Advancing Sustainability Strategies of Non-Timber Forest Product Value Chains: A Climate-Resilience Framework for Uapaca kirkiana in Zimbabwe

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Abstract

Non-Timber Forest Products (NTFPs) support rural livelihood trajectories and sustainable development. However, their value chains are beset by systemic challenges. These systematic challenges include climate vulnerability, tenure insecurity and institutional fragmentation. The study develops a climate-resilience framework for *Uapaca kirkiana* (wild loquat) value chains in Mashonaland East Province, Zimbabwe. It draws on promising practices from Rooibos (South Africa), shea butter (Ghana) and baobab (Tanzania). A sequential mixed-methods design was used. Qualitative comparative case analysis informed a survey of 453 stakeholders. Participants recruited through quota sampling during public events, included 208 harvesters, 110 processors/traders, 115 consumers and 20 key informants. Quantitative data were analysed using ANOVA and t-tests. Qualitative data underwent reflexive thematic analysis. Strong consensus emerged on five priorities: secure land tenure (mean 4.75), research-led innovation (4.76), infrastructural investment (4.70),

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benefit-sharing (4.32) and inclusive governance. Significant differences appeared between stakeholder groups for monitoring, evaluation and learning ($p<0.001$), land rights and access by gender ($p=0.001$). Qualitative evidence revealed persistent barriers incorporating tenure insecurity, post-harvest losses and exclusion of women and youth. An empirically validated, Climate-Resilience Framework for *Uapaca kirkiana* is aligned to Sustainable Development Goals (SDGs:1-no poverty, 5-gender equality, 8-decent work and economic growth and 13-climate action). The proposed framework integrates biophysical, economic, socio-institutional and adaptive governance pillars, that synchronise climate adaptation, livelihoods and forest conservation.

Keywords*: value chain upgrading, rural livelihoods, triple bottom line, global value chain, SDGs.*

INTRODUCTION

Uapaca kirkiana (wild loquat, locally known as *mazhanje*) is a prominent indigenous fruit tree species of profound socio-ecological and economic significance in Southern Africa (Shackleton *et al*., 2020). In the Miombo woodlands of Zimbabwe, rural communities have historically leveraged its nutritional and economic value to mitigate food insecurity and generate income (Gama *et al.,* 2023). Beyond these immediate benefits, the species' contribution to wood, fodder and ethnomedicine remains deeply embedded in local cultural and livelihood systems, particularly during the lean seasons preceding the main harvest (Mukamuri *et al.,* 2023). However, the long-term viability of *Uapaca kirkiana* populations and their associated value chains is increasingly compromised. Human-induced climate change threatens tree fruit-timing and species distribution (Jinga *et al*., 2021). These biophysical pressures are compounded by systemic governance deficits, including insecure tenure arrangements, weak regulatory enforcement and the systematic exclusion of local stakeholders from policy-making processes (Chinembiri *et al*., 2022; Matseketsa *et al*., 2024).

Although existing literature extensively documents the role of NTFPs in rural development and conservation (Shackleton *et al*., 2020; Angelsen *et al*., 2014), a critical disconnect persists between diagnostic research and the implementation of climate-resilient strategies and it is these lacunae in the canon which this research seeks to fill. Moreover, the integration of NTFP sustainability with the SDGs remains underdeveloped, hindering the alignment of indigenous fruit tree value chains with global development priorities (FAO, 2024). Therefore, identifying constraints and providing transferable, empirically validated solutions is critical to addressing stakeholders' lived realities (Ingram *et al.*, 2022).

To address these gaps, the present study pursues three primary objectives. First, to determine how demographic dynamics influence participation in the *Uapaca kirkiana* value chain. Second, to identify promising practices from comparative African NTFP cases: rooibos (*Aspalathus linearis*) in South Africa, shea butter (*Vitellaria paradoxa*) in Ghana and baobab *(Adansonia digitata*) in Tanzania. Third, to empirically validate these practices within the Zimbabwean context, thereby establishing the essential components of an SDG-aligned framework that enhances climate resilience across the *Uapaca kirkiana* value chain. The remainder of this study is structured as follows. Section 2 outlines the theoretical and conceptual frameworks. Section 3 presents the literature review and comparative case analysis. Section 4 describes the research methodology. Section 5 reports the results and discussion. Section 6 provides the conclusion, integrates the visual framework and offers recommendations and limitations.

THEORETICAL FRAMEWORKS

This section maps the pertinent theoretical lens grounding the study. This study is anchored in a deliberate synthesis of two complementary theoretical lenses, that infuse the Global Value Chain (GVC) framework and the Triple Bottom Line (TBL) sustainability framework.

The GVC framework conceptualises the full range of activities required to bring a product from conception to end-use, examining how these activities are coordinated across geographical scales (Gereffi *et al*., 2023). Three interrelated concepts are pivotal, incorporating governance, upgrading and institutional frameworks.

Governance refers to the power dynamics that dictate the flow of financial, material and intellectual resources within the chain, thereby determining which actors capture value (Dallas *et al*., 2019; Ponte *et al*., 2019). Upgrading describes the strategic processes through which actors enhance their position within the chain to capture greater value, occurring via process optimisation, product differentiation, functional repositioning or inter-sectoral movement (Barrientos *et al*., 2021; Humphrey and Schmitz, 2002). Institutional frameworks encompass the formal and informal rules, norms and standards regulating actor behaviour and chain performance (Cashore *et al*., 2004). In the context of NTFPs, GVC analysis has demonstrated how lead firms, certification bodies and state regulations frequently marginalise primary producers, thereby restricting their upgrading capacities (Donovan *et al*., 2022; Ingram *et al.,* 2022).

The Triple Bottom Line Framework, originally formulated by Elkington (1997) and subsequently refined (2018), posits that genuine sustainability requires simultaneous commitment to economic prosperity, social equity and environmental stewardship. Within NTFP scholarship, these pillars are operationalised through the exploration of viable markets, equitable pricing, employment generation and value-added upgrading (Kaplinsky and Morris, 2001; Donovan *et al.*, 2022). The framework further enables analysis of social sustainability through community engagement, equitable benefit-sharing, gender inclusivity, secure tenure and the preservation of indigenous and local knowledge (Shackleton *et al.*, 2020; Elias *et al.*, 2021).

Environmental sustainability is addressed through biodiversity conservation, sustainable harvesting protocols, soil and water protection and climate change adaptation (FAO, 2024; Gullison, 2025). While critics of TBL highlight its susceptibility to metric proliferation or 'greenwashing' (Norman and MacDonald, 2004), its primary utility remains its normative requirement that economic activities respect social and environmental thresholds. This study mitigates common TBL limitations by operationalising these dimensions through stakeholder-validated indicators specific to the *Uapaca kirkiana* context.

The rationale for integrating GVC and TBL frameworks is both theoretically and methodologically advantageous. The GVC analysis provides a roadmap for interrogating governance structures, power asymmetries and upgrading trajectories (Ponte *et al*., 2019; Gereffi *et al.*, 2023). However, it has been critiqued for marginalising environmental sustainability and social equity beyond the narrow scope of economic upgrading (Bolwig *et al*., 2020). Conversely, the TBL framework offers a normative compass for evaluating whether specific upgrading trajectories advance or diminish social and ecological integrity (*ibid.*). However, it lacks the granular analytical capacity to scrutinise chain-specific governance dynamics (Ponte *et al*., 2019). Their integration, therefore, provides a more holistic and analytically rigorous approach, bridging structural market analysis with normative sustainability goals. This integrated paradigm is increasingly used in sustainability-oriented research within the coffee, cocoa and forestry sectors (Ingram *et al*., 2022; Krishnan, 2023).

CONCEPTUAL FRAMEWORK

The study's conceptual framework posits that climate resilience in NTFP value chains rests on four interconnected pillars. Biophysical resilience encompasses genetic diversity, sustainable harvesting and agroforestry practices, which are critical for maintaining ecosystem services and nutrient cycling (Mabhaudhi *et al*., 2022). Economic resilience is facilitated by infrastructure, market linkages, value addition and access to finance, thereby enhancing the adaptive capacity of value chain actors to climate risk and market shocks (Agoraki *et al*., 2024). Socio-institutional resilience is underpinned by land tenure security, inclusive benefit-sharing and the equitable participation of women and youth, which are essential for sustainable development and for ensuring no one is left behind (Flintan *et al*., 2024). Adaptive governance involves robust monitoring, evaluation and learning (MEL) systems, and inclusive policy processes, driving climate resilience informed by GVC-TBL theory (De Graaf *et al*., 2021; Gereffi *et al*., 2023).

LITERATURE REVIEW- COMPARATIVE CASE STUDIES AND PROMISING PRACTICES

This section synthesises the empirical literature on sustainable and climate-resilient NTFP value chains through a structured comparative analysis of three

African cases with rooibos tea (South Africa), shea butter (Ghana) and baobab pulp (Tanzania).

CASE STUDY ANALYSIS: ROOIBOS TEA (SOUTH AFRICA)

The South African rooibos (*Aspalathus linearis*) industry is one of the most extensively documented NTFP commercialisation cases globally. Cultivated almost exclusively in the Cederberg region of the Western Cape, the sector has undergone a significant transformation from wild harvesting to large-scale monoculture (Wynberg *et al*., 2018; Joubert and de Beer, 2021). From a GVC perspective, governance is concentrated among a small number of processors and export firms, which has historically marginalised smallholder producers and Indigenous Khoisan communities (Bosch *et al*., 2021; Tucker, 2021). Upgrading has occurred mainly through process optimisation and product differentiation (e.g., organic and fair-trade certifications). Yet, functional upgrading, such as community-owned processing, remains limited (Kruger and du Toit, 2024).

Environmentally, rooibos cultivation has generated significant negative externalities, including water scarcity, soil degradation and biodiversity loss (Swart *et al*., 2020). In response, research institutions and industry have invested in breeding programmes to develop drought and disease-resistant varieties, alongside biodiversity-friendly certification schemes (Smit *et al*., 2022). Nevertheless, the sector's continued reliance on monoculture systems increases its vulnerability to climate change (Meyer *et al*., 2023). Socially, inequitable benefit-sharing and the exclusion of Indigenous knowledge holders from decision-making persist, despite fair-trade and empowerment charters (Bosch *et al*., 2021). Economically, price volatility and concentrated processing constrain smallholder incomes (Joubert and de Beer, 2021).

The rooibos case demonstrates that climate resilience requires sustained investment in research-led germplasm improvement and biodiversity-friendly production systems for *Uapaca kirkiana*. Moreover, it serves as a cautionary tale, that without secure tenure rights and inclusive governance, commercialisation can reproduce social exclusion and inequitable value capture.

CASE STUDY ANALYSIS: SHEA BUTTER (GHANA)

The shea (*Vitellaria paradoxa*) butter sector in northern Ghana is essentially feminised, with women responsible for the vast majority of nut collection and butter processing (Elias *et al*., 2021; Choudhury *et al.*, 2023). Shea trees grow wild in agroforestry parklands and their sustainable management is intrinsically linked to land-use and tenure systems.

Environmentally, the shea butter industry faces pressures from agricultural expansion, charcoal production and overexploitation of wood resources (Elias *et al*., 2021). However, agroforestry practices that integrate shea into cropping systems have been identified as a key sustainability strategy, improving soil fertility and diversifying incomes (Lovett, 2021). Low regeneration rates and tenure insecurity discourage long-term investment in tree planting and protection.

Socially, despite women's central role in NTFP production processes, they remain concentrated in low-value, labour-intensive nodes of the chain, facing persistent barriers to land ownership, credit and technological upgrading (Choudhury *et a*l., 2023). Empowerment interventions, such as women's cooperatives, training in improved processing and direct market linkages, have shown positive impacts on incomes and agency, but scalability remains a challenge (Wynberg, 2017). Economically, global demand for shea butter in cosmetics and confectionery has grown substantially, yet producers capture a disproportionately small share of final retail value (Kolavalli and Vigneri, 2018, Lovett, 2021). The shea case underscores the centrality of gender dynamics for *Uapaca kirkiana* value chains. Deliberate, well-designed empowerment interventions can transform women's livelihoods, but they must be accompanied by tenure security and access to finance. Upgrading strategies that bypass structural inequalities are unlikely to deliver equitable outcomes.

CASE STUDY ANALYSIS: BAOBAB PULP (TANZANIA)

The baobab (*Adansonia digitata*) fruit value chain in Tanzania has attracted increasing traction following the recognition of baobab as a 'superfood' in global markets (Gruenwald and Galizia, 2020; Kapinga *et al*., 2021). The species is wild-harvested, predominantly by women and children, from trees growing on communal lands. From a GVC perspective, governance is weak and fragmented: open-access conditions prevail and value chain coordination is hampered by limited infrastructure and market information systems (Mgumia *et al.*, 2021).

Environmentally, baobab populations face threats from land-use conversion, overharvesting of fruit and bark and limited natural regeneration (Sanchez *et al*., 2022). Climate change projections indicate potential range contractions, particularly in drier parts of the species' distribution (Kokou *et al*., 2025). Sustainable management practices, including selective harvesting protocols, protection of mature trees and integration into agroforestry, have been piloted but not systematically scaled (Shackleton *et al.*, 2020).

Socially, the lack of clear ownership over trees on communal land creates open-access conditions that discourage long-term stewardship. Community-Based Natural Resource Management (CBNRM) models, which devolve clear rights and responsibilities to local institutions, have shown promise but remain underutilised (*ibid.*). Economically, the baobab value chain is characterised by significant post-harvest losses, limited processing infrastructure, inconsistent fruit quality and weak market information systems (Mgumia *et al*., 2021). Capacity-building interventions focused on post-harvest handling, quality grading and collective marketing have demonstrated potential to enhance incomes and reduce waste, but they remain small-scale and donor-dependent. The baobab case offers direct parallels for *Uapaca kirkiana*, sharing similar ecological niches, harvest profiles and tenure regimes. It underscores the critical importance of tenure clarification, community-based governance and investment in post-harvest infrastructure as foundational enablers for climate-resilient value chain development.

RECURRENT PROMISING PRACTICE THEMES

The comparative analysis reveals five recurrent themes essential for building sustainable and climate-resilient *Uapaca kirkiana* value chains. First, community engagement and empowerment are non-negotiable. Top-down, extractive models consistently fail to deliver durable sustainability outcomes. Successful interventions include rooibos cooperatives, shea women's groups and baobab CBNRM's pilots actively involve communities in decision-making, chain governance and benefit-sharing from the outset (Wynberg *et al*., 2018; Elias *et al.*,2021). Empowerment is not an afterthought but a precondition for sustainability. Second, insecure land tenure is a fundamental barrier across all three cases. Where tenure is unclear or contested, long-term investment in tree planting, protection and improved harvesting practices is systematically discouraged (Choudhury *et al.,* 2023; Matseketsa *et al.*, 2024). Policy reforms that recognise and secure customary and collective rights, such as Tanzania's Certificate of Customary Right of Occupancy (CCRO), create enabling conditions for stewardship and investment (Donovan *et al.*, 2022).

Third, value chain upgrading must be deliberately pro-poor and inclusive. Moving beyond the sale of raw, undifferentiated commodities is essential for local value capture. Process and product upgrading (e.g., producing high-quality, certified products) and functional upgrading (e.g., community-owned processing facilities) can significantly increase returns to harvesters and primary producers (Wynberg, 2017). However, upgrading strategies must be designed to include women, youth and other marginalised groups, who are often excluded from higher-value nodes (Barrientos *et al.,* 2021). Fourth, investment in research, development and capacity-building is a prerequisite for climate adaptation. The development and dissemination of climate-resilient germplasm, as demonstrated in the rooibos sector, is essential for species facing climate-induced stress (Mgumia *et al.,* 2021; Smit *et al.*, 2022). Fifth, robust monitoring, evaluation and learning (MEL) systems enable adaptive governance. Systematic tracking of environmental, social and economic indicators is vital for evidence-based decisions and course correction. The rooibos industry's relatively advanced MEL infrastructure permits more responsive governance than the fragmented, project-based monitoring evident in the shea and baobab sectors (Joubert and de Beer, 2021; Ingram *et al.*, 2022).

SYNTHESIS - TOWARDS A PRELIMINARY FRAMEWORK FOR *UAPACA KIRKIANA* VALUE CHAIN

Drawing on the three case studies and the recurrent themes above, a climate-resilience framework for *Uapaca kirkiana* value chains should be built on four interdependent pillars, which will be empirically validated in the subsequent phases of this study.

Table 1: *Promising practices for Uapaca Kirkiana with reference to lessons learnt* (Case Summaries, 2026)

Pillar	**Description**
Biophysical Resilience	Prioritise conservation of genetic diversity through investment in research, development, dissemination of climate-adapted germplasm and adoption of sustainable agroforestry practices.
Socio-Institutional Resilience	Strengthen community-based management systems, clarifying secure tenure rights which establish transparent and equitable benefits, sharing mechanisms. Empowering collector and processor groups, particularly women and youth groups, is non-negotiable.
Economic Resilience	Facilitate functional upgrading by supporting small-scale processing and value addition (e.g., improved harvesting, storage, processing and preservation). Develop market linkages and explore certification that differentiates *Uapaca kirkiana* fruit products. Improve access to climate, smart-agricultural finance
Adaptive Governance	Strengthen MEL through systematic real-time tracking, adaptive management cycles and data-driven decision-making. Develop inclusive policies through active participation, co-management, equity and empowerment.

These pillars are not sequential, but mutually reinforcing, with progress in one domain enabling and amplifies progress in others. The preliminary framework informed the design of the data collection instruments and provides the analytical structure for the interpretation of empirical findings presented in Section 5.

METHODOLOGY AND RESEARCH DESIGN

The study adopted a two-phased sequential mixed-methods design (Creswell and Plano Clark, 2018). The initial qualitative phase involved a systematic literature review and structured comparative analysis of three established African NTFP value chains. The quantitative phase employed a cross-sectional survey to validate the promising practices identified during the first stage. This dual-phased approach is suited for research that requires the identification of contextually grounded practices, followed by their validation across a diverse and extensive population of value chain actors (Fetters *et al*., 2023).

The first phase analysed three well-documented African cases: Rooibos tea (South Africa), shea butter (Ghana) and baobab (Tanzania). Selection criteria included ecological and socio-economic relevance to the *Uapaca kirkiana* context and the existence of a substantial body of peer-reviewed and grey literature. The analysis followed Bereday's (1964) comparative method, as adapted by Sharma (2017). Data sources comprised peer-reviewed journal articles, book chapters and institutional reports from CGIAR centres, the FAO, UNEP and national forestry departments, identified through Web of Science, Scopus and Google Scholar using search strings combining case-specific terms with thematic keywords such as 'climate resilience', 'upgrading', 'tenure' and 'gender'. The search covered publications from 2000 to 2026, with strategic emphasis on literature published since 2020.

A quota sampling strategy was adopted to ensure representation across distinct actor groups, while bypassing geographical barriers. It targeted respondents with relevant NTFP value chain expertise and experience (Patton, 2015; Fetters *et al*., 2023). Sample size was calculated using Cochran's (1977) formula for a 95% confidence level and 5% margin of error. This yielded a target of 384 responses. The study exceeded this with 453 valid responses. Data collection continued past the minimum to reach saturation, with the process confirming no new insights. The final sample comprised 208 harvesters/producers (45.9%), 110 processors/traders (24.3%) and 20 key informants.

A structured questionnaire captured demographic characteristics, level of participation in the value chain, perceptions of the importance of 15 promising practices (derived from Phase One) on a five-point Likert scale (1=least important, 5=most important) and open-ended responses on barriers and opportunities. The instrument was piloted with 30 respondents involved in harvesting, processing and marketing of NTFPs from Harare and Mashonaland East Provinces. Pilot data-informed refinements to question wording, sequencing and response categories. Cronbach's alpha for the final instrument was 0.87, indicating good internal consistency (Fetters *et al*., 2023). A separate semi-structured interview guide was developed for key informant interviews to explore the policy and institutional environment, perceived effectiveness of existing sustainability initiatives and barriers to scaling promising practices.

Data collection was executed between May and November 2024, leveraging seven national and regional platforms in Zimbabwe (Farm to Market Fair, Zimbabwe International Trade Fair, Harare Agricultural Show, National NTFP Conference, University of Zimbabwe Research and Innovation Week, SADC Industrialisation Week and Presidential Innovation Fair). These venues provided a centralised hub for value chain actors from 10 provinces, bypassing geographical barriers. Twelve trained graduate students administered the questionnaire in English, Shona or Ndebele. The lead author conducted 20 key informant interviews (30-45 minutes) until thematic saturation was achieved (*ibid.*).

Quantitative data were entered into SPSS version 28. Descriptive statistics (frequencies, percentages, means, standard deviations) were computed. Inferential statistics, specifically one-way ANOVA and independent samples t-tests, were employed to examine differences in perceptions across stakeholder groups and demographic categories, with statistical significance set at $p < 0.05$. Effect sizes (Cohen's d for t-tests; η^2 for ANOVA) were calculated to assess practical significance (Cohen, 1988; Lakens, 2022). Qualitative data from open-ended survey responses and interview transcripts were analysed using reflexive thematic analysis following Braun and Clarke's (2021) six-phased approach. Rigour was enhanced through investigator triangulation, member checking and maintenance of an audit trail (Lincoln and Guba, 1985; (Fetters *et al.*, 2023).

The study adhered to the University of Zimbabwe's Research Ethics Policy. All participants were provided with a detailed information sheet and signed a consent form before participation.

FINDINGS

The composition of 453 study participants comprised 62% male (n=281) and 38% female (n=172) respondents (Table 2). This gender distribution presents a nuanced picture that warrants careful interpretation. Extensive literature positions women as the primary actors in NTFP collection, processing and local trade across sub-Saharan Africa (Shackleton *et al.*, 2020; Elias *et al.*, 2021; Choudhury *et al.*, 2023). However, the present study's finding of male majority suggests that in the specific context of *Uapaca kirkiana* commercialisation in

Zimbabwe, men may dominate the more visible, market-oriented nodes of the value chain, particularly trading at formal markets, transport and wholesale distribution. This interpretation is consistent with Ingram's (2020) observations in Cameroon, where men tend to assume control of NTFP value chains transitioning from subsistence harvesting to commercialised, higher-value segments.

Table 2: *Demographic Profiles of Respondents*

Characteristics	Category	N	Frequency (%)
Gender	Male	281	62.0
	Female	172	38.0
Age group	Youth (18-24)	40	8.8
	Adult (25-44 years)	200	44.2
	Middle aged (45-64 years	151	33.3
	Senior (65+ years)	62	13.7
Educational level	Primary	4	0.9
	Secondary	288	63.6
	Tertiary	161	35.5
Stakeholder group	Harvester/Producer	208	45.9
	Processor/Trader	110	24.3
	Consumer	115	25.4
	Key informants	20	4.4

n=453

The age distribution reveals that adults aged 25-44 years (44.2%) and middle-aged respondents aged 45-64 years (33.3%) constitute most value chain actors. This finding indicates that NTFP activities provide a vital source of livelihood for the primary working-age and breadwinning cohorts in rural Zimbabwean communities (Gama *et al.*, 2023). The significant participation of seniors aged 65+ years (13.7%) highlights the enduring role of indigenous knowledge and intergenerational knowledge transfer in the sector. Of particular concern, is the relatively low participation of youth aged 18-24 years (8.8%), signalling a potential sustainability challenge regarding future succession, innovation and intergenerational continuity of indigenous fruit tree management (*ibid.*).

Educational levels were predominantly secondary (63.6%) and tertiary (35.5%), with minimal primary education (0.9%). This comparatively high educational profile is a positive finding from a capacity-building and upgrading perspective.

More educated value chain actors are better positioned to adopt new technologies, interpret market information, comply with quality standards and engage in sophisticated forms of upgrading (Bolwig *et al.*, 2020). However, a sharp intergenerational divide, with 8.8% of youth respondents (18-24) reporting tertiary education, compared to 11.3% of seniors (65+). This suggests that while younger participants possess substantial human capital, the sector currently fails to offer them compelling livelihood options commensurate with their expectations. The role of study participants in the NTFP sector illustrates varied responses. Harvesters and producers constituted the largest stakeholder group (45.9%), followed by consumers (25.4%) and processors/traders (24.3%), while key informants comprised 4.4% of the total sample. The relatively small representation of key informants is, in itself, a significant finding reflecting the historically top-down and disconnected nature of NTFP support systems in Zimbabwe. This pattern is similarly documented in the Tanzanian baobab sector (Mgumia *et al.,* 2021). The composition underscores the urgent necessity for multi-stakeholder platforms. As emphasised in the rooibos and shea sectors, structured engagement between producers, private actors and government bodies is crucial for sustainable value chain development (Wynberg, 2017).

VALIDATION OF PROMISING PRACTICES

Participants rated the importance of 15 promising practices, identified through comparative case analysis, using a five-point Likert scale (1=least important, 5=most important). Table 3 presents the mean importance scores and standard deviations for each practice, disaggregated by stakeholder group.

Table 3: *Validation of Promising Practices for Climate-Resilient Uapaca kirkiana Value Chains (N=453) (Mean on 5-point scale; SD in parentheses)* **(**Nyamande *et al*., 2026)

Practice	**Harvesters / Producers (n=208)**	**Processors / Traders (n=110)**	**Consumers (n-115)**	**Key Informants N=20**	**Overall Practice Mean (SD)**
Land rights and access	4.85 (0.36)	4.65 (0.61)	4.60 (0.59)	4.85 (0.37)	4.75 (0.48)
Research-driven innovations	4.91 (0.29)	4.70 (0.58)	4.55 (0.66)	4.90 (0.31)	4.76 (0.52)
Infrastructural provision	4.70 (0.60)	4.70 (0.59)	4.65 (0.63)	4.80 (0.41)	4.70 (0.55)

Viable trade protocols/quality control	4.60 (0.62)	4.87 (0.34)	4.58 (0.61)	4.80 (0.41)	4.68 (0.53)
Sustainable biodiversity management	4.78 (0.45)	4.55(0.64)	4.50 (0.67)	4.75 (0.44)	4.65 (0.58)
Multi-stakeholder engagement	4.45 (0.72)	4.55 (0.62)	4.50 (0.69)	4.75 (0.44)	4.52 (0.65)
Inclusive policies	4.40 (0.75)	4.50 (0.67)	4.45 (0.70)	4.70 (0.47)	4.47 (0.68)
Benefit-sharing schemes	4.18 (0.81)	4.35 (0.69)	4.28 (0.74)	4.60 (0.50)	4.32 (0.71)
Monitoring, evaluation and learning	4.15 (0.79)	4.40 (0.66)	4.30 (0.73)	4.80 (0.41)	4.35 (0.68)
Access to finance	4.50 (0.71)	4.60 (0.60)	4.48 (0.68)	4.70 (0.47)	4.55 (0.64)
Gender-inclusivity	4.35 (0.76)	4.45 (0.68)	4.40 (0.72)	4.65 (0.49)	4.42 (0.70)
Value addition training	4.50 (0.71)	4.80 (0.45)	4.48 (0.65)	4.70(0.47)	4.58 (0.62)
Climate information services	4.60 (0.62)	4.50 (0.67)	4.45 (0.68)	4.65 (0.49)	4.55 (0.63)
Market linkages	4.55 (0.67)	4.80 (0.45)	4.50 (0.69)	4.75 (0.44)	4.62 (0.60)
Youth Engagement	4.40(0.74)	4.45(0.66)	4.42(0.69)	4.65(0.49)	4.45(0.67)
Overall mean score	4.58 (0.40)	4.63 (0.37)	4.41 (0.44)	4.72(0.31)	4.56(0.38)

To examine differences in perceptions across stakeholder groups, a one-way ANOVA was conducted for each practice. Significant differences were found for research-driven innovations ($F(3,449)=8.42$, $p<0.001$, $\eta^2=0.053$), land rights and access ($F(3,449) =6.17$, $p< 0.001$, $\eta^2=0.040$), viable trade protocols ($F(3,449)=7.93$, $p<0.001$, $\eta^2=0.050$), monitoring and evaluation ($F(3,449)=9.56$, $p<0.001$, $\eta^2=0.060$) and benefit-sharing ($F(3,449)=4.21$, $p=0.006$, $\eta^2=0.027$). Post-hoc Tukey HSD tests brought to the fore the fact that key informants rated monitoring and evaluation significantly higher than harvesters (mean difference=0.65, $p<0.001$, 95% CI [0.32, 0.98]) and harvesters rated land rights significantly higher than consumers (mean difference =0.25, $p=0.003$, 95% CI [0.08, 0.42]).

Independent samples t-tests examined gender differences. Males (M=4.80, SD=0.45) rated land rights significantly higher than females (M=4.65, SD=0.52), t(451)=3.21, p=0.001, Cohen's d =0.31 (small to moderate effect). Conversely, females (M=4.55, SD=0.60) rated gender-inclusivity significantly higher than males (M=4.35, SD=0.72), t(451)=3.05, p=0.002, Cohen's d=0.30. No significant gender differences were found for research-driven innovations or infrastructural provision (p >0.05).

Age-based differences (youth versus seniors) were examined using independent t-tests. Youth (18-24 years) rated youth engagement (M=4.70, SD=0.46) significantly higher than seniors (65+ years: M=4.35, SD=0.69), t(100)=2.98, p=0.004, Cohen's d=0.60 (moderate effect). Seniors rated sustainable biodiversity management (M=4.80, SD=0.40) higher than youth (M=4.55, SD =0.60), t(100)=2.45, p=0.016, Cohen's d=0.49.

Qualitative data from open-ended survey responses and key informant interviews provided essential context. Five major themes emerged. Land tenure insecurity was the most frequently cited barrier. A 52-year-old male harvester from Murehwa stated:

> How can I plant a *Mazhanje* tree for my grandchildren when the chief can allocate this land to someone else tomorrow? We take what we can get now; thinking of tomorrow is something else.

Post-harvest losses were highlighted by a 39-year-old female processor from Domboshava;:

> We lose up to half of the *Mazhanje* harvest in a good season because we cannot preserve them.

Weak trade protocols were emphasised by a 55-year-old female harvester from Marondera:

> We need written agreements with buyers. Sometimes we bring the fruits, they say the market has changed and offer less. We have no power.

Benefit-sharing scepticism was voiced by a 46-year-old female harvester from Hwedza:

> As women, we collect wild fruits, but when the money comes, men decide how it is shared. Moreover, projects that came before promised us money, but that never happened.

Lack of MEL reciprocity was noted by a government key informant:

> We lack a systematic mechanism to track the health of *Uapaca kirkiana* tree populations or the socio-economic benefits for communities. Without this data, we are making policies in the dark.

DISCUSSION

The findings demonstrate a high level of stakeholder consensus regarding the 15 promising practices for climate-resilient *Uapaca kirkiana* value chains, with an overall mean of 4.56. The highest-rated practices were research-driven innovations (4.76) and land rights and access (4.75), aligning with the rooibos sector's experience, where breeding for drought resistance has been a cornerstone of climate adaptation (Smit *et al*., 2022; Meyer *et al*., 2023). The near-maximum score assigned by harvesters to land tenure (4.85) underscores that insecure tenure is not merely a policy abstraction, but a lived constraint that renders long-term investment irrational (Chinembiri *et al*., 2022; Matseketsa *et al.*, 2024).

The significant differences detected by ANOVA and t-tests reveal important intra-stakeholder dynamics. Key informants' higher valuation of monitoring and evaluation (4.80 versus harvesters' 4.15) indicates a governance gap. While policy actors regard MEL as essential for adaptive management, primary producers perceive current systems as extractive or irrelevant. This divergence echoes observations in the Tanzanian baobab sector (Mgumia *et al.*, 2021) and underscores the need for participatory data structures that generate reciprocal value for harvesters (Ingram *et al.*, 2022). Conversely, harvesters' higher valuation of land rights compared to consumers (mean difference=0.25, $p=0.003$) reflects their direct exposure to tenure insecurity as a production constraint. Gender differences, though small in effect size, have substantive significance. Males rated land rights higher than females, consistent with patriarchal land tenure systems where men dominate formal ownership (Elias *et al.*, 2021). Females rated gender-inclusivity higher, reflecting their lived experience of marginalisation in value chain governance. The moderate effect size for youth versus seniors on youth engagement (Cohen's $d=0.60$) signals an intergenerational tension with younger actors demand more inclusion, while seniors prioritise biodiversity conservation. This highlights the need for frameworks that balance innovation with traditional ecological knowledge (Kozanayi *et al*., 2024).

Infrastructural provision (4.70) and viable trade protocols (4.68) were rated highly, particularly by processors and traders, reflecting the binding constraints of perishability and market access. With post-harvest losses reaching 50%, the lack of preservation technology locks communities into low-value nodes of the chain (Donovan *et al*., 2022; FAO, 2024). The high valuation of trade protocols (4.87) by processors, indicates that quality standards are viewed not as bureaucratic hurdles, but as market-enabling mechanisms that reduce transaction costs and facilitate premium pricing. The lower scores for benefit-sharing schemes (4.32) and MEL (4.35) do not indicate rejection of these principles, but rather deep-seated scepticism born out of historical marginalisation and extractive project designs (Bosch *et al*., 2021; Kruger and du Toit, 2024). This finding is critical in that any framework failing to address power asymmetries in benefit distribution and monitoring will likely be rejected by primary stakeholders.

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

The findings demonstrate that NTFP value chains hold substantial promise for sustainable development, yet institutional bottlenecks severely restrict this potential. The main constraints identified include insecure land tenure, limited infrastructural provision, weak research and innovation systems, poor value addition, inadequate marketing, insufficient capacity-building, limited gender and youth inclusion, including weak intergenerational stewardship. These imperatives form a non-negotiable pathway for progress. Moreover, climate resilience is not a peripheral concern. It requires grounded upgrading strategies that are locally adapted to ensure long-term survival of perennial production systems. Figure 1 presents an SDG-aligned Climate-Resilience Framework, as a translator tool for understanding *Uapaca kirkiana* value chains.

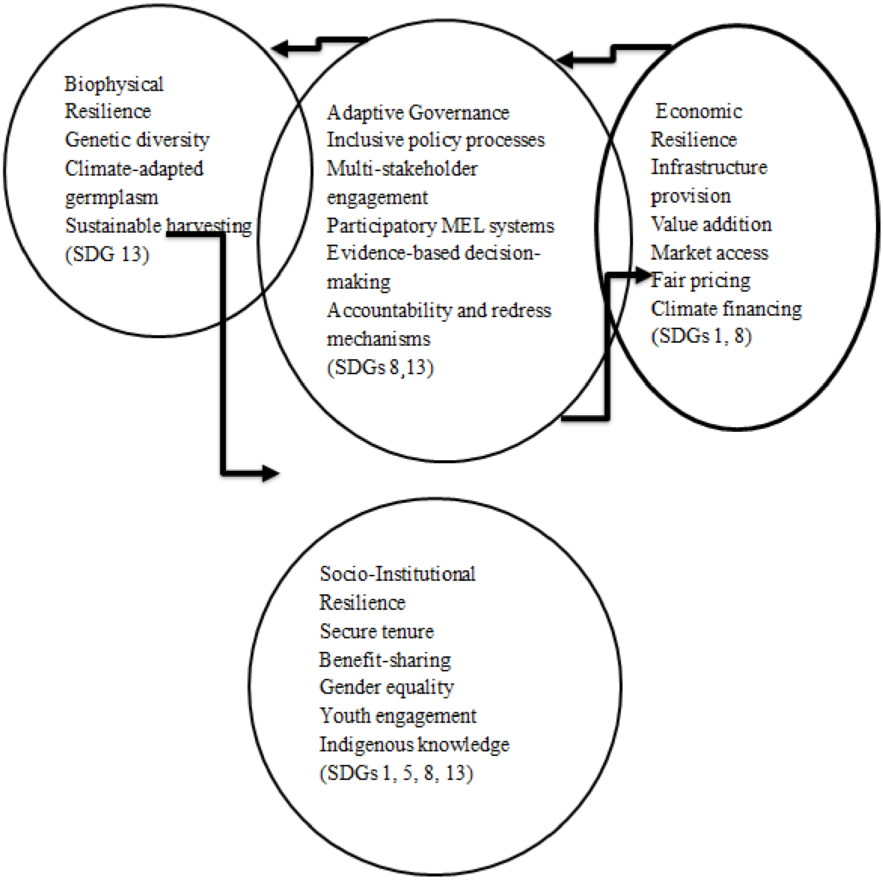

Figure 1: *SDG Aligned Climate-Resilience Framework for Uapaca Kirkiana Value Chains* (Nyamande *et al*., 2026)

As illustrated in Figure 1, the climate-resilience SDG-aligned framework for *Uapaca kirkiana* value chains is the study's principal output. The framework synthesises the comparative case analysis (Section 3) and stakeholder validation (Section 5.1) into an integrated intervention logic. It employs a nested, mutually reinforcing system of four pillars.

The biophysical resilience pillars prioritise the ecological health of the *Uapaca kirkiana* ecosystem. The framework posits that genetic conservation and germplasm availability are prerequisites for the implementation of effective climate change-resilience interventions.

Economic resilience focuses on market efficiency, value addition, infrastructure (cold storage, solar drying, processing facilities), access to finance and climate information services. Stakeholder validation highlighted research-driven innovation and infrastructural provision as critical for modernising the value chain and mitigating post-harvest losses and climate instability.

The socio-institutional resilience pillar addresses inequalities in the value chain. It prioritises secure land rights and access alongside the active participation of women and youth groups to ensure long-term investment in managing the *Uapaca kirkiana* resource base. Adaptive governance is vital at every level, highlighting the need for inclusive policies and participatory MEL systems. Essentially, this helps to mitigate elite capture and ensure the benefits of value chain development reach marginalised actors. This alignment is crucial for *Uapaca kirkiana* value chains to support SDGs 1 (no poverty), 5 (gender equality), 8 (decent work and economic growth) and 13 (climate action).

The arrows in Figure 1 indicate interconnection and feedback loops. The interdependence of the framework's elements explains why single-entry interventions are likely to underperform. For example, investing in processing infrastructure (economic resilience) without simultaneously addressing land tenure (socio-institutional resilience) will not incentivise long-term tree stewardship. Similarly, introducing climate-resilient germplasm (biophysical resilience) without inclusive governance (adaptive governance) may exclude women and youth from accessing improved varieties.

For policymakers, the findings advocate three critical reforms. First, recognition and legal registration of customary land rights for NTFP-dependent communities. This draws on models, such as Tanzania's Certificate of Customary Right of Occupancy (CCRO). Second, establishment of multi-stakeholder platforms for value chain governance. This includes active participation of harvesters, processors/traders, women and youth groups in value chain development. Third, public investment is critical for climate-resilient germplasm development and post-harvest infrastructural support (cold storage, solar dryers, processing and marketing facilities). For practitioners, using the proposed framework as a diagnostic and monitoring tool, the study recommends moving from project-based, donor-driven interventions to systemic approaches that address tenure, infrastructure, capacity-building and governance issues.

For future research, longitudinal studies are needed to assess the long-term impacts of tenure reform on tree-planting and conservation behaviour. Comparative research should test the framework's transferability to other NTFP species and socio-ecological contexts beyond Zimbabwe.

This study has several limitations. First, the quota sampling strategy, centred on major public market events and trade fairs, may have under-sampled pre-commercial, informal actors engaged in subsistence harvesting, potentially skewing findings toward more commercialised nodes of the value chain. Second, the study relied on self-reported data, which may be subject to social desirability bias and recall inaccuracies. Third, the cross-sectional design captured perceptions at a single time point (2024). Longitudinal data are required to assess how practices and priorities evolve in response to climate shocks or policy changes. Fourth, the integrated GVC-TBL framework, partially limits the analysis of deeper political economy dynamics, including elite capture at national level and the influence of extractive industries on forest resources. Fifth, the framework requires adaptation and re-validation for other NTFP species and geographical contexts beyond Zimbabwe. Despite these limitations, the study provides a grounded and holistic SDG-aligned framework, advancing both theory and practice for sustainable *Uapaca kirkiana* value chain development.

REFERENCES

Agoraki, M.K., Giakoumelou, A. and Panagloitis, K. (2024). Firm Level Climate Change Exposure and Financial Performance, *International Journal of Finance and Economics*, - 1-23. https://doi.org/10.1002/ijfe.2950.

Angelsen, A. *et al.* (2014). Environmental Income and Rural Livelihoods: A Global Comparative Analysis, *World Development*, *64*(S1), - S12-S28.

Barrientos, S., Gereffi, G. and Pickles, J. (2021). New Dynamics of Upgrading in Global Value Chains: Shifting Terrain for Suppliers and Workers, *Journal of International Business Policy*, *4*(1), - 1-17.

Bereday, G.Z.F. (1964). *Comparative Method in Education*. New York: Holt, Rinehart and Winston.

Bolwig, S., Ponte, S. and Riisgaard, L. (2020). Sustainability Standards and Value Chain Governance. In: Ponte, S., Gereffi, G. and Raj-Reichert, G. (eds.) *Handbook on Global Value Chains*. Cheltenham: Edward Elgar Publishing, - 452-468.

Bosch, J., Koen, J. and Van Der Waal, J. (2021). Benefit Sharing in the South African Rooibos Industry: Progress and Persistent Challenges, *Development Southern Africa*, *38*(3), - 401-417.

Braun, V. and Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. London: SAGE Publications.

Cashore, B., Auld, G. and Newsom, D. (2004). *Governing through Markets: Forest Certification and the Emergence of Non-State Authority*. New Haven: Yale University Press.

Chinembiri, T.S., Moyo, B.H. and Ndlovu, S. (2022). Land Tenure Insecurity and its Implications for Sustainable Forest Management in Zimbabwe, *Land Use Policy*, *118*, 106134.

Choudhury, P.R., Elias, M. and Carney, J. (2023). Gendered Dimensions of Shea Value Chains: A Systematic Review, *World Development*, *168*, 106259.

Cochran, W.G. (1977). *Sampling Techniques*. 3rd Edn. New York: John Wiley and Sons.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences*. 2nd Edn. Hillsdale, NJ: Lawrence Erlbaum Associates.

Creswell, J.W. and Plano Clark, V.L. (2018). *Designing and Conducting Mixed Methods Research*. 3rd Edn. Thousand Oaks, CA: SAGE Publications.

Dallas, M.P., Ponte, S. and Sturgeon, T.J. (2019). Power in Global Value Chains, *Review of International Political Economy*, *26*(4), - 666-694.

De Graaf, R. and Ovink, H. (2021). The Five Pillars of Climate Resilience, in *Urban Resilience and Climate Change*, 1-12. Cham: Springer, -.

Donovan, J., Stoian, D. and Poe, K. (2022). Value Chain Development for Forest and Tree Products: A Review of Recent Trends and Future Directions, *Forest Policy and Economics*, *141*, 102769.

Elias, M., Carney, J. and Choudhury, P.R. (2021). Gendered Knowledge, Rights and Value Chains: Towards Transformative Interventions, *Gender, Technology and Development*, *25*(2), - 121-144.

Elkington, J. (2018). 25 Years Ago I Coined the Phrase “Triple Bottom Line”. Heres Why Its Time to Rethink It, *Harvard Business Review*, *96*(1), - 2-5.

FAO (2024). The State of the World's Forests 2024: Forest-Based Innovations for Sustainable Development. Rome: Food and Agriculture Organisation of the United Nations.

Fetters, M.D., Curry, L.A. and Creswell, J.W. (2023). Achieving Integration in Mixed Methods Designs – Principles and Practices, *Health Services Research*, *58*(S2), - 121-131.

Flintan, F. *et al.* (2024). Collective Land Tenure and Gender Equity in Africas Rangelands: Are We Really Leaving No One Behind?, *SSRN*. Available at: https://ssrn.com/abstract=4842345.

Gama, M.M., Mafongoya, P.L. and Mubaya, C.P. (2023). Contribution of *Uapaca kirkiana* to Rural Livelihoods and Food Security in the Miombo Woodlands of Zimbabwe, *Agroforestry Systems*, *97*(3), - 451-465.

Gereffi, G., Pananond, P. and Pedersen, T. (2023). Using the Global Value Chain Framework to Analyse and Tackle Global Environmental Crises, *Journal of Industrial and Business Economics*, *50*(4), - 779-811.

Gruenwald, J. and Galizia, M. (2020). The Baobab Market: Opportunities and Challenges, *Nutraceuticals World*, *23*(5), - 42-47.

Gullison, R.E. (2025). Forest Certification and Biodiversity Conservation: A 25-Year Assessment, *Conservation Biology*, *39*(1), E14233.

Humphrey, J. and Schmitz, H. (2002). How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters?, *Regional Studies*, *36*(9), - 1017-1027.

Ingram, V.J., Rijn, F. and Waarts, Y. (2022). Sustainability in Cocoa Value Chains: A Review of Governance, Upgrading and Certification, *Current Opinion in Environmental Sustainability*, *58*, 101218.

Jinga, P., Moyo, H.P. and Manjengwa, P. (2021). Projected Climate Change Impacts on the Distribution of *Uapaca Kirkiana* in the Miombo Woodlands of Zimbabwe, *African Journal of Ecology*, *59*(2), - 389-400.

Joubert, E. and De Beer, D. (2021). Rooibos: A South African Contribution to Global Tea Culture and Health, *Journal of Food Science and Technology*, *58*(4), - 1231-1242.

Kapinga, K., Kabissa, J. and Kideghesho, J. (2021). Baobab (*Adansonia digitata* L.) Conservation and Livelihood Linkages in Tanzania, *Forests, Trees and Livelihoods*, 30(3), - 189-204.

Kaplinsky, R. and Morris, M. (2001). *A Handbook for Value Chain Research*. Ottawa: IDRC.

Kokou, K., Adjosso, N. and Kokutse, A.D. (2025*). Climate Change and African Forest Ecosystems: Vulnerability, Adaptation and Resilience*. Berlin: Springer.

Kolavalli, S. and Vigneri, M. (2018). The Shea Value Chain in Ghana: Structure, Constraintsand and Opportunities. Washington, DC: IFPRI.

Kozanayi, W., Mukamuri, B.B. and Mafongoya, P.L. (2024). Biocultural Innovation Systems for Climate-Resilient Indigenous Fruit Tree Management in Zimbabwe, *Agroecology and Sustainable Food Systems*, *48*(2), - 201-223.

Krishnan, A. (2023). Environmental Upgrading in Global Value Chains: A Systematic Review, *Journal of International Business Policy*, *6*(2), - 201-225.

Kruger, L. and Du Toit, A. (2024). Cooperative Governance and Smallholder Inclusion in South Africas Rooibos Industry, *Journal of Agrarian Change*, *24*(1), E12567.

Lakens, D. (2022). Calculating and Reporting Effect Sizes to Facilitate Cumulative Science: A Practical Primer for T-Tests and Anovas, *Frontiers in Psychology*, *13*, 865278.

Lincoln, Y.S. and Guba, E.G. (1985). *Naturalistic Inquiry*. Beverly Hills, CA: SAGE Publications.

Lovett, P.N. (2021). Shea Butter: A Sustainable Resource for Development. In: Jamnadass, R. *et al.* (ed.) *Forests, Trees and the Eradication of Poverty*, 145-168, Bogor: CIFOR, -.

Mabhaudhi, T., *et al.* (2022). Diversity and Diversification: Ecosystem Services Derived from Underutilised Crops and their Benefits for Sustainable Agricultural Landscapes and Resilient Food Systems in Africa, *Frontiers in Sustainable Food Systems*, *6*, 1026400.

Matseketsa, P., Mubaya, C.P. and Ndlovu, S. (2024). Policy Coherence and Institutional Coordination for Sustainable Non-Timber Forest Product Value Chains in Zimbabwe, *Forest Policy and Economics*, *160*, 103156.

Meyer, F., Swart, P. and Botha, A. (2023). Climate Change Impacts on Rooibos Production: Projections and Adaptation Strategies, *South African Journal of Botany*, *158*, - 112-121.

Mgumia, F., Mbilinyi, B. and Madole, S. (2021). Value Chain Constraints and Upgrading Opportunities for Baobab Products in Tanzania, *Tanzania Journal of Forestry and Nature Conservation*, *90*(2), - 33-48.

Mukamuri, B.B., Kozanayi, W. and Nyirenda, R. (2023). *Social Dynamics of Miombo Woodland Management in Zimbabwe*. Harare: SAFIRE/University of Zimbabwe Press.

Norman, W. and Macdonald, C. (2004). Getting to the Bottom of "Triple Bottom Line", *Business Ethics Quarterly*, *14*(2), - 243-262.

Patton, M.Q. (2015). *Qualitative Research and Evaluation Methods*. 4th Edn. Thousand Oaks, CA: SAGE Publications.

Ponte, S., Gereffi, G. and Raj-Reichert, G. (Eds.) (2019). *Handbook on Global Value Chains*. Cheltenham: Edward Elgar Publishing.

Sanchez, A.C., Osborne, P.E. and Haq, N. (2022). Climate Change and the Future of Baobab in Africa, *Diversity and Distributions*, *28*(5), - 1023-1037.

Shackleton, S.E., Parker, M. and Jamnadass, R. (2020). Baobab for Food and Nutrition Security in Africa. In: Dagar, J.C. *et al.* (eds.) *Agroforestry for Degraded Landscapes*. Singapore: Springer, - 321-345.

Sharma, Y.K. (2017). *Comparative Education: A Comparative Study of Educational Systems.* Mumbai: Kaniska Publishers.

Smit, P., Swart, P. and Van Der Hoven, C. (2022). Developing Climate-Resilient Rooibos: Progress and Prospects, *South African Journal of Plant and Soil*, *39*(2), - 89-98.

Swart, P., Van Der Hoven, C. and Botha, A. (2020). Environmental Sustainability of Rooibos Cultivation: A Critical Review, *South African Journal of Botany*, *135*, - 289-298.

Tucker, C. (2021). Indigenous Knowledge, Intellectual Property and Benefit Sharing: The Rooibos Case, *Journal of World Intellectual Property*, *24*(3-4), - 215-234.

Wynberg, R. and Laird, S. (2018). Fast Science and Sluggish Policy: The Conundrum of Access and Benefit Sharing for Rooibos. *Journal of Environmental Law*, *30*(3), - 447-472.