

Gendered Decision-Making in Climate-Smart Agriculture Across Two Rural Belizean Communities

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Abstract

As climate change increases the vulnerability of smallholder farming systems, understanding gender dynamics in agricultural adaptation is critical. This mixed-methods comparative case study examined farm decision-making and climate-smart agriculture (CSA) adoption among 30 women in Indian Church Village and Duck Run 2, Belize. Descriptive results showed substantial differences in institutional access, including farm-credit access reported by 46.7% of participants in Indian Church Village and none in Duck Run 2. Women in Duck Run 2 reported higher mean scores for both participation in agricultural decisions and CSA adoption, but the between-community differences were not statistically significant in this small sample. Interview accounts identified insecure land tenure, limited credit and extension access, household care responsibilities, and family support as important influences on women's capacity to adopt new practices. The findings suggest that gender-responsive CSA initiatives in the two communities should combine technical support with measures addressing access to productive assets, finance, and labor-saving resources.

Keywords: Climate-smart agriculture, women farmers, decision-making, gender, Belize

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Introduction

Climate change threatens smallholder farming systems across Belize through increasingly variable rainfall, drought, and pest pressures. Climate-Smart Agriculture (CSA) encompasses practices intended to strengthen adaptive capacity, support productivity, and, where possible, reduce greenhouse-gas emissions. These interventions are not gender-neutral: their adoption is shaped by household decision-making, access to productive resources, and the distribution of farm and domestic labor (Huyer, 2016). Development initiatives that treat households as uniform units may therefore overlook disparities affecting women's ability to influence resource allocation and adopt agricultural innovations.

This issue is relevant in Belize, where changing environmental pressures intersect with gendered household and agricultural roles. Although regional literature documents climate vulnerability and gender inequality across Commonwealth Caribbean states, empirical evidence on women's intra-household agricultural decision-making and CSA adoption in rural Belize remains limited (Commonwealth Secretariat, 2019). This study addresses that gap through a comparison of Indian Church Village in the Orange Walk District and Duck Run 2 in the Cayo District.

The two sites differ in livelihood patterns and reported access to formal agricultural credit. Household-bargaining research suggests that access to assets and independent income can influence a person's capacity to participate in household decisions (Doss, 2013). At the same time, broader social and institutional conditions can constrain the extent to which localized economic advantages translate into greater bargaining power (Agarwal, 1997).

This mixed-methods comparative case study combines survey measures with interview accounts to examine women's agricultural participation in the two communities. It compares sociodemographic and farm characteristics, institutional resource access, a six-domain Women's Participation Index, and a nine-practice CSA Adoption Score. Qualitative accounts are used to interpret the quantitative patterns and to identify barriers, supports, and motivations that are not captured by the composite measures. The study is intended to generate context-specific evidence and policy considerations rather than nationally representative estimates.

Methodology

Research Design

This study used a mixed-methods comparative case-study design to examine gendered agricultural decision-making and CSA adoption among women participating in smallholder agriculture in rural Belize. Quantitative survey measures described participant and farm characteristics and compared two composite outcomes across communities. Semi-structured interviews provided contextual evidence about resource access, household responsibilities, institutional support, and motivations. The two forms of evidence were integrated during interpretation to identify areas of convergence and divergence (Creswell & Plano Clark, 2017).

Study Site and Target Population

Empirical fieldwork was conducted in two socio-ecologically distinct agricultural communities to capture contrasting institutional environments: Indian Church Village in the Orange Walk District (population approximately two hundred and six) and Duck Run 2 in the Cayo District (population approximately six hundred). These sites feature diverse smallholder farming systems, predominantly cultivating maize, beans, vegetables, and small livestock, alongside visible female agricultural labor and active engagement with climate-resilient initiatives. The target population comprised women directly participating in production as smallholder operators, unpaid family farm workers, or agricultural laborers. Employing a convenience sampling method, thirty participants were recruited, establishing a balanced cohort of fifteen respondents per village to explore micro-level community realities.

Data Collection Procedures

Primary data collection spanned a continuous three-week period, using a two-part approach administered in private settings to ensure participant safety and minimize familial friction. First, a structured questionnaire documented participant age, farming experience, farm acreage, land tenure type, and categorical income brackets. Second, semi-structured interviews lasting sixty to seventy-five minutes captured qualitative reflections regarding institutional exclusion, extension neglect, household care burdens, and intrinsic motivations. Ethical clearance was formally granted via expedited review by the University of Belize

Institutional Review Board under reference number 25-1-00061. Voluntary written and verbal informed consent was secured from all thirty participants, data files were fully anonymized via alphanumeric codes, and individual identities were protected by aggregating qualitative disclosures under regional community tags.

Response Variables and Index Scaling

Two composite measures were constructed. The Women's Participation Index assessed decision-making across six agricultural domains: land use, input purchasing, irrigation-water management, soil conservation, technology adoption, and product marketing. The domains were informed by gender-differentiated decision-making frameworks used in CSA research (Acosta et al., 2021). Each domain was scored 3 for a decision made mainly by the woman, 2 for a joint decision, and 1 for a decision made mainly by a spouse or male relative, producing a possible total of 6–18. Higher values therefore represent greater reported participation under this scoring scheme; they should not be interpreted as a complete measure of empowerment. The CSA Adoption Score used an additive practice-count approach (Shahbaz et al., 2022) and counted nine practices reported as used on the farm: mulching, crop rotation or intercropping, improved seed varieties, terraces or other soil-conservation structures, cover crops, water harvesting or irrigation, agroforestry or tree nurseries, composting or vermicomposting, and improved fodder production. Each practice was scored 1 when reported and 0 otherwise, producing a possible total of 0–9.

Data Analysis and Triangulation

Quantitative data were summarized using means, standard deviations, frequencies, and percentages. Shapiro–Wilk tests were used to assess normality, and the participation scores for Duck Run 2 deviated significantly from normality ($p < .05$). Independent samples t-tests were retained as descriptive inferential comparisons because the groups were balanced ($n = 15$ per community), a condition under which the test can be reasonably robust (de Winter, 2013). Nevertheless, the results were interpreted cautiously given the small convenience sample and the observed non-normality. Statistical significance was assessed using two-tailed tests at $\alpha = .05$. Interview responses were reviewed thematically to identify recurring accounts of resource access, extension support, household care responsibilities, family support, and motivations. The qualitative findings were then compared with the quantitative patterns during interpretation.

Results

Sociodemographic and Institutional Profiles

The profiles of the 30 participants revealed both shared characteristics and descriptive differences between the two community groups. As summarized in Table 1, the overall mean age was 38.67 years. Participants in Indian Church Village had a mean age of 39.87 years ($SD = 9.91$), compared with 37.47 years ($SD = 10.62$) in Duck Run 2. Mean farming experience was 4.33 years ($SD = 3.54$) in Indian Church Village and 6.80 years ($SD = 5.00$) in Duck Run 2.

The clearest descriptive institutional difference concerned reported access to agricultural loans or input-credit networks. In Indian Church Village, 46.7% ($n = 7$) of participants reported access to farm credit, compared with none of the participants in Duck Run 2. Livelihood patterns also differed: 80.0% ($n = 12$) of participants in Indian Church Village identified on-farm farming as their primary livelihood, whereas 53.3% ($n = 8$) in Duck Run 2 identified off-farm labor. These figures describe the interviewed participants and should not be interpreted as community-level prevalence estimates.

Table 1. Sociodemographic and Institutional Baseline Profiles of Surveyed Female Smallholders

Descriptive Parameter Profile	Indian Church Village (n=15)	Duck Run 2 (n=15)	Combined Full Sample (N=30)
Mean Age (Years)	39.87 ($SD = 9.91$)	37.47 ($SD = 10.62$)	38.67 ($SD = 10.15$)
Mean Agricultural Experience (Years)	4.33 ($SD = 3.54$)	6.80 ($SD = 5.00$)	5.57 ($SD = 4.45$)
Active Access to Farm Credit Lines	46.7% ($n = 7$)	0.0% ($n = 0$)	23.3% ($n = 7$)
Primary Livelihood: On-Farm Farming	80.0% ($n = 12$)	26.7% ($n = 4$)	53.3% ($n = 16$)

Descriptive Parameter Profile	Indian Church Village (n=15)	Duck Run 2 (n=15)	Combined Full Sample (N=30)
Primary Livelihood: Off-Farm Labor	13.3% (n = 2)	53.3% (n = 8)	33.3% (n = 10)

Note. Only the two principal livelihood categories are displayed; therefore, percentages do not sum to 100%.

Inferential Analysis of Household Decision-Making and Climate-Smart Agriculture Adoption Patterns

Table 2 summarizes women's reported participation in agricultural decision-making and the number of CSA practices adopted in each community. The mean Women's Participation Index was 7.27 (SD = 3.37) in Indian Church Village and 9.07 (SD = 3.47) in Duck Run 2. The observed mean difference was not statistically significant, $t(28) = -1.44$, $p = .161$. Given the small sample, this result indicates that the study did not detect a community difference; it should not be interpreted as evidence that participation was equivalent in the two communities.

The mean CSA Adoption Score was 4.87 (SD = 2.33) in Indian Church Village and 5.93 (SD = 1.98) in Duck Run 2. This observed difference was also not statistically significant, $t(28) = -1.35$, $p = .187$. The direction of both mean differences favored Duck Run 2, but the estimates were imprecise and require confirmation in a larger probability-based sample.

Table 2. Comparison of Women's Participation and CSA Technology Adoption Between the Two Study Communities

Measure	Indian Church Village, Mean (SD)	Duck Run 2, Mean (SD)	Statistical comparison
Women's Participation Index	7.27 (3.37)	9.07 (3.47)	No significant difference, $p = .161$
CSA Adoption Score	4.87 (2.33)	5.93 (1.98)	No significant difference, $p = .187$

Distribution of Specific Climate-Smart Agricultural Practices

To examine the practices underlying the aggregate adoption scores, Table 3 presents the reported frequency of each of the nine CSA practices by community. Water harvesting or irrigation was reported by 93.3% (n = 14) of participants in each community. Crop rotation or intercropping was reported by all 15 participants in Duck Run 2 and by 73.3% (n = 11) in Indian Church Village.

Marked descriptive differences appeared in several labor- or resource-dependent practices. Terraces and cover crops were each reported by 86.7% (n = 13) of participants in Duck Run 2 and 33.3% (n = 5) in Indian Church Village. Conversely, agroforestry or tree nurseries and improved fodder production were more frequently reported in Indian Church Village. Because these practice-specific differences were descriptive and based on small cell counts, they should be interpreted as patterns for further investigation rather than statistically established community effects.

Table 3. Adoption Frequencies of Specific Climate-Smart Agricultural (CSA) Practices

Specific CSA Technology Category	Indian Church Village (n=15)	Duck Run 2 (n=15)	Full Study Sample (N=30)
Water harvesting/irrigation	93.3% (n = 14)	93.3% (n = 14)	93.3% (n = 28)
Crop rotation/intercropping	73.3% (n = 11)	100.0% (n = 15)	86.7% (n = 26)
Mulching	66.7% (n = 10)	80.0% (n = 12)	73.3% (n = 22)
Improved seed varieties	66.7% (n = 10)	60.0% (n = 9)	63.3% (n = 19)
Composting/vermicompost	40.0% (n = 6)	53.3% (n = 8)	46.7% (n = 14)
Soil conservation (terraces)	33.3% (n = 5)	86.7% (n = 13)	60.0% (n = 18)
Cover crops	33.3% (n = 5)	86.7% (n = 13)	60.0% (n = 18)
Agroforestry/tree nurseries	40.0% (n = 6)	13.3% (n = 2)	26.7% (n = 8)
Improved fodder production	40.0% (n = 6)	20.0% (n = 3)	30.0% (n = 9)

Qualitative Triangulation of Lived Realities and Structural Barriers

Land Tenure Rights and Institutional Financial Capital Exclusion

The descriptive results showed that none of the 15 participants in Duck Run 2 reported access to agricultural credit. Interview accounts suggested that insecure land tenure may contribute to this constraint. Some participants described lacking land in their own names and therefore being unable to offer land as collateral. Participant 1 from Indian Church Village remarked: *"I don't have my own land. I would like to have my own farm and work for myself, not for someone else."*

For participants without secure property rights or other acceptable collateral, formal agricultural credit may be difficult to obtain. This can increase the personal risk associated with investing in unfamiliar practices. Participant 2 from Duck Run 2 explained: *"Because the tools needed to start some CSA practices cost money and farm income is low, I can't take the risk of purchasing something that might not work out."*

This account illustrates how limited financial reserves can reduce willingness to experiment with unfamiliar practices. Participant 15 from Duck Run 2 similarly stated: *"If there were small subsidies or support programs to help us start these practices, I would feel more secure trying them."*

Technical Isolation and Epistemic Barriers in Extension Services

The quantitative comparison did not detect a significant difference in the number of CSA practices reported by the two groups ($p = .187$). Interview responses in both communities nevertheless described limited contact with formal training and extension services. Participant 9 from Indian Church Village noted: *"Technicians rarely come to the community to explain or help with these practices. There is a lack of economic resources, and I don't really know how to apply these practices."*

Limited technical access may make it more difficult to adopt or expand practices that require specialized knowledge or additional labor. Participant 2 from Indian Church Village stated: *"Lack of support. I wish there were more training where they explained these things better."* These accounts suggest that similar total adoption scores do not necessarily indicate adequate access to extension support. Participant 15 from Indian Church Village added: *"If there were more technical and financial support, it would be easier to put these ideas into practice."*

Intra-bargaining Isolation, Domestic Care Work, and Time Poverty

Beyond financial and technical constraints, interview accounts identified limited time associated with domestic care responsibilities as a barrier to trying new agricultural practices. Participant 4 from Duck Run 2 explained: *"It is very hard to balance housework, childcare, and farm work, which leaves me too tired or without enough time to try new methods."*

Domestic responsibilities were reported in both communities and may help explain why participation in decisions does not always translate into the time or labor needed to implement new practices. Participant 13 from Indian Church Village noted: *"I frequently have to stay at home doing household duties instead of working the land."*

Interview accounts also indicated that household support varied. Participant 5 from Indian Church Village stated: *"Sometimes I don't have my husband's support. I wish there were more training; I would attend happily."* Participant 7 from the same community added: *"Sometimes my family doesn't support me 100%, and that makes it harder to do things on my own."* These accounts show why a decision-making score should be interpreted alongside information about care responsibilities, mobility, and family support.

Substantive Household Food Security and Generational Continuity

Participants also described motivations centered on household food security and family wellbeing. Rather than discussing farming only as a commercial activity, several women described it as a means of providing food and strengthening household security. Participant 1 from Duck Run 2 explained: *"Farming helps me provide fresh and healthy food for my family, which makes me feel proud because I know exactly where our food comes from."*

This focus on localized food sovereignty transforms climate-smart agriculture from a technical government mandate into a deeply personal effort to protect the household. The farm serves as an immediate strategy to insulate children from economic vulnerability. This sentiment was echoed by Participant 11 from Duck Run 2,

who noted: *"My biggest motivation is to ensure my family always has food on the table, no matter how hard things get outside."*

Furthermore, the qualitative data highlighted a deep commitment to generational continuity, with women viewing their labor as a way to pass down resilience and agricultural knowledge to their children. This long-term vision was expressed by Participant 14 from Duck Run 2, who shared: *"I want to teach my children how to work the land so they understand the value of producing your own food and respect nature."* These accounts suggest that household food security, pride in producing food, and the transmission of agricultural knowledge were important motivations among the interviewed women - dimensions not directly measured by the two quantitative indices.

Discussion

Socio-Demographic and Farm Profile

The demographic results provide context for interpreting the two community case studies. Participants in both groups were of broadly similar mean age, while those in Duck Run 2 reported more years of farming experience on average. The small, non-probability sample does not support population-level estimates, but the profiles help identify differences and shared conditions within the interviewed groups.

The clearest descriptive institutional difference was reported access to farm credit: 46.7% in Indian Church Village compared with 0% in Duck Run 2. Interview accounts connected limited financing to insecure land tenure and the absence of assets that could be offered as collateral. These findings are consistent with household-bargaining research emphasizing the importance of control over productive assets for individual agency (Doss, 2013), but the present cross-sectional design cannot establish that land tenure caused the observed credit difference.

Climate-Smart Agriculture (CSA) Adoption and Practice Patterns

Participants in Duck Run 2 reported a higher mean CSA Adoption Score than those in Indian Church Village, but the difference was not statistically significant ($p = .187$). This does not demonstrate equivalence between communities. Instead, it indicates that the study lacked sufficient evidence to distinguish the group means, with substantial uncertainty arising from the small sample. The interviews suggest that financial risk, limited extension contact, and household labor demands may constrain adoption in both settings, providing a plausible interpretation that should be tested in larger studies.

The practice-level frequencies also show that aggregate totals can conceal different adaptation portfolios. Water harvesting or irrigation was widely reported in both communities, whereas terraces and cover crops were more frequently reported in Duck Run 2 and agroforestry and improved fodder were more frequently reported in Indian Church Village. Interview accounts associated adoption choices with immediate production needs, financial capacity, labor availability, and access to technical guidance. These patterns warrant further investigation using larger samples and direct measures of extension contact and resource requirements (Ragasa et al., 2013).

Women's Participation in Farm Decision-Making

The mean Women's Participation Index was higher in Duck Run 2 than in Indian Church Village, but the difference was not statistically significant ($p = .161$). The result should not be described as mathematical uniformity or proof of a common ceiling. Nevertheless, interview accounts from both communities described care responsibilities, limited control over land and finance, and variable family support. In the context of bargaining theory, these recurring constraints support examining whether broader institutional and household conditions restrict women's ability to translate nominal participation into control over resources and implementation decisions (Agarwal, 1997; Doss, 2013).

The interviews further show that reported participation in decisions may coexist with limited time to implement those decisions. Several women described combining farm work with childcare, food preparation, and other unpaid domestic responsibilities. This finding is consistent with gender and CSA literature warning that interventions can increase women's workload when additional agricultural responsibilities are introduced without corresponding reductions in unpaid care work (Bezner Kerr et al., 2019; Huyer, 2016).

Barriers, Support Systems, and Motivations for CSA Adoption

Across the interviews, the principal reported barriers were financial risk, limited technical support, care responsibilities, and inconsistent household support. These accounts do not establish that all women in either community face the same constraints, but they show that technology distribution alone may be insufficient when participants lack time, finance, or practical guidance.

Participants also described farming as a means of supporting household food security, maintaining pride in food production, and transferring knowledge to their children. These motivations broaden the interpretation of CSA adoption beyond commercial returns. They suggest that interventions may be more relevant when they recognize household wellbeing and locally valued outcomes alongside productivity and environmental objectives (Bezner Kerr et al., 2019).

Conclusions

This comparative case study shows that the women interviewed in Indian Church Village and Duck Run 2 reported both shared constraints and distinct institutional conditions. Credit access and livelihood profiles differed descriptively between the groups, while the study did not detect statistically significant community differences in the Women's Participation Index or CSA Adoption Score. These nonsignificant results do not establish equivalence. Rather, the interviews suggest that land tenure, finance, extension access, care responsibilities, and family support are important factors to investigate when explaining women's agricultural decision-making and CSA adoption in these communities.

The findings must be interpreted within several limitations. The convenience sample was small ($N = 30$) and restricted to two communities, so it cannot represent rural Belize or its diverse cultural and farming systems. The cross-sectional design cannot establish causal relationships, and all adoption and decision-making measures were self-reported. The two composite indices also require further validation, including assessment of reliability and treatment of decisions that may not apply to every farm. The t-tests had limited power and one outcome departed from normality. Finally, the thematic analysis identifies recurring accounts within the interviews but does not establish their prevalence beyond the participants.

Policy Recommendations and Future Directions

The findings support several context-specific policy considerations. Agricultural agencies and development organizations could pilot credit products that accept appropriate alternatives to registered land titles, while carefully evaluating repayment risk and accessibility. Extension providers could also test mobile or community-based services directed to women and schedule activities in consultation with participants to reduce conflicts with farm and care responsibilities.

CSA initiatives could combine technical training with access to labor-saving field technologies, such as drip-irrigation or appropriate small-scale weeding equipment, where participants identify these as priorities. Future research should include larger and more diverse samples, validated measures of decision-making and empowerment, direct indicators of land and extension access, and longitudinal designs capable of examining how household and institutional conditions influence adoption over time.

References

- Acosta, M., Riley, S., Bonilla-Findji, O., Martínez-Barón, D., Howland, F., Huyer, S., Castellanos, A., Martínez, J. D., & Chanana, N. (2021). Exploring women's differentiated access to climate-smart agricultural interventions in selected Climate-Smart Villages of Latin America. *Sustainability*, 13(19), Article 10951. <https://doi.org/10.3390/su131910951>
- Agarwal, B. (1997). "Bargaining" and gender relations: Within and beyond the household. *Feminist Economics*, 3(1), 1–51. <https://doi.org/10.1080/135457097338799>
- Bezner Kerr, R., Hickey, C., Lupafya, E., & Shumba, L. (2019). Integration of and constraints to gender equity in agroecological and climate-smart agriculture initiatives. *International Journal of Agricultural Sustainability*, 17(3), 226–239. <https://doi.org/10.1080/14735903.2019.1607361>
- Commonwealth Secretariat. (2019). *Gender equality in the Commonwealth*. <https://doi.org/10.14217/61a6eee4-en>
- Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.
- de Winter, J. C. F. (2013). Using the Student's t-test with extremely small sample sizes. *Practical Assessment, Research & Evaluation*, 18(10), 1–12. <https://doi.org/10.7275/e4r6-dj05>
- Doss, C. (2013). Intrahousehold bargaining and resource allocation in developing countries. *The World Bank Research Observer*, 28(1), 52–78. <https://doi.org/10.1093/wbro/lks011>
- Huyer, S. (2016). Closing the gender gap in climate-smart agriculture. *Gender, Technology and Development*, 20(2), 105–116. <https://doi.org/10.1177/0971852416643872>

Ragasa, C., Berhane, G., Tadesse, F., & Taffesse, A. S. (2013). Gender differences in access to extension services and agricultural productivity. *The Journal of Agricultural Education and Extension*, 19(5), 437–468. <https://doi.org/10.1080/1389224X.2013.817342>

Shahbaz, P., ul Haq, S., Abbas, A., Batool, Z., Alotaibi, B. A., & Nayak, R. K. (2022). Adoption of climate smart agricultural practices through women involvement in decision making process: Exploring the role of empowerment and innovativeness. *Agriculture*, 12(8), Article 1161. <https://doi.org/10.3390/agriculture12081161>