Role of Tribal Women in Sustainable Practices for Conserving Nature of Odisha, India

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Abstract.
Tribal women are significant contributors to eco-friendly agriculture and rural sustainable lifestyles, and are very closely related to the protection of natural ecosystems. As they assume work that encompasses the entire agricultural cycle, from land preparation to post-harvest operations, they prove a deep-rooted dedication to the farm sector. They contribute to the preservation of biodiversity through the use of resources seed conservation and the application of conventional methods. Because their involvement covers water conservation forest management and the sustainable use of non-timber forest resources it highlights their broader impact on ecological balance and community well-being. Investigating how local tribal women promote ecological preservation and sustainable agricultural methods is the goal of this project. Simple random sampling was used to select 336 households 25 from each of the 12 blocks in the Kandhamal district of Odisha which is known for its diverse and tribally concentrated agricultural landscapes.

Keywords: Agricultural participation, Agricultural cycle, Biodiversity, Ecological balance, Sustainable livelihoods.

1 Introduction

Tribal women depend on protection of natural resource. Their traditional understanding of the environment enables them to manage forests water bodies and soils sustainably as their lives are intimately linked to the environment (Balasubramanian and Sangha 2021). They play an important role in the use and upkeep of local resources and

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are in charge of basic domestic and agricultural duties (Chopra and Dasgupta 2008). They are fully involved in the production of food and the preservation of the environment and they take part in agriculture at every stage of the process from soil preparation to planting harvesting and post-harvest processing. Despite their crucial role they are mostly left out of the mainstream discussion and decision-making surrounding sustainable development. Tribal women can manage community seed systems encourage biodiversity and adopt eco-friendly practices more effectively because they are knowledgeable about natural cycles. In addition, they constitute the vital elements for the environmentally responsible for non-timber forest products as well as the protection of the forest areas through the provision of clean water. Even if they have not received recognition from the authorities, they still play an essential role in the conservation of the ecological equilibrium and the nourishment of the scenic population. They are a very necessary component for such policies that are socially exposed and enable the indigenous communities' eco-friendly development and the equal rights of genders.

2 Contribution to Agricultural Labor and Decision-Making

Traditionally, tribal women have been the primary performers of agricultural works that include planting, weeding, harvesting and processing, even more than men. They have not been excluded from agricultural decision-making. There is an obvious difference between decision-making skills and labour input. Mishra and Singh (2022) studied women's participation in agriculture is labour-intensive yet structurally constrained in terms of decision-making authority. This explores household and community level decision processes, shows that even though women perform nearly 70% of agricultural labour in subsistence farming systems involving such tasks as sowing, weeding, transplanting, harvesting, and post-harvest work, they rarely retain substantive control over decisions related to land use, crop selection and resource allocation. Sahu and Nayak (2021) proposed that women had been part of almost every aspect of agriculture they were still prohibited from getting the most vital agricultural resources, like owning land, getting loans from institutions, and availing of extension services. Therefore, the gender gap still exists among women in tribal agriculture; the noticeable gender gap is there, nevertheless their considerable contributions. They are quiet while they are the most necessary ones to the decision-making processes, which undeniably continue.

3 Sustainable Agricultural Practices and Agro-Biodiversity

Building a soil health and ecological balance of food security is the most significant impact produced by the entire process. As tribal women undergo sustainable agricultural practices, their main drivers have been implemented for the last decades. Crop diversification, seed conservation, and the use of organic inputs are some of the techniques used to enhance agrobiodiversity (Rout and Pattnaik 2023). Their knowledge is the most trustworthy source for the revival of the native agricultural variety. Besides, for the promotion of soil health and ecological integrity, they also use mixed-cropping systems, community seed banks, and organic composts (Rout and Pattnaik 2023). Bora

and Sharma 2020 studied participation in resource management and conservation of biodiversity involved in activities like shifting cultivation and agroforestry. They have made a great contribution to agriculture and environmental sustainability despite limited access to institutional resources. Nearly 80 per cent of tribal women in Odisha are without land ownership, hence about 15% of them are allowed official loans and extension services (Patel and Mohapatra 2021). This gap in the provision of resources is a major limiting factor to scaling up and modernising their agricultural operation. Srinivas (2022) identified that only 18 percent of tribal women had participated in agricultural extension training programs; therefore, a huge outreach and education deficit for tribal women through extension in these areas exists.

4 Challenges in Agriculture: Climate Change and Socioeconomic Barriers

The deterioration of the climate has made the tribal farm women even more vulnerable, and these form the most disadvantaged layer in the rural production systems. Changeable weather conditions, decreasing soil fertility, and water shortage have all increased the farming tasks beyond the limits of possibility. These threats to nature meet persistent socio-economic barriers i.e. poverty, low literacy, lack of extension service, and bad rural infrastructure, which limit the ability to make adjustments or switch to more climate-resilient farming methods. Pandey and Das (2020) observed that climate variability has led to direct and adverse effects on agricultural livelihoods. This impact has been disproportionate to women, as their dependence on rain-fed subsistence farming is very high. Chakraborty (2021) deliberated that the lack of access to healthcare, education, and transport as well as climate-resilient technologies, are the factors that limit women's adaptive capacity. As a result, these women are the most susceptible to the changing climatic conditions that, among other things, increase their food insecurity and exacerbate the existing gender disparities in tribal agrarian communities, although they are the most involved in agricultural labour.

5 Empowerment and Gender Equality in Agriculture

Recent research has shown how important it is to increase tribal women's access to basic resources, encourage their participation in gender-neutral agricultural systems, and expand their educational opportunities to effectively empower them. Empowering tribal farm women is the only way to increase agricultural productivity and encourage sustainable rural development. According to Kumari and Singh (2022), safe land ownership for women, improved access to financing options, and increased outreach through agricultural extension services are all essential for guaranteeing inclusive agricultural growth. These interventions greatly increase their ability to make a meaningful contribution to agricultural output and decision-making processes. Singh and Verma (2021) have highlighted cooperative farming methods and Self-Help Group (SHGs) as

collective platforms that provide tribal women with access to markets, micro-credit, and increased participation in local policymaking. Tribal women are underrepresented in institutional research and national conservation policy, despite being essential to environmental protection. Environmental policies that are gender-responsive are hampered by this marginalization. The ecological knowledge of tribal women must be acknowledged and taken into account, particularly in view of the growing problems of deforestation, climate change and biodiversity loss. This study aims to fill the existing research gap by emphasizing their significance for ecosystem preservation and sustainable farming methods. Empirical data from field interviews and case studies have been used to encourage tribal women to take part in rural development and environmental planning programs. Recognition improves their standing as recipients and their contributions to achieving sustainability.

6 Methodology

According to the 2011 Census, 198498 females were living in the nine-blocks in Kandhamal district of Odisha. The sample was selected based on an understanding of the socioeconomic background of tribal women's agricultural activity in the area, which was derived from this demographic data. Data analysis for the study was done using SPSS (Version 16). When appropriate, an effort was made to use specific coding and scoring methods to carefully convert qualitative data into quantitative representation. The primary variables were summarised using descriptive statistics such as mean and standard deviation. Pearson's correlation coefficient was applied to investigate the interrelations among these variables. In the study, the design of sampling was found to be simple random sampling, which was appropriate in view of homogeneity in the population under investigation.

A sample size of 336 tribal women engaged in agriculture was initially selected through a multi-stage stratified random sampling technique with representation from all twelve tribal blocks of the Kandhamal district. After validation regarding completeness of responses, internal consistency, and measurement framework, 334 valid responses (which account for a response rate of 99%) were finalized for analyses.

The major task of the research undertaking was the measurement of the involvement of tribal women in farm work, which was measured as the dependent variable in man-days (one man-day meaning eight hours of labour, following Mahipal, 1992). In order to obtain the desired information, a semi-structured interview schedule was prepared, keeping the objectives of the study in view, and was pre-tested.

The respondents' age, educational background, family structure, dependency ratio, household income, level of social engagement, economic motivation, exposure to mass media, participation in extension activities, decision-making, and agricultural knowledge were among the many independent variables taken into account. These variables were quantified using structured modules. A household's dependency ratio was calculated by dividing the number of dependents by the number of earners.

Trivedi (1963) used to assess social participation; Supe (1969) measured economic motivation. Shamna (2006) assessed participation in family decision-making, agricultural extension, and the media. To evaluate knowledge about cropping practices unique to a certain location, a customized schedule was created. To determine its applicability and effectiveness, this schedule was pre-tested outside of the sample region. All data were gathered through face-to-face interviews with women directly involved in farming as their main livelihood activity.

7 Result and Discussion

Turmeric dominated the predominant cropping sequence in the village chosen for this study with paddy and mustard coming in second and third respectly. Therefore assessing the degree of tribal womens participation in farming activities related to these three important crops was the main goal of the study. By keeping track of the total number of hours they spent on different tasks their participation was evaluated. These hours were then converted into man-days where eight hours of labor was considered a man-day. According to the analysis tribal women made an average of 32–96 man-days per agricultural season. Compared to more general national and regional estimates for female agricultural workers this level of engagement is significantly lower. Every year women who work in agriculture typically receive 60–125 man-days of employment. Naresh (2014) discovered that tribal women in other areas frequently worked up to 158 man-days annually while Nisha (2008) reported that Keralan women laborers averaged 122 point 49 man-days. These discrepancies point to a pattern of tribal women in the study area experiencing underemployment or limited access to agricultural labor opportunities which may be a reflection of larger socioeconomic constraints in their local setting.

Table 1: Crop-wise Participation in term of man-days

Sl.No	Crop	Man-Days
1	Paddy	09.48
2	Mustard	11.81
3	Turmeric	12.70
	Total	33.99

The average number of man-days that tribal women contributed to the cultivation of the three main crops in the study area turmeric mustard and paddy is shown in Table 1. The total number of hours worked was converted into man-days where eight hours of labor was considered a man-day in order to quantify participation. According to the data tribal women had to put in the most labor during the cultivation of turmeric averaging between 12 and 70 man-days per season. Mustard came next with 11. 81 man-days and paddy had the least amount of involvement (9. 48 man-days). The total number of man-days involved in all three crops was 33990. Due to favorable weather and the seasonal migration of male laborers this trend implies that turmeric farming in-

volved more labor-intensive tasks that heavily relied on women's participation. Mechanization at some production stages or shared labor duties could be the cause of the comparatively lower involvement in paddy.

7.1 Participation in Paddy cultivation

Table 2 shows the extent of tribal women's contribution to different phases of paddy cultivation in terms of total time contributed, total man-days, and average man-days per person. The aggregate labor input added up to 9.48 man-days per woman for paddy crop.

Among all the activities, weeding had the largest labor input, with women contributing 2.42 man-days on average, followed by harvesting (1.95 man-days) and transplantation (1.58 man-days). These activities were usually carried out solely by women, with most taking complete charge in their households.

Lowest average contributions were recorded in activities like preparation of the bed (0.77), application of manure and fertilizer (0.60), and protection of plants (0.61). Activities like bundling, carrying, and threshing also involved high level of effort but yielded lower man-day averages because of shorter time or discontinuous nature.

2,472 hours, or 379.2 man-days, were spent on all procedures. Tribal women play a wide range of roles in rice farming, especially when it comes to labor-intensive and time-consuming tasks, as this analysis demonstrates.

Table 2. The Labor Contribution of Tribal women in Paddy Cultivation

Sl. No	Operations	Total time spent	Total man-days	Average time-spent by individual farmer
1	Bed preparation	246.4	30.8	0.77
2	Transplantation	505.6	63.2	1.58
3	Manure and fertilizer	192.0	24.0	0.60
4	Weeding	774.4	96.8	2.42
5	Plant protection measures	195.2	24.4	0.61
6	Harvesting	62.4	78.0	1.95
7	Bundling	214.4	26.8	0.67
8	Carrying	140.8	17.6	0.44
9	Threshing	140.8	17.6	0.44
	Total	2472	379.2	9.48

7.2 Participation in Mustard cultivation

Table 3 gives a separation of farm women from the tribal community's participation in different activities related to mustard cultivation, both in terms of total time spent, total man-days, and mean man-days per participant. Combined labor contribution per woman averaged out at 11.81 man-days for the mustard growing season.

Amongst the operations, threshing and harvesting had the largest average contributions to which women devoted 1.90 man-days each. Work like manure and fertilizer

application (1.80 man-days), weeding (1.72), and bundling (1.34) also involved considerable time and effort. Women's involvement in early phases like land preparation (0.74) and sowing (0.63) were comparatively lesser, possibly because there was male labor or machinery support involved for these operations. However, women continued to work actively throughout the growing season.

Interestingly, carrying (0.93) and protection measures (0.85) within the farm also necessitated a high level of input, showing the participation of women in field and post-field activity. A total of 3,779.2 labour hours and 472.4 man-days were needed for mustard cultivation, which shows to the difficult nature of the task and the dominating role of women in this undertaking. This is also a sign of a seasonal change in the makeup of the workforce, usually brought on by male out-migration during the winter, which increases the need for female labour.

Table 3. Labor Involvement of Tribal Women in Mustard Cultivation

Sl No	Operations	Total time spent	Total man days	Average time spent by individual farmer
1	Land preparation	236.8	29.6	0.74
2	Sowing	201.6	25.2	0.63
3	Manure and fertilizer	576.0	72.0	1.80
4	Weeding	550.4	68.8	1.72
5	Plant protection measures	272.0	34.0	0.85
6	Harvesting	3040.0	76.0	1.90
7	Bundling	428.8	53.6	1.34
8	Carrying	297.6	37.2	0.93
9	Threshing	608.0	76.0	1.90
	Total	3779.2	472.4	11.81

7.3 Participation in the cultivation of Turmeric

Table 4 shows the widespread involvement of tribal farm women in different phases of turmeric cultivation in terms of total hours worked, converted man-days, and average man-days per person. Of the three crops, the average amount of labor contributed by each woman was 12.70 man-days. The highest labor costs were associated with harvesting and post-harvest processing, which averaged 2.03 and 2.00 man-days, respectively. These tasks, which included digging, cleaning, and curing the turmeric roots, were typically carried out by women due to their delicate nature and need for care. Weeding (1.87), washing and drying (1.40), and applying fertilizer and manure (1.95 man-days) all showed notable contributions, indicating women's active involvement in pre- and post-harvest processes. Plant protection (0.94), transportation (1.00), ground preparation (0.82), and sowing (0.69) all demonstrated persistent engagement, albeit at slightly smaller magnitudes. A total of 4,620 hours, or 507.4 man-days, are needed to

grow turmeric. This active participation highlights the vast and physical nature of turmeric production, where women's labor is crucial to ensuring crop quality and appropriate management.

The study highlighted the critical role that tribal women play in agricultural labor during the cycles of turmeric, mustard, and paddy crops. Turmeric (12.70 man-days), mustard (11.81 man-days), and paddy (9.48 man-days) had the highest average female labor participation rates. These variations imply that the amount of labor contributed by women varies depending on the crop, with turmeric being the most labor-intensive cash crop. In all three agricultural systems, labor-intensive and physically taxing tasks like harvesting, weeding, and post-harvest processing were primarily performed by women. However, their involvement in planting and preparing the land was much lower. Both deeply ingrained gender norms and a lack of technical knowledge or mechanized equipment, which are frequently owned by men, are to blame for this lack of participation in early operations.

Table 4. Tribal Women's Labor Contribution in Turmeric Cultivation

Sl. No	Operations	Total time spent (hours)	Total man-days	Average time spent by individual farmer (man-days)
1	Land preparation	260.0	32.5	0.82
2	Sowing	220.0	27.5	0.69
3	Manure and fertilizer	620.0	77.5	1.95
4	Weeding	600.0	75.0	1.87
5	Plant protection measures	300.0	37.5	0.94
6	Harvesting	3200.0	80.0	2.00
7	Washing and drying	450.0	56.2	1.40
8	Carrying	320.0	40.0	1.00
9	Post-harvest processing	650.0	81.2	2.03
	Total	4620.0	507.4	12.70

The study shows that women's agricultural labor, particularly in mustard farming, is seasonally increased by seasonal male migration, particularly during the winter cropping season. These conditions require women to perform tasks that are normally performed by men. However, these changes in responsibility are considered unofficial because they are typically not included in official labor statistics or decision-making. A greater pattern of structural injustice and invisibility includes this gender-based division of labor. Tribal women are vital to agriculture and land management, but their marginalization is exacerbated by their lack of access to institutional loans, land ownership, and agricultural extension services. The primary causes of these challenges are socioeconomic, cultural, and institutional constraints. Addressing the systemic disadvantages is necessary to ensure sustainable rural development and gender equality. Women should actively participate in managing natural resources as co-managers as

part of empowerment initiatives, going beyond simply being recognized as employees. Women's integration should be ensured by policies that promote women's financial services, farm technology training, guaranteed land rights, and active participation in decision-making organizations. For the tribal regions to accomplish the more general goals of inclusive growth and ecological sustainability, such measures are required.

8 Conclusion

This study offers comprehensive information about the vital role tribal women play in ecological preservation and sustainable agriculture in the Kandhamal district. The study demonstrates how much they contribute to the production of mustard and turmeric paddy, especially in labor-intensive processes like harvesting, weeding, and post-harvest handling. Despite their crucial role in agricultural systems, tribal women continue to face a number of structural challenges, such as restricted land ownership, limited access to credit and agricultural training, and exclusion from decision-making. Their productivity is reduced by these obstacles, and their significance as elements of rural development is diminished.

The paper significantly advances management research by offering empirical data on gendered work patterns in informal tribal-based farming environments. Modern sustainability measures enhance the application of traditional ecological knowledge, resource availability, and labor justice. A helpful tool for human resource planning that can be used to analyze productivity and advance inclusive agriculture management is the measurement of women's labor in man-days relative to particular crop activities.

The findings demonstrate the seriousness of the situation, necessitating the adoption of gender-sensitive farm policies by legislators and development experts that protect women's land rights, make it easier for them to access financial and training services, and provide inclusive extension services that respect their indigenous knowledge. Rural development programs need to shift from viewing tribal women as support staff to viewing them as active participants and decision-makers. In the end, this study promotes the creation of more equitable and sustainable rural management frameworks in line with the national agenda and the Sustainable Development Goals (SDGs) by highlighting both their strengths and weaknesses.

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