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WOMEN'S EMPOWERMENT AND ASSOCIATED FACTORS IN COMMERCIAL VEGETABLE FARMING HOUSEHOLDS OF BAGAMATI PROVINCE, NEPAL

^aDeepa Devkota*, ^aShiva C. Dhakal, ^aRishi R. Kattel, ^bKrishna P. Timsina

^a Department of Agricultural Economics and Agribusiness Management, Agriculture and Forestry University, Rampur, Chitwan, Nepal.

^b National Agricultural Policy Research Centre, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

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ABSTRACT

Women's empowerment is considered pivotal in reducing gender gaps for sustainable agricultural growth. Despite the significant role of women in commercial vegetable farming, their empowerment status and gaps compared with men, owing to disparities in resource access, decision-making, and income control, have been poorly understood. This study assessed the status of women's empowerment among commercial vegetable producing households and identified the key factors associated with women's empowerment. The primary data were collected from Kavrepalanchowk, Dhading and Chitwan districts. The study included 120 randomly selected dual-adult households with husband and wife jointly involved in commercial vegetable production. Each spouse was interviewed separately, yielding 240 individual respondents in the analytical sample. The level of women's empowerment in vegetable farming households was analysed using the abbreviated Women's Empowerment in Agriculture Index (a-WEAI), while the associated factors of a-WEAI for female farmers (a-WEAI_{female}) were further explored using Ordinary Least Squares (OLS) regression. The study revealed that the a-WEAI_{female} in the vegetable farming households is 0.704, with only about 40% of women being empowered in the five domains. About 82.5% of the women were lacking gender parity with men, and the average empowerment gap was 34.8%. The gender parity index obtained was 0.713, which indicated women are less empowered than men. The a-WEAI score demonstrated that the women in the commercial vegetable farming households are achieving 70.4% of the total potential empowerment. The OLS regression results showed that significant factors associated with women's empowerment were dependency ratio ($p < 0.001$), outmigration ($p < 0.005$), off-farm income ($p < 0.005$), and membership ($p < 0.005$). Therefore, policy initiatives to enhance women's empowerment should focus on minimizing household dependency burdens, ensuring targeted support to migrant households, providing income diversification opportunities and strengthening women's participation in farm-based organizations.

Corresponding Author: Deepa Devkota

Email: deepadevkota01@gmail.com

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INTRODUCTION

Women play a significant role in agriculture production in developing nations, including Nepal. The agriculture census of 2021/22 in Nepal revealed that out of the total farm population, 49.1% were male and 50.9% were female with male-female farmers ratio of 0.96:1 (NSO,

2023). However, their efforts are restricted because of differential access to productive farm assets and institutional services, which affects decision-making power. Sustainable agricultural growth and rural transformation are possible only through inclusiveness, which requires enhancing women's empowerment

(Peterman et al., 2010). Over the past decade, participation of women in agriculture have remarkably increased due to growing male labor out-migration, rapid diffusion of digital technologies, increased involvement in farm-based organizations, improved institutional support, and agricultural policies promoting gender equality (Quisumbing et al., 2023). Women's empowerment is not confined to labour participation and income; it is a transformative process of autonomy and power that enables them to make strategic decisions through greater control over economic resources (Ibrahim and Alkire, 2007; Kabeer, 1999; Pradhan et al., 2019). In the agricultural sector, women's empowerment is associated with access to productive capital, decision-making authority, and involvement in community-based institutions (Malapit et al., 2019). Women face significant barriers to access productive assets, including land, farm inputs, and credit which hinder women's empowerment (FAO, 2011). Providing equal opportunity to women for obtaining productive resources is necessary to enhance women's empowerment (World Bank, 2014). Women's empowerment is broadly recognized as an important driver in reducing gender disparities in farm productivity (Diirro et al., 2018).

Agriculture remains the dominant sector of Nepalese economy which involves 57.3% of the population and 46.4% share of women's participation (AITC, 2025). Vegetable farming is one of the important sub-sectors contributing 14.5% to the Agriculture Gross Domestic Product (AGDP) (MoALD, 2025). The Bagmati province accounted for 17.68% of the total vegetable area in the country, with an average productivity of 14.95 mt/ha, with Kavrepalanchowk, Dhading, and Chitwan being the leading districts in vegetable production both by area and production (MoALD, 2021). Commercial vegetable production is an important source of income, employment generation, and rural economy of the districts under the study (Gautam et al., 2021; Magar and Gauchan, 2016; Pandey et al., 2021). Compared with other crops, commercial vegetable production is a high-value enterprise that is labor- and management-intensive, requiring frequent decision-making for crop selection, input use, irrigation, pest management, harvesting, and marketing (Rana and Rahaman, 2021). In commercial vegetable production, women are actively involved in nursery preparation, transplanting, irrigation, fertilizer application, weeding, harvesting, grading, and marketing (Sigdel and Silwal, 2018). Due to male out-migration,

feminization of agriculture is very prominent in the country, which has increased involvement of women and their decisions in agricultural management activities. Feminization in agriculture refers to growing participation of women in agricultural work and farm management decisions (Lastarria-Cornhiel, 2008). Feminization has increased women's responsibilities, with many of them taking the role of primary managers of vegetable farms (Devkota et al., 2025). Therefore, vegetable producing households offer an appropriate context for evaluating empowerment of women farmers. Involvement of women for the commercial vegetable production may not translate into women's empowerment itself due to the persistence of structural biases and intra-household disparities. Although women provide substantial contribution to commercial vegetable production, gender disparities caused by limited authority to make decision on income use, farm assets, and social, cultural as well as institutional constraints faced by women farmers ultimately affects women's empowerment. There are very limited studies on the extent of women's empowerment and the factors associated with it, particularly within commercial vegetable farming households in Nepal. Therefore, this study seeks to determine the level of women's empowerment, explore the share of different indicators causing disempowerment of women, and identify factors associated with women's empowerment among commercial vegetable farming households.

METHODOLOGY

Study area

The three districts Kavrepalanchok, Dhading, and Chitwan of Bagmati province were purposively selected through multistage sampling (Figure 1) as commercial vegetable production is prominent in these districts. The households commercially producing cauliflower, tomato and cucumber were selected for the study. The three vegetables were considered as they were the major commercially grown vegetable crops in the study districts that could sufficiently represent the commercial vegetable farming households (MoALD, 2021). Expert consultation was done to select two vegetable-growing pocket areas from each district. The selected areas were Banepa and Dhulikhel municipalities from Kavrepalanchowk district, Benighat-Rorang rural municipality and Dhunibesi municipality from Dhading district, and Bharatpur and Khairahani municipalities from Chitwan district.

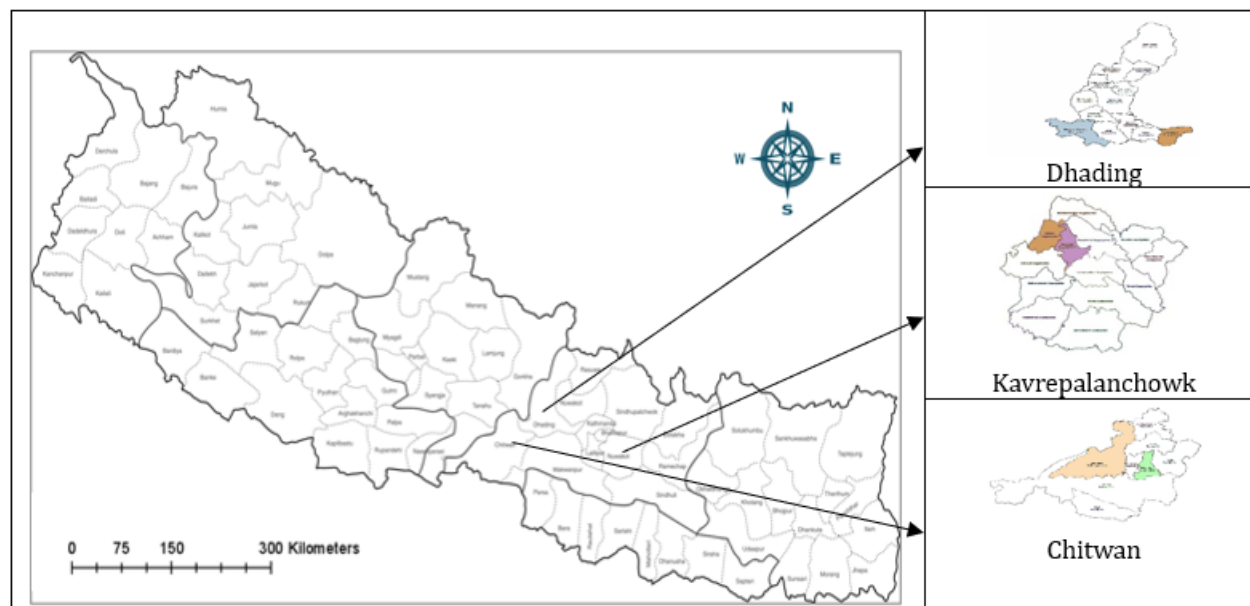


Figure 1. Map showing the study areas.

Source: (GoN, 2022)

Sampling methods and sample size

The primary data were collected through household survey administering an interview schedule from March to July 2022. The study included 120 dual-adult households with husband and wife jointly involved in commercial vegetable production. The households commercially producing at least one out of three representative vegetables were considered for the study. Before the household survey, the interview schedule was pre-tested with dual-adult commercial vegetable-producing households outside the study sample to assess its reliability and validity, and necessary revisions were made to improve the content. The validity of the content of the interview schedule was ensured through an extensive literature review and expert consultations. Both husbands and wives were interviewed individually, resulting in 240 individual respondents for the analysis. The sampled households were randomly drawn from a parent survey which included 360 commercial vegetable producing households under a broader doctoral research project. A random sub-sample for this study was selected as the analysis was confined to dual-adult households because the abbreviated Women's Empowerment in Agriculture Index (a-WEAI) requires paired responses from both the primary adult woman and primary adult man from the same household for the intra-household analysis on empowerment. The sample used in this study ensured proportional representation across three districts, including 40 households per district so the findings can be generalized to dual-adult commercial

vegetable producing households. Further, the random sampling and proportional district representation minimized potential for selection bias and ensured representation of the targeted population. The number of explanatory variables were identified based on the past empirical evidences rather than data-driven variable selection procedures. We acknowledge that the analytical sample size is modest that has been recognized as a limitation of the study. Before the primary data collection, all the respondents provided informed consent to actively participate in the study. The quantitative analysis was done using both descriptive statistics and econometric technique employing Microsoft Excel and STATA software (version 18.0).

Analytical techniques

Abbreviated Women's Empowerment in Agriculture Index (a-WEAI)

The a-WEAI approach was employed to assess women's empowerment using intra-household data from both husband and wife jointly involved in commercial vegetable production. The Women's Empowerment in Agriculture Index (WEAI) framework developed by Alkire et al. (2013) was simplified by Malapit et al. (2017) to abbreviated WEAI (a-WEAI). The a-WEAI examines women's empowerment based on five domains of empowerment (5DE), which include production decisions, resource access and control, income control, community leadership and time use. The a-WEAI also includes the Gender Parity Index (GPI), which measures intrahousehold disparities within a household by

comparing women's empowerment with men's empowerment. Among the two sub-indexes, 5DE accounts for 90% weightage and GPI accounts for the remaining 10% weightage (Alkire and Foster, 2011). This comparison allows to assess absolute as well as relative gender inequalities. The a-WEAI tool is a comprehensive framework that has been

widely adopted in gender studies to assess women's empowerment in agriculture (Bonis-Profumo et al., 2021; Diiro et al., 2018; Quisumbing et al., 2023). The domains and indicators, with their weightage adopted from Alkire et al. (2013) and Malapit et al. (2017), as well as the variables employed in the analysis are presented in Table 1.

Table 1. Domains and indicators with their weightage used in deriving a-WEAI.

Domains (5DE)	Indicators	Weight	Variables employed
Production	Input in productive decisions	1/5	Decision on vegetable field selection, vegetable type, variety, machinery use, labor hire, selling quantity and where to sell (1 high extent; 0 otherwise)
Resources	Farm assets ownership	2/15	Ownership of land (1 if Yes; 0 otherwise) and farm machineries (1 if Yes; 0 otherwise)
	Credit access and decision to use	1/15	Access to financial services (1 if Yes; 0 otherwise) Involvement on decision making to borrow loan (1 if high extent; 0 otherwise)
Income	Control over income use	1/5	Involvement on decision to spend income from vegetables (1 if high extent; 0 otherwise) Involvement on decision for major household expenditure (1 if high extent; 0 otherwise)
Leadership	Group membership	1/5	Membership of women in vital position in agricultural cooperatives or producer's group (1 if Yes; 0 otherwise)
Time	Workload (≤ 10.5 hours/day is standard cut-off)	1/5	Time allocated for vegetable farming (hrs/day) on 24-hour recall basis

The mathematical expression of five domains index (5DE) is:
 $5DE^w = 1 - (Hn^w \times A^w) \dots \dots \dots (i)$

Where,

Hn^w = The headcount ratio of disempowered women i.e.,
 Number of disempowered women / Total women (a-WEAI score < 0.8 is considered where a-WEAI score is calculated based on the weight for each indicator)

A^w = Average inadequacy score among those women who are disempowered ($A = 1 - aWEAI$ score)

Further, Gender Parity Index (GPI) was calculated to capture intra-household gender disparities in empowerment which is expressed as:

$$GPI = 1 - (I_{GPI} \times G) \dots \dots \dots (ii)$$

Where,

I_{GPI} = Proportion of women without parity calculated as the female-to-male a-WEAI ratio for each household and capping it at 1 (R-cap)

G = Average empowerment gap between the husband and wife in a household

The a-WEAI for female farmers is expressed as:

$$a - WEAI_{female} = 0.9 \times 5DE + 0.1 \times GPI \dots \dots \dots (iii)$$

After calculating a-WEAI_{female}, the percentage share of individual indicators to women's disempowerment was also calculated by determining the number of

disempowered women who had inadequacy under each indicator and multiplying it by the respective weights (Alkire and Foster, 2011).

Ordinary Least Squares (OLS) regression

To assess the factors associated with women's empowerment (a-WEAI_{female} score), the OLS regression was done which has also been employed in several studies on empowerment of women (Malapit et al., 2015; Shuai et al., 2019; Sraboni et al., 2014). Different socio-economic and institutional factors influence women's empowerment. Choudhry et al. (2019) highlighted major socio-economic factors associated with women's empowerment were barriers to education, work and ownership of property. Working status of women positively influenced their empowerment (Nowak et al., 2016). Access to credit enhanced women's ability to influence decision-making and improved gender relations at home, which accelerated economic empowerment (Malik and Luqman, 2005). Membership of cooperatives positively impacted on decision-making role of women within the household (Dohmworth and Liu, 2020). Access to technical services improved productivity and income through access to inputs and labor-saving technologies which contributed

empowerment through enhanced knowledge and control over farm income (Tripathi et al., 2026). Greater farm experience enhanced knowledge levels that build confidence, strong social networks, and institutional access (Nath and Athinuwat, 2020). The model used in Ordinary Least Squares (OLS) regression was:

$$Y_i = \beta_0 + \beta_1.X_{1i} + \beta_2.X_{2i} + \dots + \beta_k.X_{ki} + \varepsilon_i \quad \dots\dots\dots(iv)$$

Where,

Y_i = Abbreviated Women's Empowerment in Agriculture Index for females (a-WEAI_{female} score)

β_0 = Intercept

$\beta_1, \beta_2, \dots, \beta_k$ = coefficients of explanatory variables

$X_{1i}, X_{2i}, \dots, X_{ki}$ = Explanatory variables for i^{th} household

ε_i = Error term

Table 2. Definition of variables included in OLS regression.

Variables	Description of variables	Expected sign
Dependent variable		
a-WEAI _{female} score	Abbreviated Women's Empowerment in Agriculture Index score for women in the household	
Explanatory variables		
AGE	Age of the female farmers	±
EDUCATION	Years of formal education of the female farmers	+
DEPENDENCY_RATIO	Dependent family members in the household	-
AGRI_FAMILY_MEMBERS	Family members involved in agriculture	+
OUTMIGRATION	Household member migrated abroad to get better jobs (1=Yes; 0=otherwise)	+
FARM_SIZE	Size of the vegetable farm in ha	+
LIVESTOCK_HOLDING	Livestock holding in Livestock Standard Unit (LSU)	±
OFFFARM_INCOME	Off farm income of female (1=Yes; 0= otherwise)	+
ACCESS_CREDIT	Access to credit (1=Yes; 0=otherwise)	+
MEMBERSHIP	Membership of women in agriculture cooperatives (1=Yes; 0=otherwise)	+
ACCESS_TECHSERVICES	Access to technical services (1=Yes; 0=otherwise)	+
EXPERIENCE	Years of experience of the female farmer in vegetable farming	+
KAVREPALANCHOWK	Household from Kavrepalanchowk district (1=Yes; 0=otherwise)	±
DHADING	Household from Dhading district (1=Yes; 0=otherwise)	±
CHITWAN	Household from Chitwan district (1=Yes; 0=otherwise)	±

RESULTS

Descriptive analysis

The descriptive statistics given in Table 3 revealed that the average age of women farmers was about 46 years with an average of 5.5 years of formal education. The dependency ratio of the household was 49.84%, with a standard deviation slightly larger than the mean, indicating substantial heterogeneity among households. About 3 members within the household were involved in agriculture. Only about 5% of the dual-adult households reported outmigration of the other household member. The average size of the vegetable farm was 0.48 ha, and the average livestock holding was 3.29 LSU. About 41.67% of the women reported that they had off-farm income. About 57% of the women reported they had access to credit; 81% were members of the agriculture cooperatives or producers' groups, while 67.5% had received technical

services for vegetable farming. The women farmers had experience of about 16 years in vegetable farming.

Women's empowerment in vegetable farming households

The abbreviated Women's Empowerment in Agriculture Index (a-WEAI) was employed to assess the women's empowerment within the vegetable farming households (Table 4). The analysis revealed that 60% of women were disempowered and their average deprivation was 49.5%. The proportion of women without parity revealed that 82.5% of the women lacked parity as compared to men and the average gap in empowerment was 34.8%. The gender parity index is 0.713, which is < 1, suggesting that women had a lower level of empowerment than men. The a-WEAI was 0.704, which indicated that women achieved approximately 70.4% of the total attainable empowerment score.

Table 3. Descriptive analysis of the socio-demographic characteristics.

Variables	Mean	Standard deviation
Age (yrs)	45.94	8.85
Education (yrs of formal education)	5.51	4.95
Dependency ratio (%)	49.84	53.52
Family members involved in agriculture (No.)	2.58	1.48
Outmigration# (1=Yes; 0=otherwise)	0.04	0.20
Farm size (ha)	0.48	0.69
Livestock holding (LSU)	3.30	6.71
Off-farm income# (1=Yes; 0=otherwise)	0.41	0.50
Access to credit# (1=Yes; 0=otherwise)	0.57	0.50
Membership# (1=Yes; 0=otherwise)	0.81	0.40
Access to technical services# (1=Yes; 0=otherwise)	0.68	0.47
Experience on vegetable farming (yrs)	16.29	9.60

Table 4. Calculation of 5DE, GPI and a-WEAI_{female}.

Parameters	Results
Number of disempowered women	72
Total women	120
Disempowered Headcount (H_n)	0.60
Empowered Headcount (H_e)	0.40
Average Inadequacy Score (A_n)	0.495
Average Adequacy Score (A_a)	0.505
$5DE^w = 1 - (H_n^w \times A^w)$	0.703
Number of women without parity capped at 1	99
Proportion of women without parity (I_{GPI})	0.825
Average Empowerment Gap (G)	0.348
$GPI = 1 - (I_{GPI} \times G)$	0.713
$a-WEAI_{female} = 0.9 \times 5DE + 0.1 \times GPI$	0.704

Share of each indicator to the women's disempowerment

The percentage share of each empowerment indicator towards the women's disempowerment is presented in Figure 2. The decomposition analysis of each indicator showed that membership of cooperatives or producers' groups and involvement in production decisions were the predominant drivers of women's disempowerment which collectively contributed more than half of the total disempowerment. Control over the use of resources accounted for about one-fifth of the overall disempowerment, revealing that women's autonomy over farm resources is constrained. Further, credit access and decisions to use it represented a moderate barrier to women's disempowerment. The ownership of farm assets accounted for the least contribution to disempowerment. The workload had no contribution to disempowerment, indicating time is not the binding constraint. The time adequacy threshold (≤ 10.5 hours

per day) is met for vegetable farming and disempowerment is not driven by time poverty.

Factors associated with women's empowerment

The key factors associated with women's empowerment were analyzed using Ordinary Least Squares (OLS) regression. The a-WEAI score for females was the dependent variable in the regression. The mean Variance Inflation Factor (VIF) was 1.40, with the highest VIF of 2.04 for vegetable farming experience, which indicated there exists no multicollinearity in the regression model and OLS with heteroskedasticity-robust standard errors was employed. The test for endogeneity was not done, which is a limitation of the study. Thus, the findings are interpreted as associations rather than causal relationships. The model is statistically significant ($F = 3.28$, $p < 0.01$) and R^2 suggests the model explains about 25% of the variation in the dependent variable (Table 5). The R^2 value

appears modest but still reasonable for cross-sectional socio-economic studies. Several social, cultural, economic, institutional, and psychological factors can

influence women's empowerment that were beyond the scope of this study and may have contributed to unexplained variation.

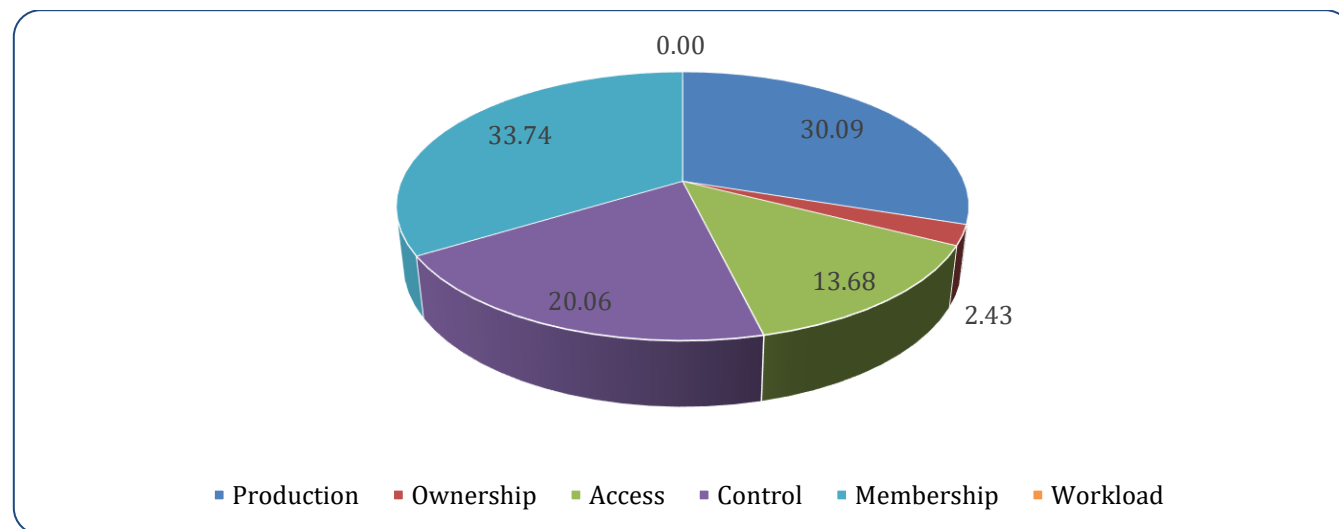


Figure 2. Percentage share of selected indicators to disempowerment of women.

Table 5. Factors associated with women's empowerment in vegetable producing households.

a-WEAI _{female}	Coefficient	Robust Std. Err.	t	p > t
AGE	0.002	0.002	1.03	0.305
EDUCATION	-0.002	0.004	-0.43	0.671
DEPENDENCY_RATIO	0.001***	0.000	3.21	0.002
AGRI_FAMILY_MEMBERS	-0.020	0.015	-1.31	0.194
OUTMIGRATION	0.188**	0.084	2.24	0.027
FARM_SIZE	0.001	0.030	0.03	0.973
LIVESTOCK_HOLDING	0.003	0.002	1.17	0.244
OFFFARM_INCOME	0.103**	0.042	2.46	0.016
ACCESS_CREDIT	-0.028	0.043	-0.66	0.508
MEMBERSHIP	0.133**	0.060	2.24	0.027
ACCESS_TECHSERVICES	-0.034	0.048	-0.71	0.479
EXPERIENCE	-0.003	0.003	-0.93	0.357
KAVREPALANCHOWK#	0.084	0.054	1.56	0.123
DHADING#	0.023	0.062	0.37	0.709
Constant	0.441***	0.138	3.18	0.002
<i>Summary statistics</i>				
Number of Observations	120			
F (14,105)	3.28***			
R-squared	0.246			

Note: ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

The significant factors associated with women's empowerment were dependency ratio ($p < 0.001$), outmigration ($p < 0.005$), off-farm income ($p < 0.005$), and membership ($p < 0.005$). Higher dependency ratio of the household was positively associated with women's empowerment with a very small magnitude. Households with out-migration had 18.8 percentage points higher a-

WEAI_{female} score on a 0–1 scale than those without out-migration. Since the study included dual-adult households with a husband and wife, the result is not viewed through a husband-migration narrative because the migrant is the other household member. Further, the departure of an economically active member from the household minimized competition over resource use, while increased

financial flow through remittances enhanced women's control over income use. Involvement of women in off-farm employment has significant positive association with women's empowerment. The result revealed that off-farm income is associated with a 10.3 percentage-point increase in a-WEAI_{female} score. Membership of women in cooperatives or producer's group was associated with a 13.3 percentage-point higher a-WEAI_{female} score. The other variables in the model were not significantly associated with women's empowerment.

DISCUSSION

Women engaged in commercial vegetable farming in the study area had a moderate level of empowerment, with the majority not attaining adequacy across major domains of decision-making, ownership of productive assets, control of income use, leadership, and time allocation. The gender parity analysis revealed that there exist intra-household gender inequalities in these domains within commercial vegetable producing households. This finding is supported by several past studies that highlighted male dominance in intra-household decision-making (Diirro et al., 2018; Malapit et al., 2014; Rammohan et al., 2023). According to Alkire et al. (2013), the theoretical basis of the Women's Empowerment in Agriculture Index considers empowerment as a multidimensional process achieved through increased decision-making authority, ownership of productive capital, better control over income use, membership in farm-based organizations, and optimal workload, rather than only participation in agricultural activities. Lack of land ownership, weak control over farm resources, and lack of authority to make decisions pose hindrances on women's empowerment (Khan et al., 2016). The involvement of women in agriculture is increasing, but clear evidence is lacking on whether this is aimed at economic empowerment or simply a growing number of women in agricultural operations (Tamang et al., 2014). In rural societies, rise in women's participation in agriculture does not necessarily reflect empowerment but rather intensify work burden due to poor land ownership, limited control over income, and poor involvement in formal farming institutions (Mishra and Sam, 2016). In Nepal, commercial vegetable farming has increased economic status of women farmers but also increased their workload for farm management (Adhikari, 2008; Balayar and Mazur, 2022). In South Asia, several studies revealed that increased participation of women in agricultural activities does not reflect higher decision-making authority or

control over productive capital due to patriarchal societies where ownership of land, assets, and other financial resources is allocated to men (Malapit et al., 2015; Seymour and Peterman, 2018). Inheritance practices and customary ownership shifted control over key productive resources towards men in Nepal (Pandey, 2010). Women are increasingly engaged in decision-making related to commercial vegetable production but the conventional gender norms continue to restrict their ownership of productive capital, control over income utilization, and access to credit and market information (KC and Race, 2020; Lamichhane et al., 2022).

The engagement of women in commercial vegetable production have expanded remarkably over the past two decades in Nepal due to increased male outmigration (Gartaula et al., 2010). Vegetable production is very important agro-enterprise in Nepal due to favorable weather conditions and higher economic returns compared with cereal crops (Bista et al., 2021; Joshi and Kalauni, 2019). The increase in women's engagement in commercial farming has contributed to household income, but women are often subjected to resource constraints, limited access to credit, poor extension support, and limited market participation, restricting their income potential (Djurfeldt, 2018). Different studies conducted in Nepal showed that women are mostly engaged in regular production activities including transplanting, weeding, and harvesting, whereas men are engaged in physically demanding work like land preparation, pesticide application, and transportation (Joshi and Kalauni, 2019). Women have limited autonomy to decide agricultural production related activities such as choice of crop and input use (Shahbaz et al., 2022). Men are mainly involved in financial transactions during input procurement and output marketing, compared to women vegetable farmers in Nepal (Bista et al., 2021; Sigdel and Silwal, 2017). Women vegetable farmers in Nepal exhibit limited authority in decision-making over inputs procurement, production, marketing and control over income use (Balayar and Mazur, 2022). Women still face institutional barriers that inhibits their leadership roles (Doss, 2018; Mwambi et al., 2021).

This study revealed that the significant factors positively associated with women's empowerment were dependency ratio, outmigration, off-farm income, and membership. Earlier studies generally linked higher dependency ratios with increased burdens of caregiving responsibilities pointing negative association between dependency ratio and women's empowerment (Malapit et al., 2015; Sraboni

et al., 2014). But the positive association obtained in this study suggested that women may have increased managerial roles and decision-making that might have been reflected in higher a-WEAI scores. However, the observed positive association is likely to be specific to the context of the study and should not be generalized as higher dependency ratios increases women's empowerment. In the household with higher dependency ratio, the roles and responsibilities of women may increase which can lead to greater involvement in decision making process within the households in some socioeconomic contexts (Seebens, 2011). The study included dual-adult households with husband and wife so very few households reported male out-migration which required cautious interpretation of the estimated association. The result is not viewed through a husband-migration narrative because the migrant is the other household member. The migration of economically active household member enhances women's empowerment by creating decision-making space within the household (Leder, 2022). With regards to the off-farm income, Bharadwaj and Findeis (2003) highlighted that women have better financial security and greater bargaining power when they have off-farm income. Financial independence enhances economic security that leads to empowerment (Srivastava, 2020). Membership in cooperatives or groups is associated with social capital (Gotschi et al., 2009), collective decision-making, and better access to farm resources (Mwambi et al., 2021), which ultimately enhances women's empowerment. The OLS regression output showed negative coefficient for some explanatory variables that were expected to have positive association, including education. But since the coefficients are statistically insignificant, there is insufficient evidence on whether these variables are positively or negatively associated with women's empowerment.

About 75% of the variation in the OLS model remained unexplained ($R^2 = 0.246$) which indicated only limited proportion of the observed variation has been captured by the explanatory variables. This suggested that women's empowerment is attributed to additional factors not considered in the model. Women's empowerment is a complex concept associated with multiple dimensions including societal norms, individual psychological characteristics and behavioral responses (Seebens, 2011; Malapit et al., 2015). Most of these factors are challenging to assess quantitatively using cross-sectional data. In the regression models analyzing multidimensional social constructs, a considerable proportion of the variation is

attributed to unobserved factors (Gujarati and Porter, 2009; Wooldridge, 2020). The variation due to the unexplained factors has also been recognized at the limitation of the study. This highlights the future research need on women's empowerment incorporating social, cultural, behavioral and institutional factors.

CONCLUSION

The a-WEAI_{female} analysis demonstrated that a notable proportion of women were disempowered within vegetable farming households. The gender parity index suggested there are disparities in women's empowerment relative to men, indicating intra-household gender inequalities. The major contribution to disempowerment comes from membership in cooperatives or producer groups signaling institutional constraints to women's representation in leadership. The second major contributor to disempowerment was input in productive decisions. This implies the major farm-level decisions are predominantly controlled by men restricting women's participation. The OLS regression highlighted that the major factors positively associated with women's empowerment were dependency ratio, outmigration, off-farm income, and membership in cooperatives or producer groups. Overall, the findings revealed that women's empowerment is shaped by institutional participation, income diversification and intra-household decision-making dynamics. Policy measures should focus on interventions that promote ownership of land and productive assets by women farmers, foster leadership roles by strengthening meaningful involvement of women in farm-based organizations, and enhance their decision-making authority within households. Furthermore, income diversification should be promoted through women-friendly capacity-building programs and income-generating activities such as agri-enterprises.

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