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Mapping gender gaps in participation and access to resources in agri-food systems of Telangana state

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Abstract

The study was conducted in Nagarkurnool district of Telangana state to examine gender participation in agri-food systems with reference to Paddy and Redgram cultivation. An ex-post facto research design was adopted and 120 respondents (60 men and 60 women) were selected through stratified random sampling. Data was collected using a pre-tested interview schedule and analyzed using frequency, percentage and chi-square tests.

The results revealed significant gender disparities across all four stages of the agri-food system. In production, women were concentrated in low (36.67%) and medium (56.66%) categories, while men dominated the high category (63.33%). In processing, women reported greater participation in the high category (58.33%) and men were concentrated in the medium (46.67%). Marketing showed the widest gap, with women clustered in the low category (58.33%) and men were concentrated in the high (55.00%). In consumption, women were strongly represented in the high category (58.33%), while men were concentrated in the low (51.67%). Access to resources also reflected similar inequalities, with women largely in low access groups for inputs, machinery, finance, labour, technology and markets, while men dominated medium and high categories. All gaps were statistically significant. The study demonstrates that gender disparities remain embedded across both participation and resource access, underscoring the need for inclusive interventions to strengthen equity and resilience in agri-food systems.

Keywords: Agri-food systems, access to resources, gender gaps and gender participation.

Introduction

Agri-food systems are central to sustaining rural livelihoods and ensuring food security. Food system or food supply chain refers to the processes that describe how food from farm ends up on our table. This system encompasses multiple stages, including production, processing, marketing and the consumption of food, thereby shaping not only the flow of food but also its role in income generation, employment and nutritional well-being. Globally, almost one-third of the labour force depends on these systems for their livelihood. However, their full potential is often constrained by structural inequalities, particularly along gender lines. Women contribute extensively in cultivation, post-harvest management and household nutrition, yet their roles are frequently undervalued due to limited access to land, technology, markets and institutional support (FAO, 2023) [1]. Addressing these disparities is critical for improving productivity and building inclusive, resilient food systems.

In India, where agriculture remains the backbone of the rural economy, women constitute a substantial share of the workforce engaged in agricultural and household foodrelated activities. Their contributions span farm operations as well as food preparation and household nutrition. Despite this, women's involvement is largely informal, characterized by limited ownership of productive resources and minimal influence in decision-making. Men are more likely to hold land titles, operate farm machinery and control marketing activities, while women remain concentrated in labour-intensive roles such as transplanting, weeding, harvesting and post-harvest processing. This unequal division of roles reduces women's economic agency and undermines the efficiency of agricultural systems (MoAFW, 2018; MoSPI, 2022) ^[6,7].

Telangana reflects these national patterns, with women actively engaged in farming but they continue to face systemic barriers in landholding, credit access and market participation. Within this state, Nagarkurnool district presents a particularly relevant context. Paddy cultivation is labour-intensive and irrigation dependent, while Redgram is predominantly rainfed and less labour demanding. The contrast between these two cropping environments provides a meaningful setting for examining how gender disparities play out across different stages of the agri-food system.

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Despite the crucial role of women in agriculture, their contributions across the food system remain undervalued and insufficiently documented. Stage-wise analysis encompassing production, processing, marketing and consumption, alongside an assessment of disparities in access to resources such as inputs, machinery, labour, finance, technology and markets is essential to capture the extent of gender gaps. Therefore, the present study was undertaken to examine gender gaps in participation and access to resources in Paddy and Redgram cultivation in Telangana state.

Materials and Methods

The study was carried out in Nagarkurnool district of Telangana state. An ex-post facto research design was adopted, as the study focused on analyzing existing conditions rather than imposing treatments. Two mandals with the highest area under these crops were chosen purposively and from each mandal, two villages were selected randomly. From every selected village, 15 male and 15 female farmers cultivating Paddy and Redgram were identified, resulting in a total sample of 120 respondents (60 men and 60 women). Stratified random sampling ensured balanced representation of both genders. Data was collected using a structured and pre-tested interview schedule through personal interview method. Information was elicited on two major aspects: (i) stage-wise participation in agri-food systems covering production, processing, marketing and consumption and (ii) access to key resources such as inputs. machinery, labour, finance, technology and markets. The schedules were carefully designed, pre-tested and refined to ensure clarity and reliability.

The data was analyzed using frequency and percentage for assessing distribution patterns, while chi-square test was applied to determine the significance of differences between male and female participation across stages of the agri-food system and their access to resources. The gender gap was calculated following the method of Waris *et al.* (2016) [11], defined as the difference between female and male participation percentages.

Results and Discussion

Gaps in gender participation across stages of agri-food systems

- Production Stage
- Processing Stage
- Marketing Stage
- Consumption Stage

Production Stage

As seen in Table 1, the production stage reflected sharp gender disparities. The majority of women (56.66%) were clustered in the medium category, while another (36.67%) fell under low participation and only (6.67%) reached the high category. By contrast, men were predominantly concentrated in the high category (63.33%), with smaller shares in medium (31.67%) and low (5.00%).

The calculated gaps further underline this imbalance. Women exceeded men in the low (+31.67 pp) and medium (+24.99 pp) categories, confirming their predominance in labour-intensive activities such as transplanting and weeding. In contrast, men outnumbered women

substantially in the high category (-56.66 pp), demonstrating their greater control over mechanization, input application and production-related decision-making. The chi-square test confirmed that these differences were statistically significant ($x^2 = 46.21$, p < 0.001), indicating that participation in production stage is strongly associated with gender. These findings revealed that women's agricultural contributions remain largely confined to manual fieldwork, while men dominate resource and technology-intensive roles. Such disparities reinforce structural gender gaps in production, limiting women's decision-making authority and access to modern resources. These results are consistent with the findings reported by Kumari (2018) [4].

Table 1: Gender participation and gaps in the production stage of agri-food systems (n=120)

S. No.	Category	Farm women (n1=60)			n men 2=60)	Gap (pp)	
		F	%	F	%		
1.	Low	22	36.67	3	5.00	+31.67	
2.	Medium	34	56.66	19	31.67	+24.99	
3.	High	4	6.67	38	63.33	-56.66	
	Total	60	100	60	100		

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square $(x^2) = 46.21$, df = 2, p < 0.001.

Processing Stage

As seen in Table 2, the processing stage showed a reverse trend when compared to production. A majority of women (58.33%) were in the high participation category, while (26.67%) were in medium and only (15.00%) in low. By contrast, men were concentrated in the medium (46.67%) and low (23.33%) categories, with just (30.00%) in the high category.

The gap values further illustrate this difference. Women outnumbered men in the high category (+28.33 pp), highlighting their strong involvement in activities such as cleaning, grading, drying and storage. On the other hand, men exceeded women in the medium (-20.00 pp) and low (-8.33 pp) categories, reflecting their relatively limited role in post-harvest handling. The chi-square test indicated a significant association between gender and participation (x² = 9.81, p = 0.007), confirming that men and women contribute unequally to processing. This pattern reflects a gendered division of labour, where women carry the primary responsibility for tasks that ensure household food security but receive little recognition or institutional support for their contributions. These results are consistent with the findings reported by Kumari (2018) [4] and Pallavi kumari et al. (2025) [10].

Table 2: Gender participation and gaps in the processing stage of agri-food systems (n=120)

S. No.	Category	Farm women ry (n1=60)			arm men (n2=60)	Gap (pp)	
110.		F	%	F	%	(PP)	
1.	Low	9	15.00	14	23.33	-8.33	
2.	Medium	16	26.67	28	46.67	-20.00	
3.	High	35	58.33	18	30.00	+28.33	
	Total	60	100	60	100		

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square $(x^2) = 9.81$, df = 2, p = 0.007.

Marketing Stage

As seen in Table 3, the marketing stage revealed the widest gender disparities among all stages. A majority of women (58.33%) were concentrated in the low participation category, while (33.33%) fell under medium and only (8.34%) were in the high category. In contrast, most men (55.00%) were in the high category, followed by (31.67%) in medium and only (13.33%) in low.

The calculated gaps underline this divide. Women had a much higher share in the low category (+45.00 pp), showing that their role was restricted mainly to minor sales and assisting in local transactions. Men dominated the high category (-46.66 pp), reflecting their greater mobility, access to markets and authority in price negotiation and decision-making. The gap in the medium category was minimal (+1.66 pp), indicating near parity at that level. The chi-square test ($x^2 = 37.61$, p < 0.001) confirmed that gender differences in marketing participation were statistically significant. These findings revealed that women's limited access to transport, credit and institutional networks constrains their ability to participate actively in marketing, whereas men dominate commercial transactions. This structural imbalance not only reduces women's economic visibility but also perpetuates gender-based inequalities in agri-food systems. These results are consistent with the findings reported by Joshi et al. (2018) [3] and Kumari (2018) [4].

Table 3: Gender participation and gaps in the marketing stage of agri-food systems (n=120)

S. No.	Category	Farm women (n1=60)		Farm men (n2=60)		Gap (pp)	
110.		F	%	F	%	(pp)	
1.	Low	35	58.33	8	13.33	+45.00	
2.	Medium	20	33.33	19	31.67	+1.66	
3.	High	5	8.34	33	55.00	- 46.66	
	Total	60	100	60	100		

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square $(x^2) = 37.61$, df = 2, p < 0.001.

Consumption Stage

As seen in Table 4, the consumption stage displayed a strong gender bias in favour of women. A majority of women (58.33%) were in the high category, while (30.00%) were in medium and only (11.67%) were in low. In contrast, most men (51.67%) were in the low category, with (33.33%) in medium and only (15.00%) in high.

The gaps highlight this contrast clearly. Women exceeded men by +43.33 pp in the high category, confirming their central role in meal planning, cooking and ensuring nutritional quality at the household level. Conversely, men dominated the low category (-40.00 pp), suggesting their limited involvement in food preparation and household consumption-related decisions. The medium category showed a marginal gap (-3.33 pp), indicating near-equal participation between men and women. The chi-square test ($x^2 = 30.63$, p < 0.001) established that these differences were statistically significant. These findings revealed that women play a leading role in ensuring household food and nutrition security, while men's contribution to consumption-related activities is minimal. Such patterns reinforce

traditional gender roles, wherein women shoulder the responsibility of managing household diets, but this critical contribution often remains undervalued in formal economic assessments. These results are consistent with the findings reported by Paul and Radharani (2017) ^[5].

Table 4: Gender participation and gaps in the consumption stage of agri-food systems (n=120)

S.	Category	Farm wom	en (n1=60)		m men 2=60)	Gap (pp)
NO.		F	%	F	%	(pp)
1.	Low	7	11.67	31	51.67	- 40.00
2.	Medium	18	30.00	20	33.33	- 3.33
3.	High	35	58.33	9	15.00	+43.33
	Total	60	100	60	100	

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square (x^2) = 30.63, df = 2, p < 0.001.

Gaps in Gender Access to Resources

- Access to Inputs
- Access to Machinery
- Access to Labour
- Access to Finance
- Access to Technology
- Access to Markets

Access to Inputs

As seen in Table 5, there were substantial gender gaps in access to agricultural inputs. A majority of women (53.33%) were in the low category, while (38.33%) were in medium and only (8.34%) reported high access. By contrast, most men (55.00%) were in the medium category and a significant share (33.33%) reported high access, while only (11.67%) were in the low category.

The calculated gaps highlight this inequality clearly. Women outnumbered men in the low category (+41.66 pp), reflecting their dependence on limited, shared or borrowed inputs. Men, however, dominated both the medium (-16.67 pp) and high (-24.99 pp) categories, showing their greater control over direct procurement of quality seeds, fertilizers and pesticides. The chi-square test confirmed that these differences were statistically significant ($x^2 = 26.81$, p < 9.810.001), indicating that access to inputs is strongly genderdifferentiated. These findings revealed that women's restricted land ownership and weaker institutional linkages limit their access to agricultural inputs, while men generally control purchase and allocation. This disparity not only undermines women's productivity but also reinforces their dependence on male counterparts for farm decision-making. These results are consistent with the findings reported by Milcah Paul and Radharani (2017)^[5].

Table 5: Gender gaps in access to agricultural inputs (n=120)

S. No.	Cotogomy	Farm women (n1=60)		Farm m	Gap	
No.	Category	F	%	F	%	(pp)
1.	Low	32	53.33	7	11.67	+41.66
2.	Medium	23	38.33	33	55.00	-16.67
3.	High	5	8.34	20	33.33	-24.99
	Total	60	100	60	100	

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square $(x^2) = 26.81$, df = 2, p < 0.001.

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Access to Machinery

As seen in Table 6, gender differences in access to machinery were highly significant. More than half of the women (51.67%) were in the low category, while (35.00%) were in medium and only (13.33%) reported high access. In contrast, a majority of men (53.33%) were in the medium category and (36.67%) enjoyed high access, with only (10.00%) in low.

The gap values clearly reflect this disparity. Women exceeded men in the low category (+41.67 pp), indicating their restricted access to farm implements and dependence on traditional tools. Men, however, dominated in both medium (-18.33 pp) and high (-23.34 pp) categories, showing their greater access to tractors, threshers and other mechanized equipment. The chi-square test ($x^2 = 25.71$, p <0.001) confirmed that these differences were statistically significant, establishing that machinery access is strongly gender-biased. These findings revealed that women's limited land ownership and financial constraints often restrict their use of mechanized equipment, while men have greater opportunities. This divide not only increases women's drudgery but also constrains overall productivity by preventing equitable use of machinery in agriculture. These results are consistent with the findings reported by Prasanna et al. (2022) [8].

Table 6: Gender gaps in access to agricultural machinery (n=120)

S. No.	Cotogomy	Farm wome	arm women (n1=60)Farm men (n2=60)			Gap
No.	Category	F	%	F	%	(pp)
1.	Low	31	51.67	6	10.00	+41.67
2.	Medium	21	35.00	32	53.33	-18.33
3.	High	8	13.33	22	36.67	-23.34
	Total	60	100	60	100	

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square $(x^2) = 25.71$, df = 2, p < 0.001.

Access to Labour

As seen in Table 7, gender differences in access to agricultural labour were statistically significant. Nearly half of the women (46.67%) were concentrated in the low category and (40.00%) were in medium, while only (13.33%) reported high access. In contrast, most men were distributed in the medium (51.67%) and high (36.66%) categories, with only (11.67%) reporting low access.

The gap values illustrate the imbalance clearly. Women exceeded men by (+35.00 pp) in the low category, indicating their limited ability to hire or mobilize labour for farm operations. Men, however, dominated the medium (-11.67 pp) and high (-23.33 pp) categories, reflecting their stronger command over hired workers and supervisory roles in labour management. The chi-square test ($x^2 = 20.02$, p <0.001) confirmed that the association between gender and access to labour resources was significant. These findings highlighted that women farmers often depend on household members or shared labour, while men are more likely to access external labour markets. This structural limitation women's efficiency and reinforces restricts dependence on male counterparts in labour-intensive agricultural tasks. These results are consistent with the findings reported by Pandey et al. (2024) [9].

Table 7: Gender gaps in access to agricultural labour (n=120)

S. No.	Catagam	Farm women (n1=60) Farm men (n2=60			en (n2=60)	Gap
No.	Category	F	%	F	%	(pp)
1.	Low	28	46.67	7	11.67	+35.00
2.	Medium	24	40.00	31	51.67	-11.67
3.	High	8	13.33	22	36.66	-23.33
	Total	60	100	60	100	

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square (x^2) = 20.02, df = 2, p < 0.001.

Access to Technology

As shown in Table 8, access to agricultural technology exhibited significant gender differences. A majority of women (56.67%) were in the low category, while (38.33%) were in medium and only (5.00%) in high. In contrast, men were largely concentrated in the medium (66.67%) category, with (15.00%) reporting high access and only (18.33%) in low.

The gap values confirm this disparity. Women had a clear excess in the low category (+38.34 pp), indicating their limited access to modern tools, digital platforms and improved technologies. Men dominated the medium (-28.34 pp) and high (-10.00 pp) categories, reflecting their greater exposure to innovations, training and institutional linkages. The chi-square test ($x^2 = 21.15$, p < 0.001) validated these differences as statistically significant. These findings revealed that women farmers face systemic barriers to technology adoption, including training gaps, mobility restrictions and weaker extension linkages. Men, on the other hand, benefit from better access to demonstrations, services and mechanized solutions. technological divide reinforces productivity gaps and hinders inclusive agricultural growth. These results are consistent with the findings reported by Prasanna et al. $(2022)^{[8]}$.

Table 8: Gender gaps in access to agricultural technology (n=120)

S.	C-4	Farm women (n1=60)		Farm mei	Gap	
No.	Category	F	%	F	%	(pp)
1.	Low	34	56.67	10	18.33	+38.34
2.	Medium	23	38.33	41	66.67	-28.34
3.	High	3	5.00	9	15.00	-10.00
	Total	60	100	60	100	

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square $(x^2) = 21.15$, df = 2, p < 0.001.

Access to Finance

As presented in Table 9, significant gender disparities were observed in access to finance. Nearly half of the women (48.33%) fell under the low category, while (43.34%) were in medium and only (8.33%) reported high access. In contrast, a majority of men (56.67%) were in the medium category, with a notable share (31.66%) in high and only (11.67%) in low.

The calculated gaps highlight this inequality. Women exceeded men in the low category (+36.66 pp), reflecting their limited access to institutional credit, reliance on informal borrowing and dependence on male counterparts for financial transactions. Men dominated the medium (-

13.33 pp) and high (-23.33 pp) categories, indicating stronger access to banks, cooperatives and formal credit systems. The chi-square test ($x^2 = 22.68$, p < 0.001) confirmed that the association between gender and access to finance was statistically significant. These results highlighted that women face systemic barriers in accessing financial services due to lack of collateral, weak institutional networks and socio-cultural constraints, while men are better positioned to obtain loans and subsidies. The persistence of such disparities reinforces women's dependence on informal credit and limits their ability to invest in productivity-enhancing technologies. These results are consistent with the findings reported by Milcah Paul and Radharani (2017) [5].

Table 9: Gender gaps in access to agricultural finance (n=120)

S. No.	Catagam	Farm wo	men (n1=60)	nen (n1=60) Farm men (n2=60)			
No.	Category	F	%	F	%	(pp)	
1.	Low	29	48.33	7	11.67	+36.66	
2.	Medium	26	43.34	34	56.67	-13.33	
3.	High	5	8.33	19	31.66	-23.33	
	Total	60	100	60	100		

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square (x^2) = 22.68, df = 2, p < 0.001.

Access to Markets

As shown in Table 10, access to markets revealed the widest gender gap among all resources studied. A majority of women (58.33%) were in the low category, while (28.33%) were in medium and only (13.34%) had high access. In contrast, men were predominantly concentrated in the high category (53.33%), followed by (35.00%) in medium, with just (11.67%) in low.

The calculated gaps further underline this disparity. Women exceeded men in the low category (+46.66 pp), indicating restricted mobility, dependence on intermediaries and exclusion from formal market spaces. Men, however, dominated the high category (-39.99 pp), reflecting their stronger presence in negotiations, price decisions and linkages with traders. The medium category showed a relatively small gap (-6.67 pp), pointing to near parity at that level. The chi-square test ($x^2 = 33.49$, p < 0.001) confirmed that the differences in market access were statistically significant. These results highlighted that women's limited physical mobility, lack of financial autonomy and weaker institutional support restrict their participation in markets, while men are more integrated into trade networks and commercial channels. Such imbalances reduce women's economic visibility and perpetuate gender-based inequalities in agricultural marketing. These results are consistent with the findings reported by Pandey et al. (2024) [9].

Table 10: Gender gaps in access to agricultural markets (n=120)

S.	Cotogowy	Farm women (n1=60)		Farm mer	Gap	
No.	Category	F	%	F	%	(pp)
1.	Low	35	58.33	7	11.67	+46.66
2.	Medium	17	28.33	21	35.00	-6.67
3.	High	8	13.34	32	53.33	-39.99
	Total	60	100	60	100	

Note: Gap (pp) = Women% - Men%; positive = higher share of women, negative = higher share of men. Chi-square (x^2) = 33.49, df = 2, p < 0.001.

Conclusion

The study revealed that gender disparities in agri-food systems vary distinctly across stages. Men dominated the high participation categories in production and marketing, reflecting their control over mechanized operations, resource allocation and market negotiations. In contrast, women were more prominent in the high categories of processing and household consumption, due to their central role in post-harvest handling, food preparation and nutrition management.

Access to resources showed a consistent imbalance, with women concentrated in low-access categories for inputs, machinery, labour, finance, technology and markets, while men dominated medium and high access categories. These patterns underline that although women are indispensable contributors to agriculture and household food security, their efforts are constrained by structural inequalities and limited institutional support.

These findings highlight the need for a more inclusive approach that addresses gaps across both genders. Strengthening extension and training programs with cross-learning components that involve men in labour-intensive activities while enabling women to participate more actively in decision-oriented roles. Introducing drudgery-reducing technologies and small-scale mechanization can ease the workload of women while also enhancing efficiency for both genders. Expanding financial inclusion and market access in a way that promotes joint participation and decision-making within households can further reduce structural inequalities.

Overall, bridging these disparities requires strategies that are not limited to empowering women alone but that also create complementary roles for men and women. Such an approach would enhance productivity, foster equity and build more resilient agri-food systems capable of contributing to sustainable rural development and food security.

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