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Gendered Labor Allocation in Smallholder Vegetable Production and Marketing: Evidence from Farming Households in Cebu, Philippines

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Abstract

This study examined sex-based differences in respondent-reported participation in smallholder vegetable production and marketing in Cebu, Philippines. Data were collected from 745 farmers in three upland vegetable-growing communities through structured household interviews. Descriptive statistics, Pearson's chi-square tests, Cramér's V, Phi coefficients, adjusted residuals, and Welch's t-test were used to assess breadwinner identification, educational attainment, farming experience, and participation in ten production and marketing activities. Breadwinner identification and educational attainment differed significantly by respondent sex, while farming experience did not. Male respondents reported higher participation in all activities, with the largest differences in pesticide spraying, harvesting, transport to market, and product selling. All chi-square findings remained significant after Bonferroni correction. Because one respondent was interviewed per household, the results represent between-group differences rather than paired spousal labor allocation. The findings provide task-specific evidence for extension interventions on pesticide safety, market access, and women's access to technical and market-related knowledge.

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Introduction

Agriculture remains a vital source of livelihood in many developing countries, where rural households depend on farming for both food and income (Arrubla-Hoyos *et al.*, 2022). In smallholder production systems, household labor plays a central role in sustaining farm operations, crop management, and marketing activities. Men and women both contribute substantially to agricultural production, processing, and market participation, yet their roles are not always equally recognized or valued (Asadullah & Kambhampati, 2021; Dunne *et al.*, 2021; Food and Agriculture Organization [FAO], 2023). Differences in access to resources, control over farm income, and participation in decision making continue to shape how labor is allocated within agricultural households (Lambrecht *et al.*, 2018; Pierotti *et al.*, 2022).

In many farming communities, men are more commonly associated with physically demanding, input-related, and market-facing activities, whereas women are more frequently involved in routine crop management and supporting household and farm tasks (Akter *et al.*, 2017; Devkota & Pyakuryal, 2017; Mamaril & Lu, 2019). Such divisions of labor are important because they may influence productivity, exposure to risk, market participation, and the recognition of household economic contribution (Briones, 2018; FAO, 2023). Philippine studies have likewise shown that women contribute substantially to agricultural production but are often less visible in the formal recognition of farm leadership and economic roles (Basconcillo, 2019; Bertuso, 2019; Rosimo *et al.*, 2019).

These issues are especially relevant in vegetable farming, where labor requirements extend across land preparation, crop establishment, maintenance, pesticide application, harvesting, transport, and sale of produce. The way these tasks are distributed within farming households can affect not only production practices but also participation in local markets and access to farm-related knowledge and resources. Understanding who performs these activities is therefore important for analyzing labor organization in smallholder agrifood systems and for informing agricultural support interventions (Tatlonghari *et al.*, 2019; Verzosa *et al.*, 2021).

Vegetable production is an important agricultural activity in the Philippines and contributes to both household food supply and local market economies. Cabbage, pechay, and spring onion are commonly grown in upland areas under labor-intensive smallholder systems. Cebu is one of the recognized vegetable-producing areas in the country, particularly for cabbage, and supplies several provinces in the Visayas region (Philippine Statistics Authority, 2026). Yet empirical evidence on how labor is allocated across specific production and marketing tasks within vegetable farming households in Cebu remains limited. Previous work conducted in the same vegetable-

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farming context in Cebu showed that the COVID-19 shock prompted institutional and local government responses aimed at sustaining vegetable production and farmer support in the area (Alburo *et al*., 2025).

Building on this context, this study addresses three questions: (1) How do male and female respondents differ in household breadwinner roles, educational attainment, and farming experience? (2) How does participation in specific vegetable production and marketing activities vary by respondent sex? (3) Do male and female respondents differ in accumulated farming experience, and how should this difference, or its absence, be considered when interpreting participation patterns? The study therefore examines gendered labor allocation within smallholder vegetable farming households in Cebu, Philippines, and contributes a task-specific account of labor differentiation across the production and marketing chain, with implications for gender-sensitive extension and rural development. The study's contribution lies not in establishing the general existence of gender differentiation in agriculture, which is already well documented, but in providing task-by-task evidence across successive stages of an upland vegetable production and marketing chain. By estimating the magnitude of male–female differences across ten discrete activities, the analysis identifies where gendered participation is most pronounced within a labor-intensive vegetable system that remains underrepresented in the Philippine literature.

1. Theoretical framing and research questions

This study is informed by an intrahousehold perspective on farm labor allocation. Rather than treating the household as a single decision-making unit, bargaining and collective approaches emphasize that who controls resources, income, and mobility can shape who performs particular tasks and whose work is recognized (Doss, 2013; Duflo & Udry, 2004; Fiala & He, 2016). In agricultural settings, these processes often interact with gender norms that associate men with purchased inputs, mobility, risk-taking, and market exchange, while women are concentrated in routine but indispensable maintenance tasks (FAO, 2023; Lambrecht *et al*., 2018; Pierotti *et al*., 2022). Observed labor differences should therefore be interpreted not only as divisions of work, but also as expressions of authority, visibility, and access to productive resources.

From this perspective, three task dimensions are especially relevant in vegetable farming: physical demand, exposure to risk, and degree of market or input control. Tasks such as pesticide spraying, harvesting, transport, and selling are not only labor activities; they may also be attached to control over purchased inputs, cash income, and interaction with markets. By contrast,

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transplanting, irrigation, and weeding are highly recurrent activities that are essential to production but often less visible in formal accounts of farm leadership. Based on the literature, gender gaps would be expected to be largest in activities involving hazard, mobility, and market exchange, and smaller, though still present, in routine crop management.

This issue is particularly relevant in labor-intensive vegetable production. Crops such as cabbage, pechay, and spring onion require repeated and varied operations from planting to marketing, and these activities may expose household members to different levels of physical effort, mobility demands, and production risks. Tasks such as pesticide application, harvesting, transport, and product selling may place certain household members in more visible or strategic positions within the farm economy, while routine maintenance tasks may remain less recognized despite their importance to production. Examining these patterns helps clarify how labor is organized in smallholder vegetable systems and how household participation relates to wider questions of livelihood, market engagement, and access to agricultural support (Asadullah & Kambhampati, 2021; Briones, 2018; Dunne *et al*., 2021; FAO, 2023).

Guided by this framework, the study examines whether reported participation differs by respondent sex across specific production and marketing tasks, and whether these differences appear more consistent with gendered household role differentiation than with unequal farming experience. It also compares breadwinner roles and educational attainment in order to situate task participation within the broader social and economic organization of farming households.

2. Materials and methods

2.1. *Study area*

The study was conducted in Cebu Province in the Central Visayas region of the Philippines, an important vegetable-producing area supplying markets in several Visayan islands. As of December 2025, Cebu Province, as part of the Central Visayas Region, remained one of the leading cabbage-producing regions in the country (PSA, 2026). The analysis focused on three upland vegetable-growing communities selected purposively on the basis of their production of cabbage (*Brassica oleracea*), pechay (*Brassica rapa*), and spring onion (*Allium fistulosum*): Barangay Nug-As in Alcoy, Barangay Mantalongon in Dalaguete, and Barangays Sudlon I and Sudlon II in Cebu City. These areas are located at elevations of approximately 600 to 800 meters above sea level and are characterized by intensive smallholder vegetable production. The location of the study sites is shown in Figure 1.

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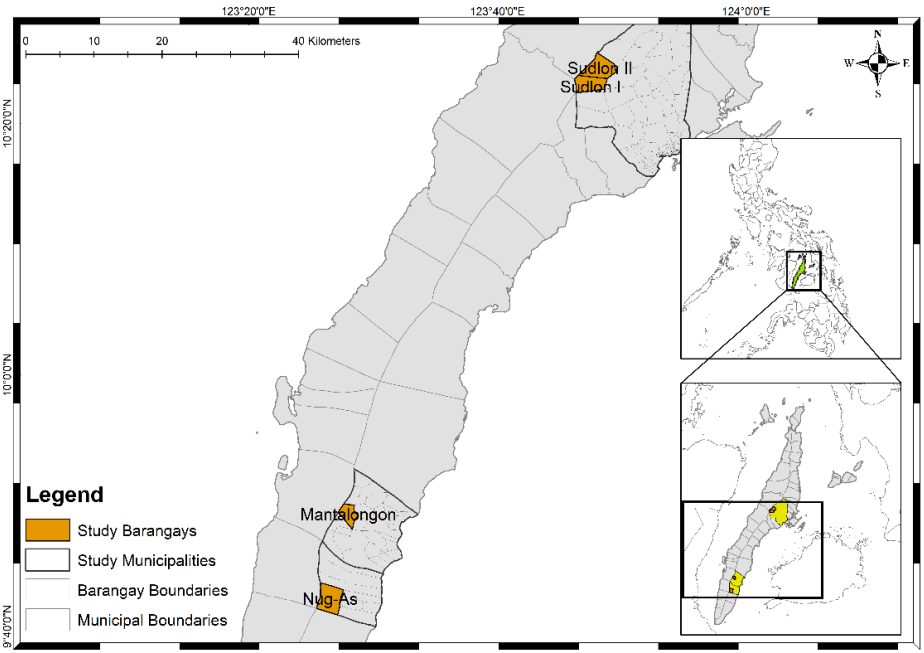
Figure 1 - Map of Cebu, Philippines showing the study sites located in the mountain barangays of Alcoy, Dalaguete, and Cebu City



Source: Authors' elaboration in ArcGIS based on secondary spatial data.

2.2. *Sampling and respondents*

The study sites were selected purposively because they are established upland communities with active production of cabbage, pechay, and spring onion. The initial recruitment target was guided by available estimates of the number of vegetable farmers in the selected communities. Respondent recruitment used a non-probability purposive and convenience-based procedure. Field teams approached eligible farmers identified through guidance from local officials and through direct household visits within the farming communities. Farmers were eligible if they had cultivated cabbage, pechay, or spring onion during the previous 12 months and voluntarily agreed to participate.

A total of 745 eligible farmers were interviewed, comprising 211 respondents from Nug-As, 247 from Mantalongon, and 287 from Sudlon I and Sudlon II. The preferred respondent was the husband or wife involved in farm management. When neither was available, the eldest household

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member engaged in farming activities was invited to participate. Because households were not selected through a probability-based random procedure and participation depended on accessibility, availability, and consent, the sample should not be interpreted as statistically representative of all farmers in Cebu. The findings apply primarily to the surveyed respondents and to comparable upland vegetable-farming communities.

2.3. *Data collection and ethical considerations*

Primary data were collected through face-to-face household interviews using a structured questionnaire developed and validated by the research team. Prior to data collection, ethical clearance was obtained from the authors' University Research Ethics (Humans) Committee, and permission was secured from the relevant municipal and city authorities, followed by courtesy visits to barangay officials. Consistent with good practice for non-interventional survey research, respondents were informed of the purpose of the study, the voluntary nature of their participation, the intended use of the data, and the treatment of their responses as confidential and anonymized in reporting. No personal identifiers were included in the analysis or presentation of results. The questionnaire gathered information on respondents' socioeconomic characteristics, farming experience, household breadwinner roles, educational attainment, and participation in selected agricultural activities related to vegetable production, harvesting, and marketing. Participation was voluntary, informed consent was obtained from all respondents, and all data were anonymized prior to analysis.

2.4. *Analytical framework and variables*

The analysis examines sex-based differences in respondents' reported participation in selected vegetable production and marketing activities. In this study, gendered labor allocation is operationalized as differences between male and female respondents in their self-reported participation in selected vegetable production and marketing activities. It is therefore a between-group measure of reported participation and not a paired observation of how husbands and wives divided labor within the same household.

Respondent sex is the primary grouping variable, and participation in selected production and marketing activities constitutes the main outcome set. Breadwinner role, educational attainment, and farming experience are treated as contextual variables because they help distinguish whether gendered participation patterns are associated with household role recognition,

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schooling, or accumulated practical experience. The selected activities were chosen to cover successive stages of the vegetable chain: land preparation, crop establishment, crop maintenance, chemical application, harvesting, transport, and selling; this is so that routine tasks can be compared with market-facing and higher-risk tasks.

Primary data consist of responses from the household survey administered in the study sites. Secondary data from the Philippine Statistics Authority are used only to contextualize the role of Cebu in vegetable production and are not combined with the survey data in the inferential tests. Because the study sites were selected purposively from active vegetable-producing communities, the findings are analytically focused on smallholder vegetable households in these sites rather than statistically representative of all farms in Cebu or the Philippines.

Because the data are cross-sectional and based on self-reported participation from one household respondent, the analysis is designed to identify patterned associations rather than causal effects. The results therefore indicate reported participation and its recognition within households, not directly observed time use or a complete measure of intrahousehold labor allocation. This distinction is important because husbands and wives may differ in how they report authority and work contributions. For this reason, effect sizes are interpreted substantively and the conclusions are framed cautiously.

2.5. *Data analysis*

The study examined labor participation in selected vegetable production and marketing activities using respondent sex as the main grouping variable. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' socioeconomic characteristics.

To examine whether participation in selected agricultural activities differed significantly between male and female respondents, Pearson's chi-square test of independence was applied. Effect sizes for significant associations were measured using the Phi coefficient (φ) for 2×2 contingency tables and Cramér's V for larger contingency tables. These measures were used to assess not only whether associations were statistically significant, but also the magnitude of the observed differences. Because 12 chi-square tests were conducted across the breadwinner, educational-attainment, and activity-participation analyses, sensitivity to multiple testing was assessed using a Bonferroni correction. The adjusted significance threshold was $\alpha = 0.00417$. Unadjusted p-values are reported in the tables for readability, but all reported

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associations remained statistically significant after correction. Differences in years of vegetable farming experience between male and female respondents were examined using Welch's independent-samples t-test, which does not assume equal population variances. This analysis assessed whether male and female respondents differed in accumulated vegetable-farming experience.

Data were analyzed using Microsoft Excel. Welch's independent-samples t-test was conducted using the Data Analysis ToolPak, while contingency tables, Pearson's chi-square tests, effect sizes, adjusted residuals, and the Bonferroni sensitivity assessment were calculated or verified using spreadsheet computation.

3. Results

3.1. *Socioeconomic characteristics of vegetable farmer respondents*

The socioeconomic characteristics of the respondents are presented in Table 1. Of the 745 vegetable farmers interviewed, 53.4% were male and 46.6% were female, indicating that both men and women were substantially involved in smallholder vegetable production in the study areas. The respondents had a mean age of 44.68 ± 13.79 years, with the largest shares belonging to the 30-39 years (24.8%) and 40-49 years (26.0%) age groups. Farmers aged 50 years and above also accounted for a considerable proportion of the sample. Overall, this age structure suggests that vegetable production in the selected communities is largely carried out by economically active adults with long-standing involvement in farm and household activities.

The data also show a generally modest educational profile. More than half of the respondents (52.1%) had elementary education, 36.4% had reached high school, and only 9.0% had attained college education, while very few had no formal education (2.6%). This pattern is consistent with observations in earlier agricultural studies showing that lower educational attainment may constrain access to improved practices, information, and other farm-related opportunities (Lambrecht *et al.*, 2018; Mamaril & Lu, 2019). In smallholder production systems, such educational patterns may shape how farm households engage with production decisions, markets, and technical support.

With respect to household economic roles, 60.5% of respondents identified the husband as the primary household breadwinner, whereas 27.7% reported shared breadwinning between spouses. Only 8.1% identified the wife as the primary breadwinner and 3.8% identified a son or daughter. This distribution suggests that while male economic leadership remains the dominant pattern in the study areas, a substantial proportion of households also rely on shared

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spousal income generation. Such a pattern is broadly in line with findings that women contribute significantly to rural household livelihoods even when men are more frequently recognized as principal providers (Asadullah & Kambhampati, 2021; Dunne *et al.*, 2021).

Table 1 - Socioeconomic characteristics of vegetable farmer respondents

Variable	**Category**	**Percentage (n=745)**
Sex	Male	53.4
	Female	46.6
Age (years)	Mean ± SD	44.68 ± 13.79
	<30	14.9
	30-39	24.8
	40-49	26.0
	50-59	17.3
	≥60	16.9
Educational attainment	No formal education	2.6
	Elementary	52.1
	High school	36.4
	College	9.0
Primary household breadwinner	Husband	60.5
	Wife	8.1
	Both spouses	27.7
	Son/Daughter	3.8
Years of experience	Mean ± SD	18.62 ± 13.05
	<5 years	12.9
	5-10 years	23.6
	11-20 years	30.6
	>20 years	32.9

Note: SD = standard deviation; years of experience represent the maximum number of years reported for cultivating cabbage, pechay, or spring onion.

Source: Authors' elaboration based on household survey data.

Respondents also had considerable farming experience. Mean years of experience reached 18.62 ± 13.05, and most respondents had been engaged in cultivating cabbage, pechay, or spring onion for more than 10

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years. In particular, 30.6% reported 11-20 years of experience and 32.9% reported more than 20 years. This indicates that vegetable production in the study communities is largely undertaken by experienced farmers. Taken together, the age, education, breadwinner, and experience profiles suggest that labor allocation in these households occurs within established smallholder production systems where both economic responsibility and farm participation are embedded in long-term household arrangements. The implications of these characteristics for gendered labor participation are examined in the succeeding sections.

3.2. *Household breadwinner roles by gender*

The distribution of household breadwinner roles by respondent gender is presented in Table 2. Results show a significant association between respondent gender and the identified household breadwinner ($\chi^2(3) = 72.16$, $p < 0.001$), with a moderate strength of association as indicated by Cramér's V = 0.31. This suggests that male and female respondents differed meaningfully in how household economic responsibility was identified.

Among male respondents, 73.9% identified the husband as the primary household breadwinner, compared with 45.2% among female respondents. In contrast, shared breadwinning between spouses was reported by 39.2% of female respondents but only 17.6% of male respondents. Female respondents also more frequently identified the wife as the primary household breadwinner (12.4%) than did male respondents (4.3%). The proportion identifying a son or daughter as the breadwinner was low in both groups. Furthermore, examination of adjusted residuals showed that the association was primarily driven by male respondents identifying the husband as breadwinner more frequently than expected (adjusted residual = 7.97), while female respondents identified the wife or both spouses more frequently than expected (adjusted residuals = 4.06 and 6.58, respectively). Identification of a son or daughter as breadwinner contributed little to the overall association.

These results suggest that although male economic leadership remains dominant in many vegetable farming households, women tend to view household income generation as more shared between spouses. This pattern is consistent with broader observations that women's contributions to rural household livelihoods are often substantial but may be less visibly recognized in household and economic decision-making (Asadullah & Kambhampati, 2021; Dunne *et al.*, 2021; FAO, 2023). In the context of smallholder vegetable production, this finding is relevant because household perceptions of breadwinning may influence how labor, income, and decision-making responsibilities are organized within the farm household. The relatively

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high proportion of households reporting shared breadwinning suggests that vegetable production and marketing are embedded not only in individual labor roles but also in joint household livelihood strategies.

Table 2 - Distribution of household breadwinner roles by respondent gender (n=745)

Breadwinner	**Male (%)**	**Female (%)**
Husband	73.9	45.2
Wife	4.3	12.4
Both spouses	17.6	39.2
Son/Daughter	4.3	3.2

$\chi^2(3) = 72.16$, $p < 0.001$, Cramér's V = 0.31.

Source: Authors' elaboration based on household survey data.

3.3. *Educational attainment and farming experience of farmers by gender*

The distribution of educational attainment by respondent gender is presented in Table 3. The results indicate a significant association between gender and educational attainment ($\chi^2(3) = 15.39$, $p = 0.002$), although the strength of the association was small, as shown by Cramér's V = 0.14. In both groups, the largest proportion of respondents had elementary education, accounting for 53.5% among males and 50.4% among females. Female respondents were more represented in the high school category (42.1%) than male respondents (31.4%), whereas male respondents had a higher proportion of college education (11.8%) than female respondents (5.8%). The proportion of respondents with no formal education was low for both sexes. Adjusted residuals indicated that the educational association was mainly attributable to the higher-than-expected representation of female respondents in the high-school category and male respondents in the college category.

These results suggest that the educational profile of vegetable farmers in the study areas remains generally modest, with most respondents concentrated at the elementary and high school levels. Although the association between gender and educational attainment was statistically significant, the small effect size indicates that the difference was not substantial. This pattern is consistent with earlier observations that lower levels of formal education may constrain farmers' access to information, improved practices, and other farm-related opportunities, while gendered labor roles in agriculture are shaped not only by schooling but also by

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household responsibilities and access to productive resources (FAO, 2023; Lambrecht *et al.*, 2018; Mamaril & Lu, 2019).

Table 3 - Distribution of educational attainment by respondent gender (n=745)

Educational attainment	Male (%)	Female (%)
No formal education	3.3	1.7
Elementary	53.5	50.4
High school	31.4	42.1
College	11.8	5.8

$\chi^2(3) = 15.39$, $p = 0.002$, Cramér's V = 0.14.

Source: Authors' elaboration based on household survey data.

The comparison of farming experience between male and female respondents is presented in Table 4. Results of Welch's independent samples *t*-test revealed no significant difference in years of vegetable farming experience between male and female farmers ($t(734.88) = -0.17$, $p = 0.867$). All 745 observations were included in the analysis, comprising 398 male and 347 female respondents. The fractional degrees of freedom resulted from the Welch–Satterthwaite unequal-variance adjustment. Male respondents had a mean farming experience of 18.54 ± 13.25 years, while female respondents had a mean of 18.70 ± 12.83 years. This indicates that male and female farmers had broadly comparable levels of experience in cultivating cabbage, pechay, or spring onion.

The absence of a statistically significant difference indicates that male and female respondents had comparable accumulated experience in cultivating the target vegetables. Farming experience therefore does not appear to account for the observed between-group participation differences. This is consistent with recent studies showing that the livelihood assets of farming households are linked to farm performance, suggesting that labor allocation should likewise be interpreted within the wider socioeconomic structure of the household (Hariyati *et al.*, 2025). In the context of household labor allocation, this is important because it indicates that the differences observed later in production and marketing activities are less likely to be explained by unequal familiarity with vegetable farming and more likely to reflect established household labor arrangements and socially defined roles within smallholder farming households (FAO, 2023; Mamaril & Lu, 2019).

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Table 4 - Comparison of farming experience between male and female farmers (n = 745)

Gender	n	Mean years ± SD
Male	398	18.54 ± 13.25
Female	347	18.70 ± 12.83

Welch's t(734.88) = –0.17, p = 0.867, SD = standard deviation.

Source: Authors' elaboration based on household survey data.

3.4. *Labor participation in vegetable production and marketing by gender*

Gender differences in participation in selected agricultural activities are presented in Table 5; while Figure 2 shows the corresponding male–female differences in percentage points. The differences were calculated as the percentage of male respondents reporting participation minus the percentage of female respondents reporting participation; positive values therefore indicate higher reported participation among male respondents. The results indicate that all ten selected activities were significantly associated with respondent gender ($p < 0.001$), showing that male and female farmers did not participate equally across the vegetable production and marketing chain. In all activities, male respondents reported higher participation than female respondents, although the strength of association varied considerably. The substantive meaning of these differences depends not only on whether they are statistically significant, but also on where the widest gaps occur across the production and marketing chain. All ten activity-level associations remained significant after application of the conservative Bonferroni-adjusted threshold of $\alpha = 0.00417$. The substantive conclusions were therefore unchanged after accounting for multiple testing.

In land preparation and crop establishment, male participation was consistently higher than female participation. Manual tillage involved 58.9% of male respondents and 25.6% of female respondents ($\chi^2 = 82.93$, $\varphi = 0.33$), while seed selection and transplanting of seedlings likewise showed significant differences, with male participation reaching 50.0% and 76.1%, respectively, compared with 25.1% and 47.6% among female respondents. These results indicate that male respondents reported higher participation in physically demanding and early-stage crop establishment activities. Similar patterns have been observed in earlier studies in rice, taro, and pineapple production, where men were more strongly associated with labor-intensive field operations, while women participated in more supportive or complementary roles (Basconcillo, 2019; Bertuso, 2019; Ezaki *et al.*, 2022; Lambrecht, 2016; Mamaril & Lu, 2019).

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A similar trend was observed in crop maintenance activities. Manual irrigation, manual weeding, and foliar fertilizer application were all significantly more common among male respondents than among female respondents. However, the effect sizes for these activities were smaller than those observed for later-stage operations, suggesting that women remained substantially involved in routine crop management even when men still predominated. This pattern is consistent with previous findings that women often participate actively in maintenance activities such as watering and weeding, although men frequently retain stronger control over field management and input application, particularly in more commercialized farming systems (Bertuso, 2019; Ezaki *et al.*, 2022; Mensah *et al.*, 2018; Rosimo *et al.*, 2019).

The strongest gender disparity was observed in pesticide spraying, where 85.8% of male respondents participated compared with only 17.5% of female respondents ($\chi^2 = 348.75$, $\varphi = 0.68$). As shown in Figure 2, pesticide spraying had by far the widest participation gap among all activities. This suggests that chemical pest management is overwhelmingly undertaken by men in the study communities. Comparable observations have been reported in other farming systems, where pesticide application is commonly assigned to men because it is perceived as hazardous, technically demanding, or closely linked to control over farm inputs (Ezaki *et al.*, 2022; Mamaril & Lu, 2019; Rosimo *et al.*, 2019). In household production terms, this concentration of chemical handling in male labor may also indicate unequal control over technically sensitive or higher-risk tasks within the farm enterprise.

Gender disparities also remained substantial in harvesting and marketing. Harvesting involved 83.0% of male respondents and 43.5% of female respondents ($\chi^2 = 125.77$, $\varphi = 0.41$), while transporting vegetables to market and product selling likewise showed moderate gender differences. Figure 2 further shows that harvesting, transport, and selling were among the activities with the widest participation gaps after pesticide spraying. These findings suggest that male respondents reported higher participation in tasks requiring physical effort, mobility, and direct market interaction. The observed participation patterns may also be shaped by structural conditions beyond individual household preferences. Distance to markets, transport availability, local buyer arrangements, access to vehicles, and the organization of input and output channels can influence which household member undertakes mobility-intensive or cash-related activities. Migration or temporary off-farm employment may further alter the labor available to a household and redistribute production responsibilities. These factors may interact with gender norms and bargaining power by affecting who has access to transport, technical information, purchased inputs, and market income. Similar patterns have been documented in studies showing that men are

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more likely to dominate harvesting, transport, and market-facing roles, while women participate more where marketing occurs nearer the household or in less mobility-intensive settings (Bertuso, 2019; Ezaki *et al*., 2022; Ferguson *et al*., 2020; Rosimo *et al*., 2019). A related Cebu study on vegetable marketing during the COVID-19 period likewise showed that transport, market access, and selling arrangements were central to the functioning of local vegetable chains, underscoring the importance of identifying which household members perform these market-facing roles (Alburo *et al*., 2024).

Interpreted through an intrahousehold lens, the largest gender gaps are concentrated in tasks that combine hazard, mobility, and market or input control. Pesticide spraying requires handling purchased inputs and exposure to health risks; harvesting, transport, and selling connect the farm directly to output realization and cash income. The concentration of men in these activities is therefore consistent not only with physical task differentiation, but also with gendered authority over risky, visible, and market-linked functions of the farm enterprise. By contrast, women's substantial participation in transplanting, irrigation, and weeding indicates concentration in regular and indispensable maintenance work. The pattern is consistent with gendered differences in reported task participation rather than with a difference in accumulated farming experience. Direct conclusions about within-household role allocation would require paired spouse interviews or time-use observations.

In this article, the term complementary is used descriptively rather than normatively. It indicates that male and female respondents reported different participation patterns across tasks of the production and marketing process, not that these arrangements are necessarily efficient, equitable, or freely chosen. In settings where access to income, mobility, and input decisions is uneven, complementarity may coexist with constraint and unequal recognition. This distinction matters for interpreting gender specialization without romanticizing it. The findings are consistent with the theoretical expectation that gender norms and bargaining conditions shape not only the amount of agricultural labor performed but also the type and visibility of tasks undertaken. Activities connected to hazardous inputs, mobility, and cash realization may carry greater authority or economic visibility, while frequent maintenance activities may remain less visible despite being essential to production. Nevertheless, the study did not directly measure bargaining power, control over income, ownership of productive resources, or decision-making authority. The results therefore support the relevance of these theoretical concepts but do not independently verify the mechanisms through which they operate.

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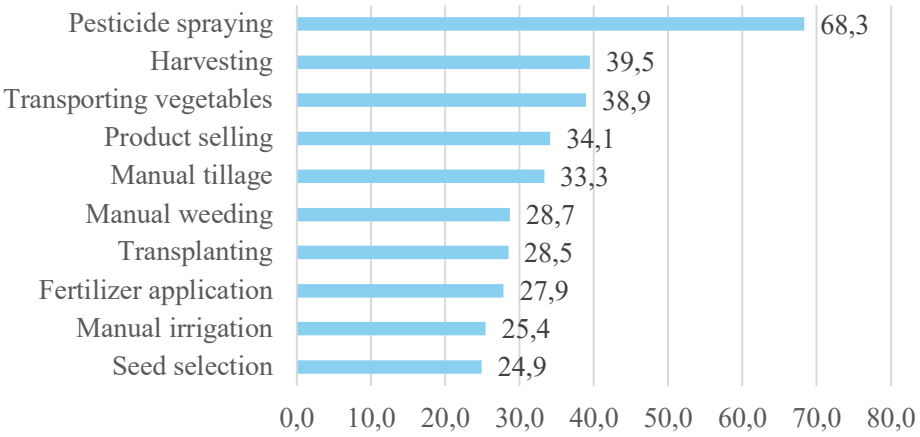
Table 5 - Differences in participation in selected agricultural activities by respondent gender (n = 745)

Activity	Male (%)	Female (%)	χ^2	df	p-value	φ
Manual tillage	58.9	25.6	82.93	1	$p < 0.001$	0.33
Seed selection	50.0	25.1	48.70	1	$p < 0.001$	0.26
Transplanting of seedlings	76.1	47.6	64.83	1	$p < 0.001$	0.29
Manual irrigation	61.5	36.1	48.35	1	$p < 0.001$	0.25
Manual weeding	86.7	58.0	78.32	1	$p < 0.001$	0.32
Foliar fertilizer application	51.9	24.0	60.51	1	$p < 0.001$	0.28
Pesticide spraying	85.8	17.5	348.75	1	$p < 0.001$	0.68
Harvesting	83.0	43.5	125.77	1	$p < 0.001$	0.41
Transporting vegetables to market	55.5	16.6	119.22	1	$p < 0.001$	0.40
Product selling	67.6	33.5	86.62	1	$p < 0.001$	0.34

Note: χ^2 = Pearson's chi-square statistic; df = degrees of freedom; φ = Phi coefficient (effect size).
Source: Authors' elaboration based on household survey data.

Figure 2 - Male-female difference in respondent-reported participation across selected agricultural activities (in percentage points)



Note: Values represent male participation percentage minus female participation percentage and are expressed in percentage points. Positive values indicate higher reported participation among male respondents.
Source: Authors' elaboration based on household survey data.

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These comparisons are between male and female respondents and should not be interpreted as paired measures of labor division between spouses. The results identify sex-based differences in self-reported participation across the sample, but they do not establish how tasks were divided between two members of the same household.

Conclusions

The study found systematic sex-based differences in respondent-reported participation across ten vegetable production and marketing activities. Male and female respondents had comparable farming experience, but male respondents reported substantially greater participation in pesticide spraying, harvesting, transport, and product selling. Female respondents also participated considerably in transplanting, irrigation, weeding, and other routine crop-maintenance activities. Reported breadwinner identification differed by respondent sex, indicating that perceptions of household economic responsibility were also gendered.

These findings describe between-group patterns among male and female respondents rather than a paired division of labor between spouses within the same households. The main contribution of the study is the task-by-task mapping of reported participation across successive stages of an upland vegetable value chain. The concentration of the largest differences in hazardous, mobility-intensive, and market-facing activities is consistent with theoretical explanations involving gender norms, resource access, and bargaining conditions.

The policy implication is that gender-sensitive agricultural support should be matched to the task structure of household labor. Extension on pesticide safety, post-harvest handling, transport logistics, and market participation should explicitly consider the higher reported participation of male respondents in those activities while also addressing women's access to related knowledge and decision-making. At the same time, interventions aimed at seedling establishment, irrigation, and crop maintenance should treat women as core agricultural actors rather than auxiliary labor. Labor-saving technologies and safer-input practices may be particularly valuable where routine maintenance burdens and market access reported participation differs across respondent groups.

Future research should use paired spouse interviews, repeated or longitudinal household observations, and time-use records to measure directly how labor is divided within households. Studies should also collect information on land and asset ownership, income control, decision-making authority, migration, transport access, buyer relationships, and value-chain participation in order to test how gender norms, bargaining power, and structural market conditions influence agricultural work.

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Conflict of Interest

The authors declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this article, the authors used ChatGPT (OpenAI) to support language improvement, wording refinement, and organization of parts of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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