the treatment effects of imputed values of work balance for each survey round (Table F.1, Appendix F).

To ensure privacy, respondents were interviewed individually, without the presence of household members or neighbors. Enumerators were matched to respondents by gender and ethnicity to minimize social distance and create a more comfortable interview environment. Questionnaires were not translated into ethnic minority languages in written form because Dao and Thai enumerators could not read their native scripts, and H'Mong enumerators preferred reading Vietnamese, the language of their formal education. However, interviews were conducted in respondents' native languages unless they were more comfortable with Vietnamese.[2]

Empowerment was measured using the core Pro-WEAI tool and adapted Nutrition module, which was adapted from a Health and nutrition module (HN) developed by IFPRI to collect data for projects with nutrition and health targets.[3] The Nutrition module has recently

[2] To ensure enumerators use consistent phrasing across different languages and dialects, we trained enumerators from all ethnicities together in Vietnamese, to make sure that they understood the core meaning of each concept. Enumerators from different ethnic groups were grouped to conduct the mock interviews. They were also asked to report daily to the researchers any nuances and difficulties that they faced when conducting the interviews, especially when explaining terms and concepts to respondents.

[3] The questionnaires were pre-tested in Mai Son with a small cohort of ten households in October 2021, focusing on refining the Vietnamese version of the questionnaire. Our enumerators underwent a comprehensive three-day training program, which included two and a half days of in-door training, and a half-day field testing. During the training sessions, the enumerators orally adapted the questionnaire to the ethnic minority languages. Data was collected using SurveyCTO.

been validated in three countries in Asia and Africa (Heckert et al., 2023). As our project primarily focused on nutrition, we only utilized the women's and children's nutrition items and excluded all questions on health issues. To mitigate survey fatigue, we used only 10 core Pro-WEAI indicators required for calculating the overall empowerment score. We excluded two optional indicators, 'Respect among household members', and 'Membership of influential groups' (Malapit et al., 2019).

Our adapted Nutrition module included questions to construct six indicators in total (Table A.2, Appendix A). Two indicators, decision-making around (i) purchasing and (ii) accessing food, were administered to both male and female respondents to allow for gender comparisons, diverging from the standard approach of applying the module to women only (Heckert et al., 2023). The remaining four indicators (whether respondents decide on their health and diet, on their health and diet during pregnancy, on their children's diet, and on weaning and breastfeeding) were collected for women only. Since the NSA primarily aimed at improving the diet quality of club members, we intentionally did not collect information on men's decisions regarding their own or their children's diet. Finally, we included questions on vegetables and legumes, as these food groups were the focus of our training, and omitted questions on milk products because milk consumption is uncommon in the study region.

The survey typically lasted 40 min for men and 50 min for women. The respondents received a small reimbursement for their time. Enumerators did not report any survey fatigue issue, during pre-test and data collection.

3.3. Data analysis

3.3.1. Pro-WEAI indicators and nutrition module

We computed the Pro-WEAI indicators following the guidelines and utilizing STATA *.do files developed by IFPRI.[4] While our analysis focused mainly on the Pro-WEAI indicators, we also calculated scores for an earlier and abbreviated version of the Women's empowerment in agriculture index (the abbreviated or A-WEAI[5]), to allow comparison of our sample of ethnic minority people with otherwise similar people of the 'Kinh' group, using results reported in an earlier study (SNV, 2017). Definitions of the ten domains of Pro-WEAI and five domains of A-WEAI and their adequacy levels can be found in Table A.1, Appendix A. Additionally, we computed the main Pro-WEAI/A-WEAI composite indices at the sample level, which are presented in Appendix B. The scores are computed using the work-life balance indicator from the first endline round only, thus not incorporating the work-life balance data collected in the second endline round.

For the Nutrition module, we calculated 'Decides to purchase food', 'Has access to food', and 'Decides on own health and diet' for the female subsample of respondents. The remaining indicators on pregnancy, breastfeeding, and children's diets were excluded since only 7 % of this subsample of women were either pregnant or had children less than two years old.

For the ten Pro-WEAI and three Nutrition sub-indicators, indicator values were estimated using two types of measurements: binary variables indicating whether a respondent passes the empowerment threshold for that indicator, and continuous variables with the absolute score for each indicator. The empowerment thresholds and scoring used for continuous measurement are described in Table A.1, Appendix A.

3.3.2. Treatment effects estimation

We estimated the intent-to-treat treatment effects (ITT) of the NSA using the following equation:

$$Y_{ij} = \alpha + \beta_1 T_{1j} + \beta_2 T_{2ij} + \rho_1 X_{ij} + \gamma_1 V_{1ij} + \gamma_2 V_{2ij} + \varepsilon_{ij} \quad (1)$$

in which Y_{ij}, our dependent variables is a vector of empowerment indicators for a woman in household i in cluster j; T_{1j} and T_{2ij} are binary variables indicating respondents residing in treated villages, and respondents randomly selected within their village as seed recipients, respectively; of them, X_{ij} are baseline covariates including ethnicities, districts, household size, education and age for both the household head and the respondents themselves, total cultivated farm area, the distance to the market as measured by travel time by foot, and a wealth index constructed as the first component from a Principal Component Analysis (PCA) with the list of all durable assets and large livestock types possessed by the family. Covariates were primarily collected during the baseline survey. When baseline data were unavailable, endline data were used instead. Since most covariates are time-invariant, this is unlikely to affect the results. Dummies $V_{1,2ij}$ indicate if households are either newly recruited after baseline or administratively excluded. Residual, ε_{ij}, is clustered at the training assignment level. Using equation (1), we can interpret β_1 as the effect of training compared to the non-intervention scenario (control), β_2 as the effect of seed provision on top of the training, and $\beta_1 + \beta_2$ as a result of the training and seed provision combined.

Thirty-four female respondents were interviewed at baseline, but we failed to recruit at endline, which caused the missing rate of 5.3 % on outcome variables over the 'endline sample', and 5.8 % over the 'baseline sample', which is negligible (Madley-Dowd et al., 2019). Thus, we dropped them in our main regression.

We estimated all treatment effects for the total sample and H'Mong and Thai subsamples.[6] This Heterogeneity treatment effect (HTE) analysis aimed at exploring potential impact mechanisms, but does not infer causality. The Dao group was excluded due to insufficient sample size for separate analysis, and their unique characteristics, which will be described in Section 4.3, prevented us from pooling them with either two ethnic groups.

We applied a correction for multiple hypothesis testing using the Romano-Wolf procedure, whereby p-values are adjusted by bootstrapping them with 3000 replications (Clarke et al., 2020). This method, which accommodates correlation within a family of indicators, is considered less conservative than a Bonferroni correction, which assumes independence across indicators. In our case, correlation between empowerment indicators warrants the use of the Romano-Wolf procedure. Tests were grouped into three families, including agency in the intrinsic, instrumental, and nutrition domains.

3.3.3. Robustness checks

We applied several robustness checks for our treatment estimation. First, we estimated the treatment effect using the baseline sample using equation (1), but dropping dummies $V_{1,2ij}$. Second, we estimated treatment effects using continuous measurements of the empowerment indicators. Descriptions of this measurement can be found in Appendix A.

Because of small sample size and the lack of baseline empowerment data, our study may not have been able to detect meaningful treatment effect with high certainty. To address this, we used several methods. First, we employed the Wild cluster bootstrap and cross-checked our results using the Bayesian framework between women's empowerment outcomes and treatment assignment variables, without including any other covariates. We assumed a flat prior $\sim$ N(0, 10000) for both

[4] https://weai.ifpri.info/weai-resource-center/guides-and-instruments/.

[5] The A-WEAI (Abbreviated-WEAI) was developed with shorter interview length and modifications for questions that were difficult to implement in the field. This tool was piloted in Uganda and Bangladesh in 2014 and officially launched in 2015 (Malapit et al., 2017). Even though the metric was criticized for its excessive focus on instrumental agency (DeJaeghere et al., 2022), the index is valuable in comparing empowerment across different populations (Malapit et al., 2015).

[6] We only estimate robustness check using 'baseline sample' for H'Mong, since most of the hurdles in sample change happened among the H'Mong group only. Thus, endline and baseline' samples are identical among the Thai.

treatment effect coefficients. These methods have been advised to overcome the power issue in causal inference when there is a limited number of clusters (Cameron et al., 2008; van de Schoot and Miočević, 2020). Second, In addition to estimating the ITT, we computed the Local average treatment effect (LATE), the treatment effects on those who actually joined the project. Thus, this estimation resulted higher treatment effects, thus improve power.

3.3.4. Ethics

The randomized control trial was approved by the institutional review board of the Public Health University Hanoi (PHUH), Vietnam, according to No 428/2020/YTCC-HD3, issued on December 4, 2020, before the baseline survey, and by Wageningen University and Research, issued on the February 1, 2021, before the intervention was implemented. The Pro-WEAI data collection obtained ethical approval 021–386/DD-YTCC from PHUH on November 1, 2021, before the inclusion of the Pro-WEAI tool in the endline survey. Oral informed consent was obtained from each participant in the study. All enumerators were trained on how to approach the potential study participants and obtain oral consent. The consent form included information about the study, confidentiality, rights of participants, reimbursement, and contact numbers. Only authorized researchers have access to the data. All data are kept in a secure hard disk and cloud storage, services provided by Wageningen University and Research.

4. Results

4.1. Respondent and household characteristics

Table 1 presents household characteristics of the total sample and across different ethnicities. Most respondents were smallholder farmers, with an average farm size of under 2 ha. The average household size was around 5.6 members, which is notably higher than the national average of 3.6 in 2020 (GSO, 2021). Households were generally located in remote areas, requiring an average of 2 h and 50 min on average on foot to reach the closest district market.

Ethnic differences were notable. Thai households had higher wealth, larger farms, and more educated household heads. The probability of a Thai household head completing primary school or higher was 0.23 (SE = 0.05) greater than for H'Mong, and 0.30 (SE = 0.04) greater than for the Dao (Table 1). In terms of remoteness, Dao households were the most isolated, traveling 0.83 h (SE = 0.26) longer than the Thai to reach the closest district market. Meanwhile, H'Mong households travelled 0.80 h (SE = 0.33) less to reach the closest district market compared to the Thai (Table 1).

Male and female respondents from the same households also exhibited different characteristics (Table 2). Specifically, female respondents attained significantly lower education levels and Vietnamese proficiency. For instance, the probability of female respondents finishing primary school or higher was 0.21 (SD = 0.42), whereas among the male members, it was 0.33 (SD = 0.44). These trends were consistent across all ethnic groups, except the Dao. Interestingly, in this group, male and female household members did not significantly differ in levels of formal education and Vietnamese proficiency (Table 2).

Furthermore, household characteristics varied among different groups of women. In comparison to women from households where both men and women were interviewed, households where only one individual was interviewed were more likely to have female household heads. Other households with only one respondent, for instance, those where men refused to be interviewed, had higher wealth levels and larger farms (Table C.1, Appendix C).

Table 1
Household characteristics of the total sample and the composing ethnic groups, and regression coefficients from a regression of each characteristic as a dependent variable on a categorical variable of ethnicities.

Household and respondent characteristics	Total sample (N = 602)	Thai (N = 209)	H'Mong (N = 319)	Dao (N = 74)
	Mean (SD)	Mean (SD)	Coefficients (SE)	Coefficients (SE)
Age of household head	45.3 (11.5)	46.7 (11.0)	−2.88** (1.19)	1.66 (2.24)
The fraction of household heads who finished primary school or higher	0.29 (0.44)	0.44 (0.48)	−0.23*** (0.05)	−0.30*** (0.04)
The fraction of household heads that is female	0.10 (0.35)	0.12 (0.37)	−0.03 (0.03)	−0.02 (0.04)
Wealth index	−0.11 (1.85)	1.59 (1.66)	−2.58*** (0.23)	−2.70*** (0.25)
Total farm size (ha)	1.84 (1.88)	2.54 (2.31)	−1.16*** (0.24)	−0.68** (0.27)
Household size	5.56 (1.81)	5.29 (1.64)	0.53*** (0.15)	−0.00 (0.29)
Reported walking duration to the closest district market (hours)	2.87 (1.65)	3.19 (1.15)	−0.80** (0.33)	0.83*** (0.26)

- Coefficients were retrieved from the OLS regression: $Y_{ij} = \beta_0 + \beta_1 i.X_{ij} + \varepsilon_{ij}$, in which Y_{ij} is a household and respondent characteristic, $i.X_{ij}$ is an ethnicity categorical variable, and the Thai group is the base level.
- Robust standard errors at the training randomization level are in parentheses.
- The number of (*) denotes the significance level: (*) p-value<0.1, (**) p-value<0.05, (***) p-value<0.01.

4.2. Balance tests

Table 3 displays the balance tests of the total sample, and Thai and H'Mong subgroups. While our randomization generally resulted in comparable control and treatment groups, we identified a few imbalances (Table 3). Specifically, in the training group, the average household size was 0.37 higher ($p < 0.05$), and travel time to the nearest district market was 0.78 h less ($p < 0.1$) than in the control group. Several imbalances were detected among ethnicities. The H'Mong training group had an extra 0.44 household members (SD = 0.14) compared to the control, while the seed group had smaller households and a more educated household head than the control. For the Thai, training and control groups were largely balanced, except that training households lived 0.56 (±0.28) hours closer to the district market than those in control clusters. Compared to the control, Thai households in the seed provision group had significantly younger and more educated respondents, and smaller farm sizes, than the control (Table 3). These imbalances, along with other household and individual characteristics, were controlled for in the treatment effect estimations.

4.3. Description of Pro-WEAI and A-WEAI scores

4.3.1. Indices–level analysis

Table 4 summarizes Pro-WEAI scores by gender and ethnic groups. Empowerment levels measured by Pro-WEAI were consistently low. In the aggregate sample, only 13 % (SD = 0.33) of women met the empowerment cut-off, and although women were less empowered than men, only 29 % (SD = 0.18) of men achieved empowerment. Women's empowerment levels were similar for households with only a female respondent and households with both male and female respondents. For the latter set of households, we constructed a gender parity measure (Table D.1, Appendix D); and only 48 % (SD = 0.50) of households achieved gender parity, meaning either that the female respondent's 3DE score met the empowerment cutoff (which we observe in 13 % of households), or that she did not meet the empowerment cutoff, but the

Table 2
Individual characteristics of male and female respondents in dual-adult households of the total sample and disaggregated by ethnicity (Mean (SD)).

Respondent characteristics	Total sample (N = 541)		Thai (N = 192)		H'Mong (N = 279)		Dao (N = 70)	
	Men	Women	Men	Women	Men	Women	Men	Women
Age of respondents	41.5 (11.7)	−1.71*** (0.48)	42.9 (11.5)	−2.15** (0.77)	40.6 (11.7)	−1.28* (0.65)	41.5 (11.7)	−2.13 (1.62)
Fraction of respondents finished primary school or higher	0.33 (0.44)	−0.12*** (0.02)	0.51 (0.47)	−0.13*** (0.04)	0.24 (0.4)	−0.13*** (0.03)	0.22 (0.36)	−0.02 (0.07)
Can read and write in Vietnamese fluently (a)	0.34 (0.48)	−0.18** (0.08)	0.75 (0.45)	−0.35** (0.16)	0.24 (0.43)	−0.19* (0.09)	0.14 (0.38)	0.03 (0.18)

- (*) denotes the significance level of the coefficient β_1 in the OLS regression: $Y_{ij} = \beta_0 + \beta_1 X_{ij} + \varepsilon_{ij}$, in which Y_{ij} is a respondent characteristic, X_{ij} is a dummy variable if the respondent is female, ε_{ij} is clustered at the training randomization level.
- The number of (*) indicates the significance level: (*) p-value<0.1, (**) p-value<0.05, (***) p-value<0.01.
- (a) The sample size for the variable 'Can read and write Vietnamese fluently' is 438 in the total sample (56 men and 382 women).

Table 3
Mean (SD) of household and respondent characteristics of the control group, and coefficient of each characteristic and treatment assignment of the total sample, H'Mong and Thai sub-samples.

Household and respondent characteristics	Total sample			H'Mong			Thai		
	Control (N = 217)	Training only (N = 392)	Seed provision on top of training (N = 189)	Control (N = 96)	Training only (N = 223)	Seed provision on top of training (N = 109)	Control (N = 87)	Training only (N = 122)	Seed provision on top of training (N = 60)
	Mean (SD)	Coefficient (SE)	Coefficient (SE)	Mean (SD)	Coefficient (SE)	Coefficient (SE)	Mean (SD)	Coefficient (SE)	Coefficient (SE)
Age of respondent	40.1 (11.6)	−0.68 (1.31)	0.29 (1.22)	39.7 (12.2)	−1.67 (1.87)	1.99 (1.8)	41.4 (10.9)	0.10 (1.93)	−2.47** (0.96)
Age of household head	45.7 (11.47)	−0.1 (1.65)	−0.76 (1.38)	43.3 (10.7)	0.52 (2.11)	0.37 (2.14)	47.5 (10.9)	−0.16 (2.32)	−2.36 (1.47)
The household head finished primary school or higher	0.34 (0.46)	−0.07 (0.06)	−0.02 (0.04)	0.30 (0.46)	−0.14 (0.04)	0.03*** (0.05)	0.46 (0.48)	0.03 (0.08)	−0.12 (0.08)
Respondents finished primary school or higher	0.22 (0.41)	−0.03 (0.05)	0.03 (0.03)	0.09 (0.28)	0.03 (0.04)	−0.01 (0.04)	0.36 (0.48)	−0.02 (0.07)	0.10** (0.04)
The household head is female	0.07 (0.27)	0.07** (0.03)	−0.03 (0.03)	0.05 (0.23)	0.08 (0.05)	−0.02 (0.03)	0.06 (0.26)	0.1 (0.06)	0.01 (0.07)
Wealth index	0.09 (1.85)	−0.26 (0.53)	−0.14 (0.19)	−0.6 (1.45)	−0.57 (0.47)	0 (0.14)	1.44 (1.67)	0.42 (0.37)	−0.36 (0.31)
Total farm size (ha)	1.88 (2.11)	0.03 (0.33)	−0.21 (0.15)	1.44 (1.28)	−0.04 (0.34)	−0.14 (0.21)	2.49 (2.9)	0.33 (0.48)	−0.49*** (0.15)
Household size	5.34 (1.77)	0.41** (0.16)	−0.16 (0.12)	5.57 (1.92)	0.44*** (0.14)	−0.25* (0.12)	5.24 (1.7)	0.15 (0.18)	−0.14 (0.22)
Reported walking duration to the closest district market (hours)	3.38 (1.95)	−0.74* (0.38)	−0.12 (0.15)	3.01 (2.53)	−0.77 (0.74)	−0.22 (0.17)	3.49 (1.13)	−0.56* (0.28)	0.07 (0.26)

- Coefficients were retrieved from the OLS regression: $Y_{ij} = \beta_0 + \beta_1 T_{1i} + \beta_2 T_{2ij} + \varepsilon_{ij}$, in which Y_{ij} is the household and respondent characteristic, T_{1i} is the treatment assignment of training intervention, T_{2ij} is treatment assignment of seed provision on top of the training.
- Robust standard errors clustered at the training randomization level are in parentheses.
- The number of (*) denotes significance level of p-value: (*) p-value<0.1, (**) p-value<0.05, (***) p-value<0.01.

male respondent from the same household achieved a lower 3DE score than the female respondent (which is the case for 35 % of households).

By ethnicity, Thai women and men had the highest levels of empowerment among the three ethnic groups, likely reflecting their greater wealth, education, and Vietnamese proficiency (Table 4). Empowerment scores among H'Mong and Dao women did not statistically differ, yet H'Mong men were significantly more likely to achieve the empowerment cut-off than Dao men (dx/dy = −0.14, SE = 0.04). Furthermore, the proportion of empowered Dao men (6 %) was slightly lower than that of Dao women (9 %). About 71 % of Dao households achieved gender parity, which was significantly higher than for both Thai and H'Mong. H'Mong women were the least empowered, with low empowerment (3DE) scores and high gender disparity (Table 4).

Table 5 summarizes empowerment using a subset of modules based on the A-WEAI. Using this measure, the rate of disempowerment among ethnic minority women fell sharply from 87 % (Pro-WEAI) to 44 %, and among men from 71 % to 52 %. This difference reflects the inclusion of intrinsic agency and mobility in Pro-WEAI, whereas A-WEAI focuses on instrumental and collective agency (Appendix A). With its narrower focus, A-WEAI shows that rural ethnic minority women in our sample were not significantly more disempowered than poor, low-education majority-ethnic women in rural Central Vietnam (SNV, 2017). Without aiming to draw any causal inference, this suggests that poverty may be a key driver for disempowerment, coinciding with the observation that Thai people in our study, also the wealthiest group, were the most empowered (Tables 1 and 4). Using A-WEAI also confirmed that Dao women were less likely to be disempowered than men, and revealed a similar pattern among the H'Mong, as 56 % of H'Mong women were disempowered compared to 76 % of H'Mong men (Table 5).

Table 4
Pro-WEAI mean scores and standard deviations at the individual level of the total sample disaggregated by sex and ethnicity, and regression coefficients retrieved from OLS and marginal effects (dx/dy) retrieved from probit regressions between each empowerment indicator and ethnicity categorical variable.

	N	Total 3DE score at individual level		Being empowered (3DE score≥8)		Gender parity achieved	
		Mean (SD)	Coefficients (SE)	Mean (SD)	Marginal effects (dx/dy) (SE)	Mean (SD)	Marginal effects (dx/dy) (SE)
Women							
All	602	5.69 (1.61)	N/A	0.13 (0.33)	N/A		
Thai	209	6.59 (1.20)	1.49*** (0.2)	0.22 (0.42)	0.68*** (0.19)		
H'Mong	319	5.10 (1.63)	(base)	0.08 (0.26)	(base)		
Dao	74	5.68 (1.40)	0.57** (0.26)	0.09 (0.29)	0.12 (0.39)		
Men							
All	541	6.31 (1.80)	N/A	0.29 (0.45)	N/A		
Thai	192	7.51 (1.18)	1.76*** (0.24)	0.51 (0.50)	0.31*** (0.06)		
H'Mong	279	5.74 (1.79)	(base)	0.19 (0.39)	(base)		
Dao	70	5.24 (1.39)	−0.50** (0.23)	0.06 (0.23)	−0.14*** (0.04)		
Dual adult households							
All	541					0.48 (0.50)	N/A
Thai	192					0.44 (0.50)	−0.02 (0.05)
H'Mong	279					0.46 (0.50)	(base)
Dao	70					0.71 (0.46)	0.24*** (0.07)

- OLS coefficients and probit marginal effects (dx/dy) were retrieved from the regression $Y_{ij} = \beta_0 + \beta_1 i.X_{ij} + \varepsilon_{ij}$, in which Y_{ij} is empowerment indicator, $i.X_{ij}$ is ethnicity categorical variable and the Thai ethnic group is the base level, ε_{ij} is clustered at the training randomization level.
- Robust standard errors in parentheses were clustered at the training randomization level.
- The number of (*) denotes significance level of coefficients: (*) p-value<0.1, (**) p-value<0.05, (***) p-value<0.01.

Table 5
Pro-WEAI and A-WEAI composite scores by gender and ethnic groups.

	N	Disempowerment head count (%)		Three/Five Domains of empowerment scores		Gender Parity Index (GPI)		Index score	
		Pro-WEAI	A-WEAI	Pro-WEAI	A-WEAI	Pro-WEAI	A-WEAI	Pro-WEAI	A-WEAI
Women									
All ethnic minority	602	87.0	43.5	0.59	0.83				
Majority	676	N/A	43.1	N/A	0.86				
Thai	209	77.5	23.9	0.70	0.93				
H'Mong	319	92.5	55.6	0.49	0.72				
Dao	74	90.5	45.9	0.58	0.81				
Men									
All ethnic minority	541	71.2	52.1	0.67	0.78				
Majority	676	N/A	30.3	N/A	0.90				
Thai	192	49.0	9.95	0.83	0.97				
H'Mong	279	80.8	75.9	0.77	0.88				
Dao	70	94.3	74.3	0.54	0.71				
Dual adult- households									
All ethnic minority	541					0.85	0.96	0.62	0.84
Majority	676					N/A	0.95	N/A	0.87
Thai	192					0.87	0.98	0.72	0.93
H'Mong	279					0.82	0.96	0.55	0.79
Dao	70					0.92	0.95	0.62	0.82

(*) the scores of the majority group adapted from (SNV, 2017).

4.3.2. *Indicator–level analysis*

4.3.2.1. Pro-WEAI indicators. Our analysis of the ten Pro-WEAI indicators sheds light on the contributions of disempowerment and gender gaps in each sub-indicator. 'Intrinsic agency' and 'Mobility' emerged as major contributors to disempowerment for both women and men, with women facing slightly greater constraints. For instance, 52 % of women and 44 % of men did not meet the empowerment threshold for 'Self-efficacy'. However, this pattern did not hold for the Dao group, where Dao men had the lowest 'Self-efficacy' of all groups (Table 6). 'Mobility' constraints were also common across genders; 61 % of women and 53 % of men were disempowered in this domain. This gender gap was especially pronounced among the H'Mong and may be linked to the remoteness of their communities (Table 6).

Despite these similarities, women experienced greater disempowerment in 'Work balance'. Across three ethnic groups, 58 % of women reported working more than 10.5 h per day, compared to 23 % of men. Although both men and women contributed to domestic, productive, and care work, the distribution was gendered. Women spent more time on domestic and care work, whereas men concentrated more on productive work (Fig. E.1, Appendix E).

Men and women demonstrated comparable levels of empowerment across several instrumental agency indicators. Disempowerment was low for both men and women in 'Ownership of land and other assets' and 'Input in productive decisions', with no significant gender differences across ethnic groups. The exception was the Thai group, with Thai men having a lower likelihood of meeting the 'Control over use of income' empowerment cut-off than the total sample average (Table 6).

Women were more likely than men to achieve the empowerment threshold for 'Group membership'. This pattern held for the H'Mong and Dao, but not for the Thai, among whom both men and women showed similarly low levels of disempowerment in this indicator (Table 6). For example, 73 % of H'Mong men reported non-membership in any group, compared to only 3 % of Thai men. Similar disparities existed across

Table 6
Mean and standard deviation of absolute contribution of each Pro-WEAI sub-indicator to disempowerment by total sample disaggregated by sex and ethnicity.

Sub-indicators	Total sample		Thai		H'Mong		Dao	
	Men	Women	Men	Women	Men	Women	Men	Women
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Intrinsic agency								
Intimate partner violence not acceptable	0.34 (0.47)	0.53*** (0.50)	0.19 (0.39)	0.23 (0.42)	0.42 (0.49)	0.72*** (0.45)	0.43 (0.50)	0.53 (0.50)
Autonomy income	0.58 (0.49)	0.60 (0.49)	0.53 (0.50)	0.65* (0.48)	0.64 (0.48)	0.60 (0.49)	0.46 (0.50)	0.46 (0.50)
Self-efficacy	0.44 (0.50)	0.52** (0.50)	0.09 (0.28)	0.25*** (0.43)	0.56 (0.50)	0.68*** (0.47)	0.96 (0.20)	0.62*** (0.49)
Instrumental agency								
Access to and decision on financial services	0.41 (0.49)	0.50*** (0.50)	0.25 (0.43)	0.33* (0.47)	0.50 (0.50)	0.59*** (0.49)	0.51 (0.50)	0.55 (0.50)
Ownership of land and other assets	0.06 (0.23)	0.05 (0.22)	0.00 (0.00)	0.00 (0.00)	0.11 (0.32)	0.10 (0.30)	0.00 (0.00)	0.00 (0.00)
Input in productive decisions	0.03 (0.18)	0.02* (0.13)	0.02 (0.14)	0.01 (0.12)	0.05 (0.21)	0.02 (0.15)	0.01 (0.12)	0.00 (0.00)
Control over use of income	0.57 (0.50)	0.58 (0.49)	0.63 (0.48)	0.71*** (0.46)	0.50 (0.5)	0.49 (0.50)	0.70 (0.46)	0.61 (0.49)
Visiting important locations	0.53 (0.5)	0.61* (0.49)	0.57 (0.50)	0.65 (0.48)	0.45 (0.5)	0.58** (0.49)	0.79 (0.41)	0.62 (0.49)
Work balance [(a)]	0.28 (0.45)	0.62*** (0.49)	0.21 (0.41)	0.56*** (0.50)	0.31 (0.46)	0.66*** (0.48)	0.30 (0.46)	0.62** (0.49)
Collective agency								
Group membership	0.46 (0.50)	0.29*** (0.45)	0.03 (0.16)	0.01 (0.12)	0.73 (0.45)	0.46*** (0.50)	0.60 (0.49)	0.31*** (0.47)

- (*) denotes the significance level of the coefficient β_1 in the probit regression: $Y_{ij} = \beta_0 + \beta_1 X_{ij} + \varepsilon_{ij}$, in which Y_{ij} is empowerment sub-indicator, X_{ij} is a dummy variable if the respondent is female, ε_{ij} is clustered at the training randomization level.
- The number of (*) indicates significance level: (*) p-value<0.1, (**) p-value<0.05, (***) p-value<0.01.

genders and ethnicities when excluding the dietary diversity clubs (Table E.2, Appendix E).

Another notable gender gap was observed in attitudes toward 'Intimate partner violence (IPV) acceptable' under any situation. This gap was mainly observed in the H'Mong group, where 72 % of women found IPV acceptable in any situation, compared to 42 % of men. In contrast, the Thai group exhibited the lowest acceptance of IPV among both men and women, with rates of 19 % and 23 % respectively. Although a similar proportion of Dao men to H'Mong men found IPV acceptable, a lower proportion of Dao women found that men have the authority to punish women who deviate from the 'patriarchal' social norms (Table 6).

4.3.2.2. Nutrition modules. Regarding the inadequacy of nutrition indicators, women's empowerment varied across decision domains. (Fig. 3). Specifically, only 5 % lacked empowerment in the 'Decides on their own diet' indicator, but empowerment diminished substantially during pregnancy. Empowerment was higher in indicators related to their children's diet and the weaning and breastfeeding period, although these findings need to be interpreted with care because only 40 women reported being pregnant or having given birth in the two years before the study. Notably, all Thai women were empowered when it came to the 'Decides on weaning and breastfeeding' indicator. Both men and women faced disempowerment over 'Decides to purchase food', particularly within the Dao group. Informal discussions with enumerators suggest that respondents often attributed their lack of empowerment to poverty. Moreover, men were more prone to experience disempowerment in this indicator compared to women (Fig. 3), which holds across all three ethnicities.

4.4. Treatment effects

4.4.1. Treatment effects on the total sample

Table 7 presents Intent to treat treatment effects (ITT) estimates of treatment effects on women. In general, training did not significantly affect either general or domain-level indicators of women's empowerment, and after correcting for multiple hypothesis testing, only two of the ten binary indicators were significantly affected: women in the treated villages were more likely to score adequately on the 'Mobility' indicator (dx/dy = 0.18, SE = 0.04), and 'Group membership' (dx/dy = 0.15, SE = 0.04). Women's participation in training sessions involved traveling to a central location within the village, and this mobility seems

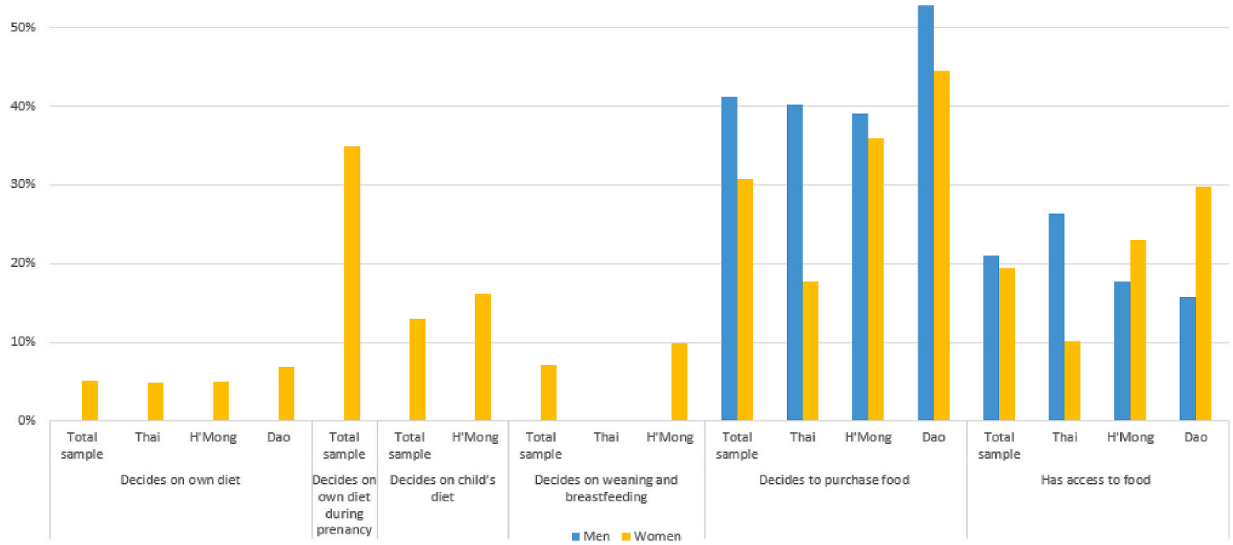

Fig. 3. Uncensored inadequacy headcount ratio (%). It reflects the percent of respondents who are inadequate in each indicator.

Table 7
Intent to treat Treatment effects (ITT) of the interventions on Pro-WEAI and Decision on Nutrition individual indicators Probit and OLS model for binary individual indicators and general indicators of total endline sample and H'Mong and Thai endline samples.

Dependent variables	Total sample			H'Mong			Thai		
	Control (N = 217)	Training only (N = 392)	Seed provision on top of training (N = 189)	Control (N = 96)	Training only (N = 223)	Seed provision on top of training (N = 109)	Control (N = 87)	Training only (N = 122)	Seed provision on top of training (N = 60)
	Mean (SD)	Coefficients/ Marginal effects (dx/dy) (SE)	Coefficients/ Marginal effects (dx/dy) (SE)	Mean (SD)	Coefficients/ Marginal effects (dx/dy) (SE)	Coefficients/ Marginal effects (dx/dy) (SE)	Mean (SD)	Coefficients/ Marginal effects (dx/dy) (SE)	Coefficients/ Marginal effects (dx/dy) (SE)
General indicators									
Empowerment (count)	5.67 (1.68)	0.24 (0.18)	0.15 (0.15)	4.69 (1.54)	**0.75***** (0.17)	0.23 (0.25)	6.63 (1.19)	−0.13 (0.17)	0.19 (0.17)
Empowerment (binary)	0.15 (0.36)	−0.04 (0.04)	0.05 (0.03)	0.03 (0.18)	**0.10**** (0.04)	0.00 (0.03)	0.25 (0.44)	−0.12* (0.07)	0.14*** (0.04)
Intrinsic agency (count)	1.41 (0.99)	−0.04 (0.07)	0.12* (0.07)	0.86 (0.85)	**0.16**** (0.07)	**0.18*** (0.09)	1.95 (0.76)	−0.12 (0.11)	0.02 (0.09)
Instrumental agency (count)	3.57 (0.97)	0.15 (0.11)	0.01 (0.10)	3.38 (0.98)	**0.38**** (0.14)	0.02 (0.15)	3.71 (0.89)	−0.06 (0.14)	0.17 (0.13)
Individual indicators (binary)									
Intrinsic agency									
Intimate partner violence not acceptable	0.54 (0.5)	−0.05 (0.04)	0.03 (0.05)	0.31 (0.46)	−0.05 (0.06)	0.09* (0.05)	0.78 (0.42)	0.05 (0.07)	−0.11** (0.05)
Autonomy in income	0.38 (0.49)	0.00 (0.05)	0.05 (0.05)	0.3 (0.46)	0.13** (0.06)	0.02 (0.07)	0.38 (0.49)	−0.14** (0.07)	0.15* (0.08)
Self-efficacy	0.48 (0.5)	0.01 (0.03)	**0.04*** (0.02)	0.25 (0.44)	0.11** (0.05)	0.06* (0.03)	0.79 (0.41)	−0.04 (0.05)	−0.01 (0.04)
Instrumental agency									
Access to and decision on financial services	0.58 (0.5)	−0.08* (0.05)	0.06 (0.04)	0.47 (0.50)	−0.01 (0.06)	0.04 (0.06)	0.74 (0.44)	**−0.21***** (0.07)	0.17** (0.06)
Ownership of land and other assets	0.95 (0.21)	0.10 (0.08)	−0.01 (0.04)	0.9 (0.31)	0.10 (0.08)	−0.01 (0.04)	1.00 (0.00)	N/A	N/A
Input in productive decisions	0.99 (0.12)	−0.02 (0.02)	0.02** (0.01)	0.98 (0.14)	−0.01 (0.04)	0.02 (0.01)	0.99 (0.11)	N/A	N/A
Control over use of income	0.43 (0.5)	−0.04 (0.07)	0.00 (0.05)	0.42 (0.5)	0.14* (0.07)	0.04 (0.08)	0.37 (0.49)	−0.11 (0.08)	−0.07 (0.08)
Visiting important locations	0.27 (0.44)	**0.18***** (0.04)	−0.01 (0.04)	0.3 (0.46)	0.15** (0.07)	−0.04 (0.03)	0.22 (0.42)	**0.20***** (0.06)	0.09 (0.06)
Work balance [(a)]	0.46 (0.5)	0.06 (0.04)	−0.04 (0.04)	0.43 (0.5)	0.04 (0.06)	−0.03 (0.05)	0.49 (0.5)	0.07 (0.05)	−0.07 (0.04)
Collective agency									
Group membership	0.69 (0.46)	**0.15***** (0.04)	0.01 (0.04)	0.45 (0.5)	**0.25***** (0.05)	0.02 (0.08)	0.97 (0.18)	N/A	N/A
Nutrition module									
Decision on own nutrition	0.97 (0.18)	−0.03 (0.02)	0.00 (0.01)	0.98 (0.14)	0.01 (0.02)	−0.02 (0.02)	0.97 (0.18)	−0.05* (0.02)	0.03 (0.02)
Decisions to purchase food	0.67 (0.47)	0.02 (0.04)	0.00 (0.05)	0.56 (0.50)	0.09 (0.07)	−0.03 (0.07)	0.84 (0.37)	−0.05 (0.05)	0.00 (0.05)
Has access to food products	0.79 (0.41)	0.02 (0.04)	0.01 (0.03)	0.78 (0.42)	0.02 (0.06)	0.01 (0.05)	0.85 (0.36)	0.08 (0.06)	0.00 (0.02)
Model specifications									
N		602			319			209	
N clusters		36			17			14	

- The Marginal effects (dx/dy) were retrieved from the post estimation of probit regression, and coefficients were computed using OLS regression using equation (1). Independent variables were ethnicities, district, age of respondents, age of household head, total farm size, household size, education level of household head, education level of respondent, gender of household head, distance to closest district market, missing for education levels, missing distance to district market, dummy indicating if the respondents were from newly recruited clusters or administratively excluded due to change in village borders.
- Probit estimation of the treatment effects over the indicators 'Ownership of land and other assets', 'Input in productive decisions' and 'Group membership' among the Thai group was not reliable due to low incurrence of disempowerment (less than 5 %).
- (a) Treatment effects of work balance indicators were estimated using pooled samples from two survey rounds, March and July 2022.
- Multiplicity corrected p-values are the values after multiple hypothesis testing using the Romano-Wolf procedure, bootstrapped with 3000 replications. Three families were created, including intrinsic and instrumental agencies, and Nutrition module. We corrected for coefficients' p-values from both OLS and probit regressions.
- The number of (*) denotes significance level of coefficients' uncorrected p-values from both OLS and probit regressions (NOT the marginal effects). **(*)** p-value<0.1, **(**)** p-value<0.05, **(***)** p-value<0.01.
- The Marginal effects (dx/dy) in **bold** denote the coefficients' p-value after multiplicity correction less than 0.1.
- The sample of indicators 'Intimate partners violence not acceptable' and 'Control over use of income' were 600 in the model (1) as some respondents refused to answer these modules.

to have spilled over to other types of travel. The effect was, however, not large enough to influence the aggregated empowerment indicators. The treatment also reduced the probability of achieving empowerment on 'Access to and decision on financial services' (dx/dy = −0.08, SE = 0.05), but significance disappeared when correcting for multiple hypothesis testing (Table 7).

Besides, our analysis reveals significant treatment effects of the seed provision intervention compared to the training-only group. Women who were randomized to receive seeds showed significant improvements in several sub-indicators of empowerment, particularly in terms of 'Input to productive decisions' (dx/dy = 0.02, SE = 0.01), and 'Self-efficacy' (dx/dy = 0.04, SE = 0.02), with the latter effect remaining significant after multiple hypothesis testing corrections.

4.4.2. Heterogeneity of treatment effects

Table 7 presents ITT estimates for the Thai and H'Mong (as mentioned earlier, leaving out Dao households due to a smaller sample of households and insufficient statistical power to detect any treatment effects). While the analysis is not causal, it offers important insights into the mechanisms behind the impacts observed at the total sample level.

The training intervention had contrasting effects on Thai and H'Mong women. The treatment effects were nuanced among the Thai, with a positive effect of training on their 'Mobility' (dx/dy = 0.20, SE = 0.06), but negative effects on 'Autonomy in income' (dx/dy = −0.14, SE = 0.07) and 'Access to and decisions on financial services' (dx/dy = −0.21, SE = 0.07). Consequently, the training reduced aggregate empowerment scores for Thai women, although only the effects on 'Mobility' and 'Access to and decisions on financial services' remained significant after adjusting for multiple hypothesis testing (Table 7).

Meanwhile, the H'Mong women exhibited a different response to the training. They experienced positive impacts not only on 'Mobility' (dx/dy = 0.15, SE = 0.07), but also on other aspects like 'Group membership' (dx/dy = 0.25. SE = 0.05), 'Autonomy in income' (dx/dy = 0.13, SE = 0.06), 'Self-efficacy' (dx/dy = 0.11, SE = 0.05), and 'Control over use of income' (dx/dy = 0.14, SE = 0.07). Although these effects were not maintained after adjusting for multiple hypothesis testing, we still observed significantly higher aggregated empowerment scores in both count and binary measurement methods.

Moreover, our analysis also revealed that both Thai and H'Mong benefited from the seed provision intervention. Thai seed recipients had a higher probability of achieving empowerment cut-offs than the training-only group (dx/dy = 0.14, SE = 0.04). Sub-indicator analysis showed significant positive effects of seed provision on 'Access to and decisions on financial services' (dx/dy = 0.17, SE = 0.06), and 'Autonomy in income' (dx/dy = 0.15, SE = 0.08). However, 'IPV acceptance' was unintentionally increased (dx/dy = −0.11, SE = 0.05). For the H'Mong, seed provision amplified the impact of the training, especially enhancing their 'Self-efficacy'(dx/dy = 0.06, SE = 0.03), and reduced IPV acceptance (dx/dy = 0.09, SE = 0.05).

Finally, we did not find any evidence that our interventions increased the workload of the participating women, for the total sample or in any subgroup (Table 7, Appendix F and G).

4.4.3. Robustness checks

Our robustness checks demonstrate that the findings are generally consistent across different samples, measurement methods, and statistical techniques. Consistent with our standard approach, we found positive impacts of training on 'Mobility' and 'Group membership', regardless of whether using the baseline sample, or outcomes were measured as binary or continuous indicators (Table F.2-F.3, Appendix F). These effects remained significant after correcting for multiple hypothesis testing, reinforcing their robustness.

The effect on 'Self-efficacy', however, showed more variation. While it was significant in the endline sample using discrete measurement, it disappeared in the baseline sample, yet reappeared when using continuous measurement (Table F.2-F3, Appendix F). This pattern indicates some sensitivity to sample composition and measurement scale, rather than true positive treatment effect.

In the subgroup analysis, training led to consistent improvements in 'Mobility', 'Group membership', and 'Self-efficacy' of the H'Mong group, regardless of the sample or measurement approach (Table F2-F3, Appendix F). Meanwhile, all the significant effects found using the endline sample and discrete measurement of seed provision disappeared in the other sample composition and measurement.

Among Thai women, the treatment effects of the training persisted across measurements. Treatment effects estimated by continuous measurements revealed positive treatment effect of the training on 'Input in productive decision', though this was not captured by the discrete measurement. Moreover, most treatment effects of the seed provision on top of the training under the continuous measurement, except for 'Self-efficacy'. Compared to the training-only group, the seed provision increased 1.10 (SE = 0.34) points over the 'Self-efficacy' scale. This suggests that while Thai women scored higher on 'Self-efficacy' and 'Input in productive decisions', these improvement were insufficient to reach the empowerment cutoffs for those indicators.

Robustness checks using a Wild clustered bootstrap and the Bayesian framework (see Section 3.3.2), based on the endline sample, revealed no major deviations from our standard estimation approach (Appendix F, Tables F.4-5 & Figure F.1-3). These results further support the reliability of our standard estimation approach, even in the context of small sample sizes.

5. Discussion

Our study aimed to investigate the empowerment levels of women and men among ethnic minorities in rural northern Vietnam, as well as to explore how nutrition-sensitive agriculture interventions can empower rural women in this context. Our findings offer important contributions on both fronts.

5.1. Women's and men's empowerment level

Our finding shows that rural ethnic minority women appear to have a certain degree of agency, particularly in terms of instrumental and collective agencies. Based on A-WEAI measurements, their level of empowerment over these domains was comparable to Kinh women with low income and education. The disempowerment level of 'Control over income' indicator of both men and women in our study context, indeed, is a sign of gender-inclusiveness. Income management responsibilities appear to be shared across genders, regardless of individual engagement in various productive activities. While this may reflect a lack of full control for either gender, it also avoids the burden falling entirely on one person to manage all household income streams. This aligns with earlier findings that financial decision-making among ethnic minorities may be more gender-equitable than commonly assumed (World Bank, 2019).

These finding aligns with recent studies arguing that rural ethnic minority women employ strategic forms of agency to navigate restrictive socio-cultural environments, exerting influence over household matters in subtle yet impactful ways (Keow-Bomar and Vang, 2016). From an instrumental perspective, both men and women face similar disempowerment rooted in structural economic barriers, including poverty, limited access to resources, and weak market integration, typical challenges in rural and remote settings. This suggests that poverty, rather than solely gender or ethnicity, may be a primary constraint on instrumental agency.

However, when non-instrumental domains, such as intrinsic agency, are incorporated into the analysis, a more complex and concerning picture emerges. Our Pro-WEAI results revealed that 'Intrinsic agency' and 'Mobility' are the principal contributors to disempowerment for both men and women. While individuals may participate in household or economic decisions, many still lack self-confidence or psychological autonomy. This suggests a deeper form of symbolic and structural

marginalization. One plausible explanation is that the internalization of majority discourses that depict ethnic minorities as 'backward' or 'barbaric' may contribute to a collective sense of interiority among some minority groups (Fanon, 1967; C. D. Nguyen and Tran, 2024). Cross-ethnic comparisons further support this interpretation. The Thai were found to be more empowered across both instrumental and intrinsic domains than the H'Mong and Dao. The Thai community's relative economic advancement, better education access, and reduced exposure to ethnic prejudice likely contribute to this disparity (Hiwasaki and Minh, 2022).

Additionally, our findings reveal that rural ethnic minority women face unique challenges beyond those shared with men. The gender gaps are most evident in 'Workload' and 'Mobility'. Women were also more likely than men to find intimate partner violence (IPV) acceptable under any circumstance. This suggests that gender norms that legitimize violence may be deeply internalized, aligning with other studies (Malapit et al., 2019; Sardinha and Nájera Catalán, 2018).

Although women are more likely to be disempowered in almost all domains, they have better 'Collective agency' and various indicators in their traditional domains, including food access and nutrition. In our study context, women had more control over the diets of both themselves and their children. This finding deviates from studies conducted in Bangladesh, Burkina Faso, and Mali, where women were more likely to experience disempowerment over their child's diet (Heckert et al., 2023). This finding highlights the context-dependent nature of women's empowerment.

Nevertheless, higher reported levels of women's empowerment do not always translate into greater use of resources. For example, women are found to have better access to financial services than men, but this does not necessarily translate into credit use, especially from formal lenders (Table 6 and Fig. E.2, Appendix E). These disparities could be due to greater constraints in mobility and language proficiency among women compared to men (Porter, 2002). Men may make all the financial decisions under women's names, as shown in a study in Eastern India. Nevertheless, this study also suggested lower credit use could be a deliberate choice, rather than exclusion (Kramer et al., 2021). Therefore, further investigation is needed to capture the contextual conditions under which women exercise choice.

Our findings also show the intersection between gender and ethnicity in shaping the empowerment experience. At the aggregate level, the Thai emerged as the most empowered group, with men and women either outperforming or matching the other groups across domains, which is consistent with earlier research. The H'Mong and Dao showed similar overall empowerment scores, which diverges from previous studies showing the greater disempowerment level among the H'Mong compared to the Dao (DeJaeghere et al., 2022). Yet our findings revealed that their gender dynamics are varied. H'Mong women are systematically disadvantaged relative to men across multiple domains, resulting in the widest gender gap of the three groups. By contrast, among the Dao, men are often more disempowered than women. In several sub-indicators, Dao men hold a weaker position, challenging the common assumption that women are always more vulnerable group in patriarchal societies (Crookston et al., 2021).

This finding likely reflects gendered stereotypes. In such a context where income-generating opportunities are scarce, men may find it difficult to fulfill their traditional role as providers. In some cases, traditional gendered roles can exclude men in certain markets, as shown in the tourism sector in Sa Pa (Lê, 2015), or the informal street sector in urban Vietnam (Kawarazuka et al., 2017). When men are unable to fulfil their traditional role as the provider, they can develop a sense of disempowerment (McKenzie et al., 2018; Silberschmidt, 2001). However, these findings should not be interpreted as evidence that women are no longer disadvantaged under patriarchal norms. Rather, social expectations could be a burden for both men and women, but in different ways. As shown in our study, Dao women continue to face unique and deeply rooted barriers, including a heavier workload and constrained mobility, or other gendered expectations that our study did not cover. Taken together, our findings underscore the importance of situating empowerment within rural ethnic-specific gender norms.

5.2. Treatment effects of the NSAs on women's empowerment

Our findings showed that the NSAs can improve women's empowerment by elevating 'Group membership' and 'Mobility' indicators. The positive effect on 'Group membership' is expected in a group-based intervention such as NSA, especially given that its measurement includes participation in a platform like 'Dietary diversity clubs' (Quisumbing et al., 2022). The observed effect on 'Mobility' aligned with broader patterns seen in group interventions. For example, the formation of self-help groups in microfinance interventions in South Asia played a crucial role in improving women's physical mobility (Finnis, 2017; Weber and Ahmad, 2014). These effects could be interpreted differently based on the context, as shown in our study.

Our heterogeneity treatment effects suggest different outcomes of the NSA across subgroups, although both enjoyed increased 'Mobility'. Among the Thai, treatment effects were more nuanced, and our most plausible explanation is the interaction between community's characteristics and the COVID-19. The Thai were more exposed to COVID-19, with higher numbers of close contacts and cases throughout 2021 (Appendix H). Their closer integration into markets and the majority community also made them more vulnerable to the government's selective social distancing policies (Y. T. B. Nguyen and Leisz, 2021). In this context, an intervention that increased 'Mobility' and social interaction may have heightened perceptions of risk, potentially undermining empowerment related to income-related indicators, thus reducing overall empowerment (Bergenholtz et al., 2021). This outcome is somewhat unexpected given the Thai's consistently high participation rates and involvement during the session while H'Mong group was somewhat more reserved, as recorded by field assistant's reports. In a companion study evaluating impact of the NSA on crop and diet diversity using mixed methods approach, both groups expressed their wish to prolonging the training, indicating their appreciation of the intervention (L. T. T. Nguyen et al., 2025b). These might partly reflect compliance with state directives, and initial high level of participation to state-run civil organizations. During the NSA's implementation, the Women's union play a strong role in mobilizing club members, suggesting that participation may be perceived as a duty rather than a choice.

By contrast, the H'Mong appear to have experienced multiple improvements due to the training. This might be due to limited number of infected cases or close contacts during the pandemic (Appendix H), likely linked to their isolationist survival strategy. The targeted social distancing policy may also have had less impact on within-community mobility. Consequently, the intervention might not trigger the same tension between empowerment and perceived risk. Thus, increased 'Mobility' seems to trigger true empowerment gain, as shown in the enhanced 'Self-efficacy' and aggregate score. Stronger effects among the H'Mong may also stem from the voluntary nature of participation. They exhibited low initial level of 'Group membership', and the Women's Union had limited activities among the H'Mong communities, as they are known for their resistance to state authority. Thus, participation is more likely reflecting individual demand, making empowerment gains more visible than the Thai.

Moreover, for the H'Mong, improvements in 'Mobility' and 'Group membership' indicators may carry particular significance. Women's participation in public spaces is traditionally restricted, and increased mobility or group membership might not be considered beneficial for all participants. Yet, evidence suggests that both H'Mong men and women aspire to greater female involvement outside the households (DeJaeghere et al., 2024). NSAs could provide a culturally acceptable reason for women to engage more in public life, while still staying in the safe side in bargaining with patriarchal system as NSAs fall well within

women's traditional domains. Furthermore, since the activities happen within the village, allowing women to join easily, as lack of transportation mean is one of the reason for mobility constrains in H'Mong villages. In this context, increased mobility and group membership can be interpreted as desirable empowerment effects.

We found no treatment effect on the 'Input in productive decisions' indicator, which is unsurprising since the initial level of this indicator in our study context is already high. While previous restudies have reported that NSAs may inadvertently increase women's workload through two mechanisms: the additional time required to participate in the intervention, and the extra efforts invested in domestic work to achieve nutrition goals (Margolies et al., 2023). However, we did not observe similar effects with our interventions. This could be due to the limited meaningful impact of the interventions on nutrition outcomes, as reported in a companion study (L. T. T. Nguyen et al., 2025b).

6. Conclusion

This study provides insights into women's and men's empowerment among ethnic minority groups in rural northern Vietnam. We find that these women and men exhibited meaningful agency, particularly in instrumental and collective domains, comparable to Kinh women of similar socio-economic status. However, both genders remain significantly disempowered in intrinsic agency and mobility. These patterns suggest that systemic ethnic discrimination imposes a dual burden, economic marginalization, which restricts instrumental empowerment, and symbolic exclusion, which undermines intrinsic agency. This deeper form of disempowerment, rooted in internalized stigmas, cannot be addressed by economic interventions alone.

Apart from disadvantages suffered from minority status, ethnic minority women also face gender-specific challenges beyond shared experiences with minority men, particularly in work balance, restricted mobility, and tolerance of gender-based violence. Moreover, our results suggested that normative empowerment, such as reported access to financial services, does not always translate into actual resource use, highlighting the gap between formal inclusion and real agency.

NSAs show promise in enhancing certain dimensions of empowerment, particularly collective agency and mobility, especially in rural settings. However, our subgroup analysis revealed that this carries nuanced implications in different contexts. This could be negative in the context where social distancing is advisable, but positive where women are constrained by mobility and participation in the public sphere, and the change is aspired to by both men and women. Our results also underscore the importance of context in shaping intervention effectiveness, not only the initial conditions, but also the development along the implementation, as shown by the Thai's heightened perceived risk due to the interaction of the group-based training and the pandemic.

To fully realize their potential in empowering women, NSAs should incorporate a clear and well-targeted empowerment component. Engaging both men and women is a promising strategy to enhance outcomes and reduce backlash against women (Ambikapathi et al., 2021; Quisumbing et al., 2023). Such interventions can promote shared domestic and emotional responsibilities and include gender dialogue activities to foster mutual understanding and strengthen family cohesion. Empowerment, in this sense, goes beyond individual growth to include improved relationships and the well-being of significant others (Galiè and Farnworth, 2019). This approach is particularly relevant in the studied ethnic groups, where their culture emphasizes the importance of both men and women collaborating to create a harmonious environment (Herr, 2014).

Nevertheless, NSAs alone are unlikely to trigger structural transformation on their own, even among the H'Mong, which experience significant empowerment gain thanks to NSAs. This is because in rural ethnic minority context, the root causes of disempowerment are a combination of systemic ethnical marginalization and local social norms. The group gained the most in NSAs, indeed, faced the most severe structural inequities, with women faced the strongest suppression among the three study groups. Thus, empowerment requires an integrated approach that tackles these interconnected factors to ensure meaningful and durable impacts. Effective empowerment strategies must combine policy-level reforms, community engagement, and culturally sensitive programs to create enabling environments.

Our results also highlight that gender and ethnicity intersect to shape distinct patterns of empowerment. Different patriarchal systems lead to women's and men's disempowerment in varying domains. Experiences with NSAs also differed by ethnicity. Even when treatment effects appear similar, their implication vary depending on the initial context, interacting with emerging conditions during intervention implementation.

Our study did not capture the internal dynamics or equity within rural communities. While group-based NSAs can enhance collective agency, they may also reinforce dominant norms or exclude dissenting voices (Nichols, 2021). Future research should investigate how the intersection of different dimensions of identity, such as age group, marital status and education, shapes equity, empowerment experiences and experiences with NSAs. Qualitative and participatory methods are particularly well-suited to capturing these nuanced dynamics.

CRediT authorship contribution statement

Lan Thuy T. Nguyen: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Marrit van den Berg:** Writing – review & editing, Supervision, Methodology, Conceptualization. **TjeerdJan Stomph:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization, **Berber Kramer:** Writing – review & editing, Methodology, Conceptualization. **Deborah Nabuuma:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Conceptualization.

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Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrurstud.2025.103948.

Data availability

Data will be made available on request.

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