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EXPLORING GENDER INEQUALITIES IN HORTICULTURAL FARMING: A STATISTICAL ANALYSIS USING THE MANN-WHITNEY U TEST

Tapati Rudrapal* and Anindita Saha
Department of Agricultural Extension, Palli Siksha Bhavana, Visva-Bharati University, Sriniketan-731236, West Bengal, India
*Corresponding author E-mail: rtapati40@gmail.com
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ABSTRACT

This study investigated the gender dynamics in horticultural farming in Tripura, highlighting the differentiated roles played by farm men and farm women across various stages of cultivation. Carried out in the horticulturally active districts of Sepahijala and South Tripura, the research aimed to evaluate and compare the involvement of both genders in 18 essential horticultural activities, with a focus on identifying disparities and patterns in the division of labour. A total of 320 respondents (160 men and 160 women) were selected through simple random sampling. Data were collected via personal interviews using a structured, pre-tested questionnaire, and participation levels were rated on a 4-point scale. Since the Shapiro-Wilk test confirmed a non-normal data distribution, the Mann-Whitney U test was used to assess gender differences in participation, with significance determined at $p < 0.05$. Results revealed a clear gendered division of labour: farm men showed higher involvement in strategic and high-input tasks such as crop selection (Mean= 4.00), irrigation (Mean= 3.93), and land preparation (Mean= 3.82), while farm women were more engaged in manual and maintenance-related activities like weeding (Mean= 2.99), harvesting (Mean= 2.77), and transportation (Mean= 2.61). Women's participation was notably lower in decision-making and technical roles, such as crop selection (Mean= 1.21) and pesticide application (Mean= 1.31). Participation level analysis showed that 48.8% of farm men had high participation, with none in the low category, while 54.4% of farm women fell in the low participation group, and none reached the high category. The Mann-Whitney U test confirmed a statistically significant difference ($p < 0.001$) in participation levels between genders, and a rank biserial correlation of 1.00 indicated a very large effect size. These findings highlight the substantial gender gap in horticultural farming, largely influenced by socio-cultural barriers, limited access to training, and lack of decision-making authority for women. The study concludes that gender sensitive interventions such as improving women's access to training, technology, and decision-making platforms are essential to promote equitable participation and improve the overall efficiency, inclusivity, and sustainability of horticultural development in Tripura.

***Keywords*:** Gender dynamics, Labour Participation, Mann-Whitney U test, Shapiro-Wilk test, horticultural farming,

Introduction

India's development is strongly linked to agricultural progress, with extension services serving as a key bridge between research, policy, and farmers, historically led by public institutions to strengthen rural agriculture and allied sectors (Parashar and Tyagi, 2025). Tripura cultivates around 2.72 lakh hectares about 26% of its total geographical area with a net sown area of 2.55 lakh hectares. The cropping intensity in Tripura is 191%, significantly higher than the national average of 142% (Directorate of Agriculture, Government of Tripura 2022). Women demonstrated a high level of involvement in vegetable production, contributing over 80% to tasks such as land preparation, stable collection, seed cleaning, sowing, seedling transplantation, weeding, and the sorting and grading of produce. As more men shift to non-agricultural sectors, women's roles in horticulture and

other agricultural domains have significantly expanded. In this context, the study aimed to examine women's participation across different horticultural activities (Tripathi *et al*., 2015). A gender-specific analysis in agriculture offers key insights into the unequal access to resources and labour contributions of men and women. Understanding their distinct roles across farming, allied, and household tasks is crucial for identifying and bridging gender gaps (Rudrapal *et al*., 2025). Differences in farm level resources such as natural assets, capital, landholding size and labour along with market access, service availability, and socio-cultural contexts, result in the development of diverse crop-livestock systems tailored to local conditions (Rao., 2006). Entrepreneurship is widely acknowledged as a vital means of empowering people with limited capital or management experience to achieve sustainable livelihoods. In this regard, both agriculture and dairy farming play a pivotal role in rural development by boosting milch animal productivity and creating diverse income opportunities. (Rudrapal *et al*., 2023). Economic empowerment of women is vital, as it enhances their sense of security and contributes significantly to societal advancement. Women play a key role in driving the overall development of resource-constrained farm families. However, their contributions are frequently overlooked, especially in decision-making related to farms and households domains they often manage (Roy & Kadian., 2016). Women's participation in the horticultural sector has grown alongside the expansion in crop area and production, with women taking on key roles in the cultivation of fruits, vegetables, and flowers (Baba *et al*., 2010). Women are integral to national progress, and their contributions are gaining growing acknowledgment. In spite of various obstacles, numerous women have excelled in entrepreneurship, showcasing strong willpower and perseverance. Their success reflects both individual strength and the broader potential of women in driving development (Rudrapal *et al*., 2024).

Materials and Methods

The present study was conducted in the Sepahijala and South Tripura districts of the state of Tripura, selected due to their prominent role in horticultural farming and higher agricultural activity levels compared to other districts. These districts served as representative areas where agriculture constitutes a major source of livelihood, thereby aligning well with the study's objective of assessing the extent of participation of farm men and farm women in horticultural practices. The study population consisted of individuals actively engaged in horticultural farming. A total of 320 respondents, comprising 160 farm men and 160 farm women were selected through simple random sampling to eliminate selection bias and ensure equal probability of inclusion. This sampling technique helped capture a broad spectrum of experiences and participation patterns among farm men and farm women. Data collection was undertaken through personal interviews, using a structured and pre-tested questionnaire. The pre-testing ensured clarity, coherence, and appropriateness of the questions to the local farming context. The structured format enhanced data consistency, and face-to-face interviews allowed the collection of in-depth responses while ensuring respondents' understanding of the questions. The study focused on 18 critical horticultural farming activities. Each activity was evaluated using a four-point scale designed to measure the level and mode of participation. The scale was defined as follows:

- 4 – Activity performed independently by either farm men or farm women
- 3 – Jointly by both farm men and farm women
- 2 – Jointly performed along with other family members
- 1 – jointly performed with assistance from family, hired labour, machinery and contractual support (indicating partial involvement)

To assess the distributional properties of the collected data, the Shapiro-Wilk test for normality was applied. The test results indicated *p*-values below 0.05, suggesting that the assumption of normality was violated. Consequently, this justified the use of non-parametric methods for further analysis. Given the non-normal distribution of the data, the Mann-Whitney U test was utilized as the primary statistical tool. This test is particularly suitable for comparing two independent groups when data are ordinal. In this research, it was applied to detect statistically significant differences in participation patterns between farm men and farm women across the selected horticultural farming activities. A significance level (α) of 0.05 was adopted. Results with *p*-values less than 0.05 were considered statistically significant, implying that gender differences in participation for specific farming tasks were unlikely to be due to chance. This methodical approach provided robust insights into the gender dynamics of horticultural farming in the study areas.

Results and Discussion

Table 1 presents the mean values and ranks of farm men and farm women across 18 horticultural farming activities, highlighting gender-based

differences in task participation. Among farm men, the highest mean value was observed in crop selection (Mean = 4.00, Rank 1), followed by irrigation (Mean = 3.93, Rank 2), and land preparation (Mean = 3.82, Rank 3). Other activities where men showed high participation included ploughing (Mean = 3.74, Rank 4), marketing (Mean = 3.73, Rank 5), and pesticide and insecticide application as well as mulching (both with Mean = 3.71, Rank 6). On the other hand, the lowest mean values among men were recorded for harvesting (Mean = 2.43, Rank 17) and weeding (Mean = 2.68, Rank 16), suggesting relatively limited involvement in these labour-intensive tasks. In contrast, farm women exhibited the highest mean value in weeding (Mean = 2.99, Rank 1), followed by harvesting (Mean = 2.77, Rank 2), and transportation to field (Mean = 2.61, Rank 3). Notably, women also actively participated in budding (Mean = 2.56, Rank 4) and land preparation (Mean = 2.38, Rank 5). However, lower mean values were recorded for women in activities that typically involve decision-making or technical knowledge, such as crop selection (Mean = 1.21, Rank 18), pesticide and insecticide application (Mean = 1.31, Rank 17), and training (Mean = 1.41, Rank 16). These results underscore a clear division of labor in horticultural practices. Men were more engaged in strategic, high-input, and physically demanding operations, whereas women primarily contributed to hands-on, routine, and maintenance activities. The findings suggest the need for gender-sensitive interventions that enhance women's skills and participation in technical and decision-oriented aspects of horticulture. A related study found that women were predominantly engaged in stubble collection, transplanting, and weeding of horticultural crops, while also playing a key role in field preparation, harvesting, and cleaning activities (Tripathi *et al*., 2015).

Table 1 : Mean value of horticultural farming activities of farm men and farm women (n=320)
Farm men=160, Farm women=160

S.No.	A. Horticultural farming activities	Farm Men		Farm Women	
		Mean	Rank	Mean	Rank
1.	Land preparation	3.82	3	2.38	5
2.	Ploughing	3.74	4	1.66	14
3.	Levelling	3.09	14	1.96	12
4.	Manure and fertilizer application	3.67	7	1.76	13
5.	Sowing of seeds for rootstock	3.22	12	2.07	9
6.	Grafting	3.64	9	2.13	8
7.	Budding	3.27	10	2.56	4
8.	Crop selection	4.00	1	1.21	18
9.	Transportation to field	3.04	15	2.61	3
10.	Planting	3.19	13	2.00	11
11.	Irrigation	3.93	2	2.23	6
12.	Weeding	2.68	16	2.99	1
13.	Pesticide and insecticide application	3.71	6	1.31	17
14.	Training	3.65	8	1.41	16
15.	Pruning	3.26	11	2.20	7
16.	Mulching	3.71	6	2.02	10
17.	Harvesting	2.43	17	2.77	2
18.	Marketing	3.73	5	1.58	15

The distribution of farm men and farm women based on their level of participation in horticultural farming is presented in Table 2. Among farm men, 48.8% (n= 78) were found to have a high level of participation, while 51.2% (n= 82) fell into the medium participation category. Notably, none of the farm men were categorized under low participation. In contrast, no farm women (0%) were observed in the high participation group. A majority of farm women, 54.4% (n= 87), exhibited a low level of participation, while the remaining 45.6% (n= 73) fell into the medium category. This trend suggests that men tend to be more actively involved in horticultural operations overall, while women's participation remains limited, likely due to socio-cultural, economic, or access-related constraints.

Table 2 : Distribution of farm men and farm women according to their level of participation in horticultural farming

(n=320)
Farm men=160, Farm women=160

	Category	Farm men		Farm women	
		Frequency	Percentage	Frequency	Percentage
Participation in horticultural farming	High	78	48.8	0	0
	Medium	82	51.2	73	45.6
	Low	0	0	87	54.4

Hypothesis testing

H_{01}: There is no significant difference in the extent of participation of farm men and farm women in horticultural farming

H_{11}: There is a significant difference in the extent of participation of farm men and farm women in horticultural farming

The Mann-Whitney U test results, as shown in Figure 1, indicate that farm men had higher mean and median participation levels in horticultural farming than farm women. This suggests greater involvement of men in farming activities. Moreover, the taller box in the figure reflects higher variability in participation among farm men. In contrast, women's participation was more consistent but generally lower. This highlights a clear gender disparity in farming roles.

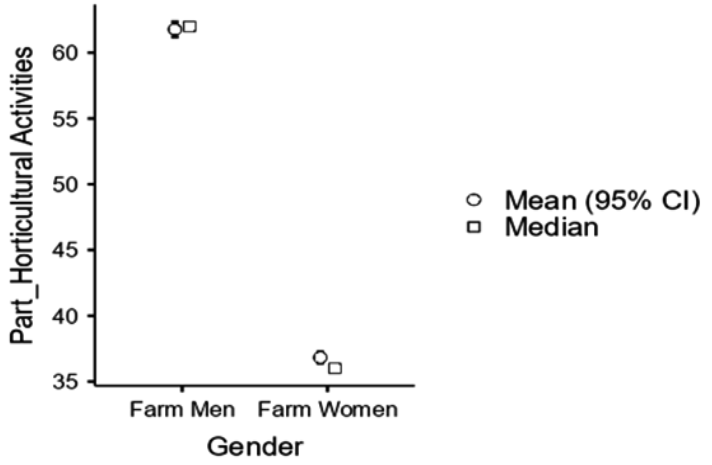

Fig. 1 : Mean and median difference between horticultural farming of farm men and farm women

Table 3 presents the results of the Mann-Whitney U test comparing the participation of farm men and farm women in horticultural farming. The findings show that farm men (N= 160) had a higher mean participation score of 61.8 with a median of 62.0, whereas farm women (N= 160) had a significantly lower mean of 36.8 and a median of 36.0. The standard deviations were 3.67 for men and 2.80 for women, indicating slightly more variability among male participants. The test yielded a statistically significant difference ($p < 0.001$), with a rank biserial correlation of 1.00, signifying a very large effect size and a clear distinction between the two groups in terms of their involvement in horticultural activities.

Table 3 : Mann-Whitney U test analysis on horticultural farming of farm men and farm women

Participation	Group	N	Mean	Median	SD	SE
horticultural farming	Farm men	160	**61.8**	**62.0**	3.67	0.290
	Farm women	160	36.8	36.0	2.80	0.222
	Statistics	***p*-value**			**Effect size**	
	0.00	<0.001	Rank biserial correlation		1.00	

Conclusion

The study aimed to analyze the extent and nature of gender-based participation in horticultural farming, focusing on 18 key farming activities. The findings clearly illustrate a gendered division of labour, with farm men primarily engaged in strategic, technical, and physically demanding activities, while farm women were more involved in manual, routine, and maintenance-related tasks. Among men, the highest participation was seen in crop selection (Mean= 4.00), irrigation (Mean= 3.93), and land preparation (Mean= 3.82) activities typically linked to decision-making and higher input use. Conversely, farm women recorded the highest participation in weeding (Mean= 2.99), harvesting (Mean= 2.77), and transportation to field (Mean= 2.61), with very low involvement in strategic roles such as crop selection (Mean= 1.21) and pesticide application (Mean= 1.31). The distribution of participation levels further reinforced this disparity. While 48.8% of farm men fell into the high participation category and none in the low, a contrasting pattern emerged for women, with 54.4% showing low participation and none in the high. This indicates that women are structurally limited in their involvement, likely due to socio-cultural barriers, restricted access to training and technology, and limited decision-making authority. Statistical analysis using the Mann-Whitney U test revealed a significant difference ($p < 0.001$) in participation levels, with men scoring a higher mean of 61.8 and women a lower mean of 36.8. The rank biserial correlation of 1.00 confirmed a very large effect size, indicating a pronounced gender gap in horticultural engagement. Overall, the study highlights the need for gender-sensitive interventions in horticulture. Enhancing women's access to training, decision-making roles, and technical inputs can help bridge this divide. Promoting inclusive agricultural policies and capacity-building initiatives is crucial for ensuring equitable participation, boosting productivity, and empowering farm women as key stakeholders in horticultural development.

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