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Assessment of Mechanization and Equipment Gaps in Cassava Processing Centres in Selected Local Government Areas of Ondo State, Nigeria

John Akintomide Ogidan[1], Oluwatoyosi Adetimehin Mary[1], and Olapeju Aderinola Adenekan[2*]

[1]Department of Agricultural Technology, Federal Polytechnic Ile Oluji, Ondo, Nigeria

[2]National Centre for Technology Management, Victoria-Island, Lagos, Nigeria

*Corresponding Author:
Email: olapejuadekola@gmail.com

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Abstract

Given cassava roots' short postharvest shelf-life (24–48 hours) and persistent mechanization deficits in rural agro-processing, there remain limited location-specific evidence on the equipment in use, the energy sources that power processing, and the gendered division of labour within cassava processing centres in Nigeria. Accordingly, this study assessed mechanization and equipment gaps in small-scale cassava processing centres in three Local Government Areas (LGAs) of Ondo State, Nigeria (Owo, Akoko South West, and Akoko South East). A structured questionnaire, key-informant interviews, and direct on-site observation were used to document firm characteristics, staff capacity, equipment availability by unit operation, energy sources, and perceived constraints to productivity. Across 41 centres, mechanization was strongest for grating, dewatering/pressing, and milling, while peeling, washing, drying, and frying/roasting remained entirely manual. All centres relied on diesel engines as prime movers, reflecting energy unreliability and associated cost pressures. The most frequently cited barriers to improved performance were limited financing/poor turnover, high machine and operating costs, market uncertainty, and infrastructure-related constraints. The findings provide centre-level evidence to guide targeted technology upgrading, financing, and capacity-building interventions to strengthen value addition and livelihoods in cassava processing.
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Keyword: Cassava processing, Mechanization, Equipment gaps, Value addition, Prime movers, Processing centres, Nigeria

INTRODUCTION

Cassava (Manihot esculenta Crantz) is a major staple and industrial crop across tropical and subtropical regions, and it plays a critical role in food security and rural incomes in Nigeria (Acheampong *et al.*, 2021; IITA, 2007). It is a highly versatile commodity with numerous end uses and value-added by-products, which may be consumed fresh or processed into more stable product forms (Ezedinma *et al.*, 2007; Kolawole *et al.*, 2010). For instance, cassava is widely processed into gari, a locally consumed starchy staple, and serves as a valuable feedstock for biofuel production and animal feed formulation. Nigeria is consistently ranked among the world's largest producer of cassava (FAO, 2023).

Despite Nigeria's leading position in global cassava production, the value chain remains constrained by post-harvest perishability and limited processing efficiency. Cassava roots deteriorate rapidly after harvest (often within 24–48 hours), creating a narrow window for processing and marketing (Nweke, 1994).

Traditional cassava processing practices are labour-intensive, time-consuming, and often associated with low throughput and inconsistent product quality (Stephen and Eric, 2009; Teeken *et al.*, 2018). Women are frequently central to cassava processing and marketing in many Nigerian settings, particularly in manual operations, which can increase drudgery and occupational risks (Teeken *et al.*, 2018). Mechanization can reduce losses, improve hygiene and standardization, and expand market opportunities for products such as gari, flour, and starch. Thus, helping to promote rural development, increase revenues for growers, processors, and dealers, and ultimately improve national food security (Adeniyi *et al.*, 2023).

However, equipment adoption is uneven across processing stages, and many studies discuss value addition without providing facility-level evidence on which unit operations lack machinery, how energy sources shape equipment use, and how labour is distributed by gender within processing tasks (Legg *et al.*, 2022; Adeniyi *et al.*, 2023). This study provides on-site, centre-level evidence to identify critical mechanization gaps and associated constraints, thereby supporting more targeted interventions.

To this end, this study aimed to assess mechanization status and equipment gaps in cassava processing centres in selected LGAs of Ondo State, Nigeria. Specifically, it (i) assess the distribution and basic characteristics of processing centres, (ii) assessed staff education, specialization, and training, (iii) evaluated equipment availability by unit operation and energy sources, (iv) identified perceived constraints to productivity, and (v) explore gendered patterns of participation across processing operations.

METHODOLOGY

Study Design and Study Area

A cross-sectional assessment was conducted in three Local Government Areas (LGAs) of Ondo State, Nigeria: Owo, Akoko South West, and Akoko South East. These LGAs were selected to capture variation in cassava-processing activity across the study region. Akoko South East local government has an area of 225.2 km2 and a population of 126,600 at 2006 census and its administrative headquarters in Isua -Akoko; Akoko South West local government with an area of 340 km2 and a population of 228,383 at 2006 census with her headquarters in Oka- Akoko and Owo local government has an area of 993.7 km2 and a population of 222,262 at 2006 census and its administrative headquarters in Owo.

Sampling and Sample Size

A total of 41 cassava processing centres were assessed (Owo: 20; Akoko South West: 14; Akoko South East: 7). Centres were identified through local listings and field reconnaissance, and owners/managers were approached for participation.

Data Collection

Data were collected using a structured questionnaire administered to owners/managers, complemented by key-informant interviews and direct observation of processing equipment and operations. Information covered firm characteristics, market reach, ownership structure, staff education and specialization, training practices, equipment availability by unit operation, prime movers/energy sources, perceived constraints, and gender distribution across processing activities.

Ethical Considerations
Ethical principles were observed throughout the study. Verbal informed consent was obtained from all participants, participation was voluntary, and confidentiality and anonymity were assured. Data collection was non-invasive and posed minimal risk to respondents. Formal institutional ethical approval was not obtained for this study; however, all procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki for research involving human participants.

Data analysis
Questionnaires were coded and entered for analysis using descriptive statistics (frequencies and percentages). Results are presented in tables and figures. Where responses were incomplete for a variable, the applicable denominator is stated in the results section or figure caption.

RESULTS

Distribution and Basic Characteristics of Processing Centres

Processing centres were unevenly distributed across the three LGAs (Figure 1). Owo accounted for nearly half of the assessed centres (20/41; 48.78%), followed by Akoko South West (14/41; 34.15%) and Akoko South East (7/41; 17.07%).

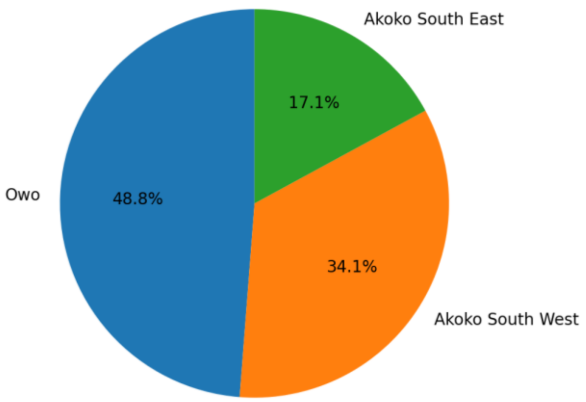

Figure 1: Distribution of Processing Centres by LGA (n = 41)

Firm Age
Firm age varied (Figure 2), with the largest share operating for 1–5 years (11/41; 26.83%). Figure 2 shows the years-in-operation distribution for the assessed centres (n=41).

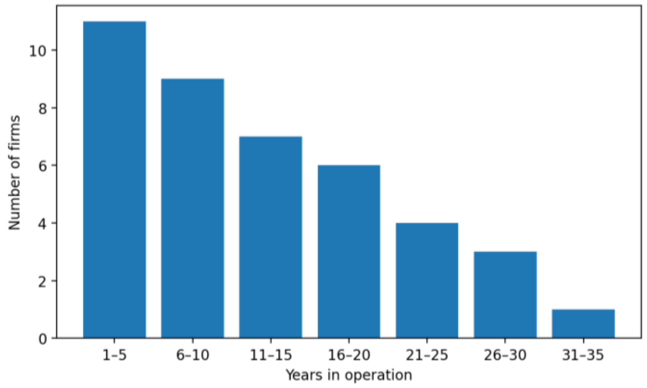

Figure 2: Firm Age Distribution by Years in Operation (n = 41)

Market Reach and Ownership Structure
Usable market-reach information was available for 27 centres (Figure 3). Among these, local and regional distribution dominated, while national distribution was reported infrequently. Ownership was predominantly sole proprietorship (35/41; 85.37%), with the remainder operating as partnerships (6/41; 14.63%); no joint ventures were reported (Figure 4).

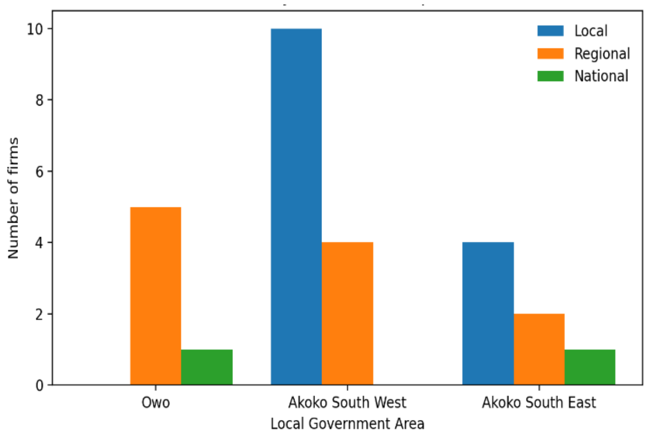

Figure 3: Market Reach by LGA (n = 27)

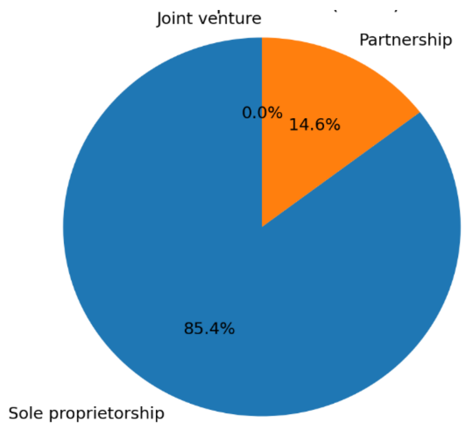

Figure 4: Ownership Structure of Assessed Processing Centres (n = 41)

Human Capital: Education, Specialization, and Training

Across centres, managerial and supervisory staff were largely educated to post-secondary level (Table 1). For example, owners/CEOs were reported as HND/BSc (51.22%) or ND (48.78%). Specialization patterns suggest task alignment: production managers were mostly science/technology-trained (65.85%), whereas marketing managers were primarily management-trained (85.37%) (Table 2). Training programmes were reported by 26 centres (63.41%). Among centres with training (n=26), monthly training was the most common frequency (38.46%), although one centre did not specify a frequency (Table 3).

Table 1: Educational Qualification of Management Staff (n = 41 centres)

Designation	PhD	MSc	HND/BSc	ND	SSCE
Owner/CEO	0	0	21(51.22)	20(48.78)	0
Production manager	0	4(9.76)	15(36.59)	17(41.46)	5(12.20)
Marketing manager	0	1(2.44)	16(39.02)	20(48.78)	4(9.76)
Administration manager	0	0(0.00)	18(43.90)	20(48.78)	3(7.32)
Maintenance/technical manager	0	0(0.00)	20(48.78)	15(36.59)	6(14.63)

Table 2: Staff Specialization by Designation (n = 41 centres)

Designation	Science/Technology	Management	Other
Owner/CEO	21(51.22)	20(48.78)	0
Production manager	27(65.85)	14(34.15)	0
Marketing manager	6(14.63)	35(85.37)	0
Administration manager	7(17.07)	27(65.85)	7(17.07)
Maintenance/technical manager	19(46.34)	8(19.51)	14(34.15)

Table 3: Availability and Frequency of Staff Training (n = 41; frequency among centres with training, n = 26)

Item	Frequency	Percentage
Training programme available	26	63.41
No training programme	15	36.59
Training frequency (among firms with training; n=26): Monthly	10	38.46
Training frequency (n=26): Quarterly	7	26.92
Training frequency (n=26): Annually	6	23.08
Training frequency (n=26): Semi-annually	2	7.69
Training frequency (n=26): Not stated	1	3.85

Constraints to Productivity and Mechanization

Respondents identified financing constraints and equipment costs as major barriers to improved performance. For instance, 30 of 41 respondents agreed/strongly agreed that lack of financing/poor turnover constrained productivity, and 26 agreed/strongly agreed that machine costs were prohibitive (Table 4). Market uncertainties and infrastructure deficits were also frequently endorsed as constraints, while erratic power supply and technology-information gaps were reported with mixed responses (Table 4).

Equipment Availability by Unit Operation and Energy Sources

Equipment availability varied sharply by unit operation (Table 5). Milling machines were universally present (41/41; 100%). Graters (38/41; 92.68%), presses/dewatering machines (40/41; 97.56%), and sifters/sieving machines (36/41; 87.80%) were also common. In contrast, no centre had mechanized peelers, washers, dryers, or mechanical fryers/roasters, indicating persistent mechanization gaps in the most labour-intensive and hygiene-sensitive stages. All centres relied on diesel engines as prime movers (41/41; 100%), with no reported use of petrol engines or electric motors (Table 6).

Table 4: Perceived Obstacles to Productivity and Performance (Likert counts; n = 41 per item)

Obstacle	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Lack of financing/poor turnover	20	10	0	8	3
High cost of machines	15	11	1	10	4
Inadequate water supply	5	9	5	21	1
Government/legal regulations	4	3	0	30	4
Lack of skilled personnel	8	6	0	25	2
Lack of information on technology	6	4	0	28	3
Market uncertainties	14	6	0	11	10
Erratic power supply	3	8	2	10	18
Lack of infrastructure	12	12	0	10	7
Other (e.g., machine operating costs)	20	14	0	3	4

Table 5: Availability of Processing Equipment by Unit Operation and LGA (n = 41 centres)

Unit operation/equipment	Owo	Akoko SW	Akoko SE	Total	Percentage
Mechanical peeler	0	0	0	0	0.00
Mechanical washer	0	0	0	0	0.00
Grater	20	12	6	38	92.68
Press/dewatering machine	18	14	8	40	97.56
Sifter/sieving machine	6	12	18	36	87.80
Mechanical fryer/roaster	0	0	0	0	0.00
Dryer	0	0	0	0	0.00
Milling machine	20	11	10	41	100.00

Table 6: Prime Movers Used in Processing Centres (n = 41 centres)

Prime mover	Frequency (n)	Percentage (%)
Diesel engine	41	100
Petrol engine	0	0
Electric motor	0	0

Gendered Participation in Processing Operations

Respondents were predominantly male (28/41; 68.29%) (Table 7; Figure 5). Task-level participation differed markedly by gender (Table 8). Men were more frequently reported for harvesting, grating, and dewatering, whereas women predominated in peeling, washing, sieving, fermenting, and roasting/frying. These patterns indicate that mechanization initiatives should be accompanied by gender-responsive training and inclusion to avoid reinforcing inequities or displacing women from key livelihood roles.

Table 7: Gender of respondents (n = 41)

Gender	Frequency (n)	Percentage
Male	28	68.29
Female	13	31.71

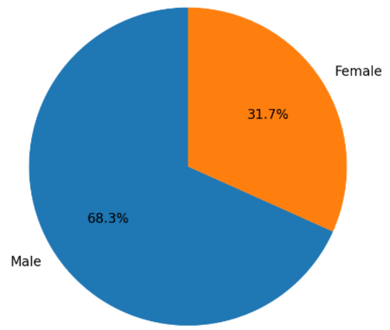

Figure 5: Gender of Respondents (n = 41)

Table 8: Gender Distribution by Processing Activity (n = 41 per activity)

Operation	Male n (%)	Female n (%)
Harvesting	28(68.29)	13(31.71)
Peeling	12(29.27)	29(70.73)
Washing	0	41(100)
Grating	30(73.17)	11(26.83)
Fermenting	14(34.15)	27(65.85)
Dewatering	24(58.54)	17(41.46)
Sieving	11(26.83)	30(73.17)
Roasting/Frying	5(12.19)	36(87.80)

DISCUSSION

Interpretation of Mechanization Gaps and Value-Chain Implications

This current study highlights persistent mechanization gaps in small-scale cassava processing in Ondo State, consistent with broader challenges documented in Nigeria's cassava value chain. While mechanization coverage was high for core throughput steps (grating, pressing, milling), the continued absence of mechanized peeling, washing, drying, and frying/roasting indicates that labour-intensive and quality-critical stages remain vulnerable to bottlenecks, hygiene risks, and inconsistent product quality (Food and Agriculture Organization of the United Nations [FAO] & International Fund for Agricultural Development [IFAD], 2005). Because cassava quality can also be shaped by location-specific environmental conditions and contamination pressures (e.g., trace metals and processing-related contamination pathways), mechanization upgrades should be pursued alongside basic quality assurance and raw-material screening to protect product safety and marketability (Akas *et al.*, 2017; Jacob *et al.*, 2023).

Institutional Structure, Financing, and Market Development

The prevalence of sole proprietorship suggests strong owner control and rapid decision-making; however, it can constrain access to pooled capital and formal credit needed for equipment upgrades. Respondents' emphasis on financing constraints and high machine/operating costs aligns with evidence that limited funds and high processing-equipment costs remain among the most severe barriers for cassava processors in Nigeria (Achem, 2011). These constraints underscore the need for context-appropriate financing (e.g., tailored credit/leasing), shared-service or cooperative equipment models, and strengthened local fabrication and spare-parts ecosystems to reduce lifecycle costs. Where market-reach information was available, distribution remained largely local/regional, pointing to the need for deliberate commercialization strategies particularly improved product standards/quality assurance, market information systems, and structured buyer linkages to expand beyond local markets (Abali *et al.*, 2014).

Human Capital, Training, and Readiness for Innovation Uptake

Relatively high post-secondary education among key staff suggests a stronger baseline for technology awareness, record-keeping, and managerial coordination capabilities that can support mechanization planning and quality management. However, education alone rarely translates into sustained equipment adoption when the enabling environment is weak. Evidence from Nigerian agri-food systems shows that behavioural willingness to adopt "better practices" often collides with systemic constraints such as limited infrastructure, cost burdens, and inadequate service support, meaning that even knowledgeable actors may default to suboptimal routines when practical options are unavailable (Oludoye *et al.*, 2026; Omoyajowo *et al.*, 2025).

Although training programmes were present in most centres, uneven frequency and limited hands-on depth can reduce their impact. Strengthening competency-based training focused on equipment operation, preventive maintenance, troubleshooting, and basic quality control can improve utilization, reduce downtime, and extend machine lifespan. This should be paired with system-level supports (stable power options, access to spare parts, and local technical service) because Nigeria's innovation ecosystem has long faced coordination and linkage gaps that weaken diffusion of practical technologies and maintenance capabilities (Babalola *et al.*, 2017).

Energy Dependence and Sustainability Considerations

Universal reliance on diesel engines in these processing centres reflects a pragmatic response to chronic grid unreliability in Nigeria, but it also locks processors into high recurrent fuel and maintenance costs, raising the unit cost of cassava processing and weakening competitiveness (World Bank, 2023). Beyond cost, diesel dependence has clear environmental and occupational-health implications because diesel exhaust contains pollutants associated with adverse respiratory and cardiovascular outcomes (U.S. Environmental Protection Agency [EPA], 2025).

Upgrading strategies should therefore combine reliability with cost and emissions management, rather than treating "power" as a background constraint. A feasible pathway is hybridization: (i) adopting energy-efficient motors and process improvements to reduce fuel intensity per batch, (ii) deploying shared/cluster energy infrastructure (e.g., cooperative mini-power solutions for multiple processors) to spread fixed costs, and (iii) integrating distributed energy resources (where viable) to displace part of diesel self-generation and stabilize operations (Dadzie *et al.*, 2024). Importantly, behavioural capacity matters alongside hardware. Evidence on energy conservation and "sufficiency" behaviours suggests that structured awareness, routine monitoring, and practical conservation habits can measurably shape energy use; embedding these principles into centre-level operating procedures (e.g., shutdown protocols, preventive maintenance schedules, fuel-use tracking, and operator accountability) can reduce waste and lower operating costs even before major capital upgrades (Adeyemi *et al.*, 2025). This can be reinforced through Environmental Management System (EMS)-aligned practices, where feasible, to institutionalize energy and environmental performance tracking within SMEs (Amiolemen *et al.*, 2024)

Gender Implications and Equitable Mechanization

Gendered patterns in unit operations are consistent with evidence that women play central roles in cassava processing and marketing in Nigeria, especially in labour-intensive tasks that are often performed manually (Teeken *et al.*, 2018; FAO & IFAD, 2005). However, this dominance in processing does not automatically translate into control over technology choices or equitable access to equipment: documented gender-based constraints including differential access to resources, training, and processing/marketing opportunities can limit women's ability to benefit fully from upgrading initiatives (Olaosebikan *et al.*, 2019). Mechanization initiatives should therefore be designed as gender-responsive upgrading, not simply equipment deployment. This means (i) intentionally training and certifying women as equipment operators and basic maintenance technicians, (ii) including women in decision-making structures (equipment selection, fee-setting, scheduling, and cooperative leadership), and (iii) embedding safeguards such as women-targeted financing/leasing, transparent machine-access rules, and monitoring of workload and income changes to ensure productivity gains do not translate into livelihood displacement (International Finance Corporation, 2017).

CONCLUSION AND RECOMMENDATIONS

This study provides centre-level evidence on mechanization status, equipment gaps, energy dependence, and gendered labour patterns in cassava processing centres across three LGAs in Ondo State, Nigeria. Mechanization was common for grating, pressing/dewatering, sieving, and milling, but absent for peeling, washing, drying, and frying/roasting. Financing constraints, equipment costs, market uncertainty, and infrastructure deficits were repeatedly identified as barriers to improved performance.

Policy and programme actions should prioritize: (i) affordable mechanization packages that target the most labour-intensive stages (peeling, washing, drying, frying/roasting), (ii) accessible financing and shared-service schemes to lower entry costs, (iii) strengthened training on operation, maintenance, and quality assurance, and (iv) gender-responsive approaches that expand women's access to equipment training and control over value-added opportunities.

Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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