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Women's Role in Agroforestry and Household Sustainability in Bonto Somba Village, Maros: A Mixed-Methods Study

Peran Perempuan dalam Agroforestri dan Keberlanjutan Rumah Tangga Petani di Desa Bonto Somba, Maros: Studi Metode Campuran

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Abstract
Women play a vital but under-recognised role in smallholder agroforestry. This study analyses the relationship between women's role in agroforestry management and farm household sustainability in Bonto Somba Village, Maros Regency. A mixed-methods design was applied to 100 women respondents from 300 agroforestry households selected through purposive-quota sampling. Sustainability was measured across economic, food, social, and environmental dimensions; women's role was measured using a role index and working time. Data were analysed using Spearman correlation, Mann-Whitney test, and multiple linear regression. Household sustainability was moderate (mean 3.35), with the environmental dimension weakest. The women's role index strongly correlated with sustainability (ρ=0.708; p<0.001) and was its dominant determinant, whereas women's working hours were not significant. Women's share of household working time negatively correlated with sustainability, and households where women bore the entire workload had significantly lower sustainability. It is concluded that women's role strengthens household sustainability through breadth of involvement and decision-making authority rather than longer working hours. Empowerment programmes should widen women's access to capital, processing technology, and decision-making instead of adding to their workload.
Keywords: *agroforestry; household sustainability; women's role; work time allocation.*

Abstrak
Perempuan berperan penting namun kurang diakui dalam agroforestri rakyat. Penelitian ini menganalisis hubungan peran perempuan dalam pengelolaan agroforestri dengan keberlanjutan rumah tangga petani di Desa Bonto Somba, Kabupaten Maros. Metode campuran digunakan dengan 100 responden perempuan dari 300 rumah tangga agroforestri melalui purposive-quota sampling. Keberlanjutan diukur pada dimensi ekonomi, pangan, sosial, dan lingkungan; peran perempuan diukur melalui indeks peran dan curahan waktu kerja. Analisis data menggunakan korelasi Spearman, uji Mann-Whitney, dan regresi linear berganda. Keberlanjutan rumah tangga tergolong sedang (rerata 3,35), dengan dimensi lingkungan terlemah. Indeks peran perempuan berkorelasi kuat dengan keberlanjutan (ρ=0,708; p<0,001) dan menjadi penentu dominan, sedangkan jam kerja perempuan tidak signifikan. Porsi waktu kerja perempuan berkorelasi negatif dengan keberlanjutan, dan rumah tangga yang seluruh beban kerjanya ditanggung perempuan memiliki keberlanjutan lebih rendah. Disimpulkan bahwa peran perempuan memperkuat keberlanjutan melalui keluasan keterlibatan dan kewenangan pengambilan keputusan, bukan jam kerja panjang. Program pemberdayaan perlu memperluas akses perempuan terhadap modal, teknologi pengolahan, dan ruang pengambilan keputusan, bukan menambah beban kerja.
Kata kunci: agroforestri; curahan waktu kerja; keberlanjutan rumah tangga; peran perempuan.

1. INTRODUCTIONS

Agroforestry combines forest trees with crops and/or livestock on the same land (Nair, 1985) and can reconcile household production with conservation, particularly on slopes bordering forests. It contributes to agricultural productivity, ecosystem services and human well-being (Brown et al., 2018), outperforms monoculture in economic-environmental assessments (García de Jalón et al., 2018), and provides a large share of forest farmers' income in Indonesia (Manurung et al., 2025).

Household sustainability also depends on how households allocate labour and make farm decisions (Melati, 2021). Women take part in almost every management stage, from planting to processing and marketing, yet their work is often treated as supporting labour and left unrecorded (Kinasih & Wulandari, 2021). Countries, women perform most agroforestry work but control the smallest share of its resources and value (Catacutan & Naz, 2015; Kiptot, 2015; Kiptot & Franzel, 2012).

Gender research shows that household outcomes depend more on women's authority over resources and decisions than on their volume of work (Doss, 2018; Meinzen-Dick et al., 2019). This authority is what the Women's Empowerment in Agriculture Index and its project-level version measure (Alkire et al., 2013; Malapit et al., 2019), and it is associated with better food security and farm efficiency (Tesafa et al., 2025) and with more sustainable farming practices (Fertő & Bojnec, 2025). In agroforestry value chains, women cluster in downstream, value-adding nodes with little control over upstream nodes (Kassaye et al., 2025; Kiptot et al., 2014).

Indonesian studies confirm women's importance in agroforestry but measure it narrowly. (Qurniati & Putra, 2024) described women's involvement in land management in the Batutegi Forest Management Unit; (Kinasih & Wulandari, 2021) mapped the gender division of labour in the Upper Citarum Watershed; (Melati, 2021; Nurjanah, 2020) calculated family labour contributions by gender; (Agroforestri & Sembiring, n.d.) measured women's income contribution; (Wiyanti et al., 2023) showed that women can be farm decision-makers; and Villamor et al. (2015) documented shifts in gender roles following land-use change in Sumatra. None of these studies statistically tested the pathway linking women's role to multidimensional household sustainability.

The distinction matters for programme design: if women's contribution is merely additional labour, interventions will add working time; if it operates through breadth of role and decision-making authority, interventions should widen women's access to and control over resources.

This study makes three contributions. First, it separates two measures usually treated as one, namely a role index capturing breadth of involvement and decision-making authority, and working time in hours, and tests them simultaneously. Second, it measures household sustainability across economic, food, social and environmental dimensions rather than income alone. Third, it uses women's share of household working time as a marker of labour support from other members, distinguishing excessive workload from a strengthened role.

Bonto Somba Village, Tompobulu District, Maros Regency, is a hilly area bordering a forest, with mixed-garden agroforestry and high female involvement. Forestry extension there has been studied Imran et al. (2024), but gender in agroforestry has not. This study therefore analyses how women's role in agroforestry management relates to farm household sustainability.

Research Hypotheses

Based on the framework above, the research hypotheses are formulated as follows:

1. H1: The women's role index has a positive effect on farm household sustainability.
2. H2: Women's working time has a positive effect on farm household sustainability.
3. H3: Women's share of total household working time is negatively associated with farm household sustainability.
4. H4: Labour support from other household members has a positive effect on farm household sustainability.

H1, H2 and H4 were tested using Spearman correlation and multiple linear regression, whereas H3 was tested using Spearman correlation and the Mann-Whitney test comparing households with and without labour support from other household members.

Figure 1 presents the conceptual framework: the four variables above are independent variables, the number of family members helping and land area are controls, and four-dimensional household sustainability is the dependent variable.

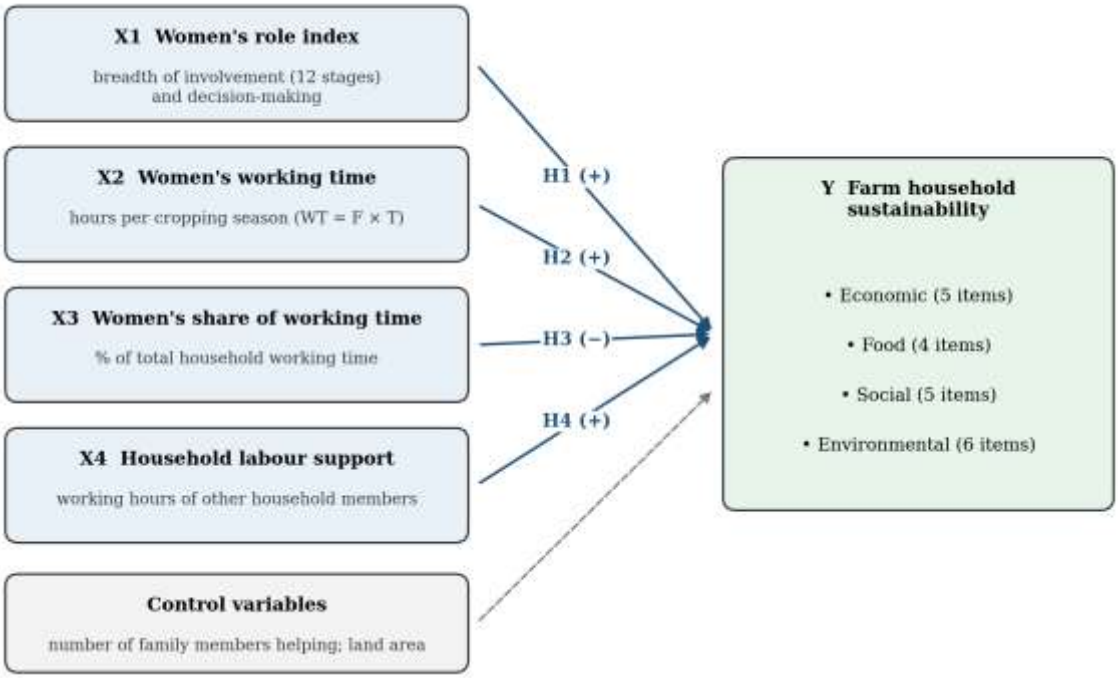


Figure 1. Conceptual framework of the study.

2. RESEARCH METHODS

The study was conducted in Bonto Somba Village, selected purposively for its developed mixed-garden agroforestry, hilly forest-margin terrain relevant to environmental sustainability, and active female involvement in land management. Fieldwork ran from January to May 2026 (instrument preparation in January, data collection from February to April and analysis in May).

A descriptive-analytical mixed-methods design was used. The population comprised 300 agroforestry households, sampled in two stages. First, eligible households were identified purposively: (1) agroforestry land actively managed in the current season, (2) an adult female member directly involved in agroforestry, and (3) willingness to be interviewed. Purposive selection was used because the objective required women actually involved in management; random selection risked including uninvolved women unable to report on their role or working time. Second, 100 women (about 33 per cent of the population) were drawn from eligible households by quota sampling, one per household. This proportion exceeds the 10–30 per cent considered adequate for surveys of large populations (Arikunto, 2010), lies within the 30–500 range suitable for multivariate analysis (Sugiyono, 2019) and meets the minimum for regression with five predictors. The non-probability design limits statistical generalisation (Section 3.7). Farmer group leaders, village officials and community leaders served as key informants.

Primary data came from structured questionnaires, in-depth interviews, observation and documentation; secondary data came from the village office, Statistics Indonesia (BPS), government agencies and the literature. Household sustainability was measured by 20 five-point Likert items: economic (5), food (4), social (5) and environmental (6). Women's role was measured by a role index covering involvement in twelve activity stages and in decision-making, and by women's working time.

Working time was calculated as WT = F × T, where F is the frequency of an activity per cropping season and T the hours per occasion, summed over nine stages for annual crops only. Women's labour contribution was calculated as WLC = WTw / (WTw + WTm) × 100%, where WTw and WTm are women's and men's working time. For example, fertilising three times a season for 3.5 hours each gives WT = 3 × 3.5 = 10.5 hours; at sample level, WLC = 62.25 / (62.25 + 90.25) × 100% = 40.8% (Table 2).

Item validity, tested on all 100 respondents with corrected item-total correlation, was confirmed for every item against the critical r of 0.197 (df = 98; $\alpha = 0.05$, two-tailed); coefficients ranged from 0.351 to 0.773 for sustainability and from 0.208 to 0.648 for women's role. Cronbach's alpha was 0.933 for sustainability (economic 0.865; food 0.796; social 0.747; environmental 0.815)

and 0.816 for women's role. Data were analysed with descriptive statistics, Spearman correlation (α = 0.05), cross-tabulation, the Mann-Whitney test and multiple linear regression on the aggregate sustainability score.

Regression assumptions were checked with the Kolmogorov-Smirnov test (normality), tolerance and VIF < 10 (multicollinearity), and the Glejser test with residual plots (heteroscedasticity); autocorrelation was not tested because the data are cross-sectional.

Because all variables came from self-reports by the same respondents, common method bias was addressed procedurally and statistically (Podsakoff et al., 2003). Anonymity was guaranteed, and working time was reconstructed from activity frequency and duration rather than measured on a perception scale. In Harman's single-factor test (unrotated principal component analysis of all 33 Likert items), the first factor explained only 35.77 per cent of the variance, below the 50 per cent threshold, so common method bias is not a serious concern.

Before each interview, respondents were told the study's purpose, the data collected and its use, and gave verbal informed consent, which the enumerator recorded on a consent form with the respondent's name, the date and a signature or thumbprint. Forms were stored separately from the coded questionnaires. Participation was voluntary, respondents could decline or withdraw at any stage, and data are reported in aggregate. Permission was obtained from the Bonto Somba Village government and the local farmer group committee.

3. RESULTS AND DISCUSSIONS

Respondent Characteristics

Respondents had a mean age of 41.18 years, a mean landholding of 0.77 ha and a mean household size of 4.29; 79 practised agrisilviculture and 21 agrosilvopasture. Small holdings and moderate household size mean that management relies on family labour, making intra-household work allocation central to household performance.

Level of Farm Household Sustainability

The household sustainability index for each of the four indicators is presented in Table 1.

Table 1. Household sustainability index by indicator (n = 100).

Indicator	Number of items	Mean score	Standard deviation	Alpha	Category
Economic	5	3.44	0.73	0.865	High
Food	4	3.59	0.71	0.796	High
Social	5	3.40	0.61	0.747	Moderate
Environ-mental	6	3.07	0.66	0.815	Moderate
Aggregate sustainability	20	3.35	0.60	0.933	Moderate

Source: Primary data, processed, 2026.

Aggregate sustainability was moderate (mean 3.35). The food indicator was highest (3.59), followed by economic (3.44) and social (3.40), while environmental was lowest (3.07) and the only indicator clearly below the aggregate. Households therefore mainly enjoy direct, short-term benefits, namely food and additional income, while long-term benefits requiring technical investment remain limited. This is consistent with (Park et al., 2019), who identified subsistence as the most tangible benefit of home and mixed gardens, and with (Kiptot et al., 2014), who linked agroforestry to food security in women-managed households.

Five respondents were in the very high category, 43 high, 40 moderate, 11 low and 1 very low; thus 48 per cent of households achieved high to very high sustainability and 12 per cent remained low to very low. The three lowest item scores were all environmental: soil and water conservation (2.47), reduction of excessive chemical use (2.62) and use of crop residues or organic fertiliser (3.04). The low conservation score matches women's low involvement in conservation work, indicating that conservation is not yet a routine household practice. This matters because environmental protection is the main rationale for agroforestry on sloping land (Pantera et al., 2021; Ridwan & Sarjito, 2024), and women's involvement in conservation decisions is a key determinant of adoption (Musafili et al., 2024). Within the social indicator, the ability to express opinions in groups scored lowest (3.09), although involvement in important household decisions scored high (3.51). Recognition of women's role is thus stronger in the household than in village institutions, echoing the limited public space for women reported by (Kiptot, 2015).

Contribution of Women's Working Time

Women's labour contribution by activity stage is presented in Table 2 and Figure 2.

Table 2. Mean working time and women's labour contribution by activity stage (hours per cropping season, n = 100).

Activity stage	Women (hours)	Men (hours)	Total (hours)	Women's contribution (%)
Land preparation and clearing	3.61	7.06	10.67	33.8
Seedling preparation	3.60	7.18	10.78	33.4
Planting	5.28	6.23	11.51	45.9
Fertilising	10.44	21.54	31.98	32.6
Pest and disease control	11.07	21.54	32.61	33.9
Crop maintenance	10.92	12.46	23.38	46.7
Harvesting	5.47	6.35	11.82	46.3
Processing	6.60	2.67	9.27	71.2
Marketing	5.26	5.22	10.48	50.2
Total	62.25	90.25	152.50	40.8

Source: Primary data, processed, 2026. Women's contribution was calculated as WLC = WTw / (WTw + WTm) × 100%.

Households devoted 152.50 hours per cropping season to agroforestry, of which women contributed 62.25 hours (40.8 per cent), a substantial rather than supporting share, consistent with Melati and Wulandari (2021).

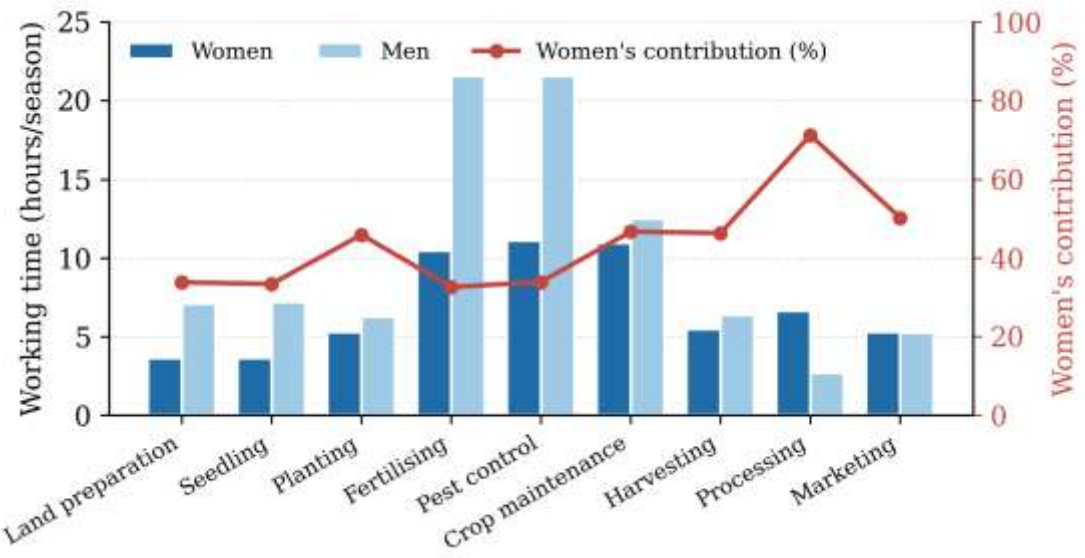


Figure 2. Working time of women and men and women's labour contribution by activity stage (n = 100)

Women dominated processing (71.2 per cent) and reached near parity in marketing (50.2), crop maintenance (46.7), harvesting (46.3) and planting (45.9), but contributed least to physically demanding, input-intensive stages: fertilising (32.6), seedling preparation (33.4), land preparation (33.8) and pest and disease control (33.9). Women are therefore concentrated in downstream stages that convert harvests into household value, linking production and consumption. (Kassaye et al., 2025) reported the same pattern in Ethiopian fruit-tree agroforestry, where women dominated processing and retail but had little control over upstream nodes.

Relationship between Women's Role and Household Sustainability

The results of the Spearman correlation test between women's role and the sustainability indicators are presented in Table 3.

The women's role index was strongly and significantly correlated with aggregate sustainability ($\rho = 0.708$; $p < 0.001$); H1 is accepted. The relationship was strongest for the social (0.716) and food (0.701) indicators, followed by economic (0.675), and weakest but still significant for environmental (0.493). Decision-making involvement was also significantly correlated with all indicators, especially social (0.689). The quality of participation, namely women's say over crops,

inputs, timing, sales and income use, is thus a pathway distinct from physical involvement (Alkire et al., 2013; Doss, 2018; Wiyanti et al., 2023).

Women's working hours were not correlated with sustainability ($\rho = -0.052$; $p = 0.610$), whereas women's share of working time was negatively correlated ($\rho = -0.248$; $p = 0.013$). A very high share signals missing labour support rather than a stronger role. In 12 households, women bore all agroforestry work without male support; their mean working time was the highest (86.08 hours versus 62.25 overall), yet their sustainability score was the lowest (2.98 versus 3.40 for supported households; Mann-Whitney $p = 0.014$). H3 is therefore accepted. This supports the view that empowerment is not a heavier workload (Meinzen-Dick et al., 2019) and that household performance relates to authority rather than work intensity (Tesafa et al., 2025).

Table 3. Spearman correlation coefficients between women's role and household sustainability indicators (n = 100).

Variable	Economic	Food	Social	Environmental	Aggregate sustainability
Women's role index	0.675**	0.701**	0.716**	0.493**	0.708**
Role in activity stages	0.669**	0.698**	0.669**	0.475**	0.689**
Involvement in decision-making	0.440**	0.437**	0.689**	0.426**	0.543**
Women's working time (hours)	-0.087	-0.027	0.000	-0.015	-0.052
Women's share of working time (%)	-0.223*	-0.190	-0.200*	-0.239*	-0.248*
Land area (ha)	0.088	0.180	0.176	0.218*	0.187
Respondent age (years)	0.147	0.161	0.206*	0.131	0.190

*Source: Primary data, processed, 2026. ** significant at α = 0.01; * significant at α = 0.05.*

Separate Spearman correlations showed a similar relationship in both agroforestry patterns: $\rho = 0.712$ ($p < 0.001$) for agrisilviculture (n = 79) and $\rho = 0.688$ ($p = 0.001$) for agrosilvopasture (n = 21), with no significant difference (Fisher's $z = 0.18$; $p = 0.858$). Because the agrosilvopastoral subgroup is small, this similarity should be confirmed with a larger sample.

Cross-Tabulation of Women's Role and Sustainability

Table 4. Cross-tabulation of women's role category and household sustainability category (n = 100).

	Household sustainability category, n (%)					
Women's role category	Very low	Low	Moderate	High	Very high	Total
Low	0	2 (100.0)	0	0	0	2 (100.0)
Moderate	1 (2.0)	8 (16.3)	33 (67.3)	7 (14.3)	0	49 (100.0)
High	0	1 (2.1)	7 (14.9)	34 (72.3)	5 (10.6)	47 (100.0)
Very high	0	0	0	2 (100.0)	0	2 (100.0)
Total	1 (1.0)	11 (11.0)	40 (40.0)	43 (43.0)	5 (5.0)	100 (100.0)

Source: Primary data, processed, 2026. Figures in parentheses are row percentages.

Respondents were concentrated on the main diagonal (Table 4). Of the 47 with a high role, 39 (83.0 per cent) had high to very high sustainability, whereas of the 49 with a moderate role only 7 (14.3 per cent) reached the high category, 33 remained moderate and 9 were low to very low, consistent with the correlation results.

Table 5 groups respondents by women's role level and the presence of labour support from other household members.

Table 5. Household sustainability by women's role level and household labour support.

Household group	n	Women's time (hours)	Total household time (hours)	Sustainability score	Category
High role, with support	45	57.09	162.31	3.83	High
Moderate role, with support	43	61.00	160.77	2.95	Moderate
High role, without support	4	89.00	89.00	3.15	Moderate
Moderate role, without support	8	84.62	84.62	2.89	Moderate

Source: Primary data, processed, 2026. High role includes respondents with a women's role index ≥ 3.41.

Households combining a high women's role with labour support had the highest score (3.83) and were the only group in the high category, significantly above the other three groups combined (2.96; Mann-Whitney $p < 0.001$). The first two groups had almost identical total working time (162.31 and 160.77 hours), and women worked slightly more in the second, yet their scores differed by 0.88 points. The difference reflects the quality of women's role, that is, the breadth of stages covered and decision-making position, rather than work volume.

Regression Analysis of the Contribution of Women's Role

Residuals were normally distributed (Kolmogorov-Smirnov with Lilliefors correction, p = 0.615), and VIF values (1.028–1.075; tolerance 0.930–0.973) indicated no multicollinearity. The simultaneous Glejser test (p = 0.245) and the Breusch-Pagan test (p = 0.259) indicated no heteroscedasticity, although household labour support was significant among the individual Glejser coefficients (p = 0.013; other variables p = 0.363–0.946). Re-estimation with heteroscedasticity-robust (HC3) standard errors left all conclusions unchanged: the role index remained highly significant (p < 0.001), labour support remained significant (p = 0.033) and the other variables remained non-significant.

Table 6. Multiple linear regression of the determinants of household sustainability (n = 100).

Independent variable	Coefficient	Standard error	t value	p value	Remarks
Constant	-0.119	0.329	-0.36	0.719	Not significant
Women's role index	0.922	0.085	10.84	< 0.001	Highly significant
Women's working time (hours)	-0.0011	0.002	-0.62	0.534	Not significant
Household labour support (hours)	0.0023	0.001	2.77	0.007	Highly significant
Number of family members helping	-0.0084	0.038	-0.22	0.825	Not significant
Land area (ha)	0.205	0.145	1.41	0.161	Not significant

Source: Primary data, processed, 2026. $R^2 = 0.597$; *adjusted* $R^2 = 0.576$; *F-test* $p < 0.001$.

The model was significant and explained 57.6 per cent of the variation in household sustainability. The remaining 42.4 per cent reflects factors outside the model, such as market and capital access, farmer group institutions, extension intensity, biophysical land conditions and off-farm income: market access shapes prices and sales certainty, capital access shapes investment in seedlings, organic fertiliser and conservation, and institutions and extension shape the flow of information and technology. This explanatory power is high for household cross-sectional data but confirms that women's role is not the sole determinant.

The women's role index was the strongest determinant (b = 0.922; p < 0.001): a one-point increase is associated with a 0.922-point increase in sustainability, other things being equal, confirming H1.

Women's working hours were not significant once the role index was controlled for (b = −0.0011; p = 0.534); H2 is rejected. Three explanations apply. First, hours measure input, not position: what matters is at which stages women work and how much authority they hold over production, sales and income. Extra hours in physically demanding upstream stages do not confer control over outcomes, whereas processing and marketing place women where harvests become household value (Table 2). Second, long hours often substitute for absent household labour; households without support recorded the highest women's working time (84.62–89.00 hours) and lower sustainability (Table 5). Third, the relationship is probably non-linear: beyond a point, extra hours become a burden that crowds out childcare, food provision and group participation. This accords with the view that empowerment is not a heavier workload and that authority, not work intensity, relates to household performance (Doss, 2018; Meinzen-Dick et al., 2019; Tesafa et al., 2025).

Labour support from other household members had a positive and significant effect (b = 0.0023; p = 0.007); H4 is accepted. The coefficient looks small because it is expressed per hour of support per season. Multiplied by men's mean working time of 90.25 hours (Table 2), it corresponds to about 0.21 points, roughly one-third of the standard deviation of sustainability (0.60), which is practically meaningful. When other members handle heavy upstream tasks such as land preparation, fertilising and pest control, women can focus on processing, marketing and decisions, the domains most closely linked to sustainability. This matches Catacutan and Naz (2015), who identified labour scarcity as a key constraint for female-headed households. The effect is nonetheless far smaller than that of the role index, so labour support is an enabling factor rather than a primary determinant.

The coefficient for the number of family members helping was negative but small and non-significant (b = −0.0084; p = 0.825), so it is statistically indistinguishable from zero; its VIF of 1.035 rules out multicollinearity. The headcount simply does not reflect labour actually contributed: it was barely correlated with hours of support (r = 0.059; p = 0.558), and 11 of the 12 households with no male working hours still reported one to four helping members. Members who help sporadically, only in light stages or outside annual crops raise the headcount without adding working time; it is hours of support, not the number of helpers, that matter. Land area was also non-significant, suggesting that within narrow holdings management matters more than size.

The relationship may be endogenous. Reverse causality is possible, since more secure households may give women more room to participate and decide, and unobserved factors such as education, family gender norms and social capital may affect both women's role and sustainability (Antonakis et al., 2010). Lacking panel data or a valid instrument, the role coefficient of 0.922 is interpreted as a conditional association, not a causal effect. The consistency of results across correlation, cross-tabulation, difference tests and regression, and the comparison of groups with near-identical working time (Table 5), strengthen the findings but do not establish causality.

Strengthening women's role should therefore mean wider access to and control over resources, technology and decision-making, together with a fairer division of household labour, not a heavier workload. This is consistent with extension-based empowerment that builds capacity and institutions (Ibrahim et al., 2024) and with gender-responsive land-management policy(Fertő & Bojnec, 2025; Musafili et al., 2024).

Limitations of the Study

The study has several limitations. First, its cross-sectional design shows association, not causation, and cannot control for the endogeneity discussed in Section 3.6. Second, working time covered annual crops only, excluding perennials, livestock and non-timber forest products; women's contribution may be underestimated, and measurement error may attenuate the working-time coefficient towards zero. The non-significance of working hours should thus be read cautiously, although the dominance of the role index, which was measured independently of hours, and the group comparison with near-identical working time (Table 5) are unaffected; a sensitivity analysis was not possible because perennial data were not collected. Third, production and income were not measured, so sustainability, especially its economic dimension, rests on perceptions without objective validation. Fourth, the purposive-quota sample of women in a single village limits generalisation. Fifth, the absence of male respondents from the same households prevents comparison of perceptions within households.

4. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Agroindustri pengolahan gula aren di Kabupaten Mamuju terpapar oleh variasi risiko Agroforestry household sustainability in Bonto Somba was moderate (3.35), highest for food (3.59) and weakest for the environment (3.07), especially soil and water conservation. Women's role was strongly associated with sustainability ($\rho = 0.708$; $p < 0.001$) and was its dominant determinant ($b = 0.922$), whereas women's working hours were not significant; the model explained 57.6 per cent of the variation. H1, H3 and H4 are accepted and H2 is rejected. Women's contribution operates through breadth of involvement and decision-making authority rather than longer working hours, and households whose workload rests too heavily on women tend to be less sustainable.

Theoretically, the findings correct the common assumption in Indonesian gender and agroforestry research that women's contribution equals their working time. The two measures are not interchangeable: role breadth and authority are strongly associated with sustainability, working hours are not, and an excessive share of working time is negatively associated. This supports the view that agency and control over resources link gender to household performance and adds that excessive female workload signals household vulnerability rather than empowerment. Future studies should therefore measure role breadth and authority separately from work intensity

Recommendations

Empowerment programmes should widen women's access to capital, processing technology and training and strengthen their position in farm and group decisions, rather than increase their working time. Extension workers and village governments should prioritise households where women carry the entire workload, and conservation and reduced chemical use should become technical assistance topics that directly involve women.

Farmer groups, village governments and customary institutions can (1) form women's agroforestry groups, independently or as sections of existing groups, for joint processing and marketing; (2) train women to process the village's leading commodities, with support for packaging, licensing and market access; (3) ensure women's representation on group committees and in village forums, including decisions on village funds for agriculture; and (4) revive rotating or mutual-help (gotong royong) labour arrangements for households where women bear the whole workload, especially for land preparation, fertilising and conservation.

Progress can be monitored through (1) the share of women on group committees and in village forums; (2) women's decision-making scores on production, sales and income, using project-level empowerment indicators (3) the number and sales of women-managed processing enterprises; (4) fewer households where women carry the entire workload; and (5) adoption of soil and water conservation and environmental sustainability scores.

Future research should (1) use longitudinal or panel designs over several seasons to trace changes in women's role and test causality; (2) measure capital access, technology adoption, production and income directly; (3) extend working-time measurement to perennials, livestock and non-timber forest products; (4) compare communities with different tenure and institutional settings, such as private land and social forestry areas; and (5) survey paired women and men in the same households to examine intra-household perceptions and authority.

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