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Research Article

Gender-Responsive Evaluation of Poultry Manure Rates and Improved Cassava Varieties for Yield, Weed Suppression, and Processing Traits in Umudike, Abia State, Nigeria

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Abstract

Women smallholder farmers play a central role in cassava production and processing in southeastern Nigeria, yet limited access to land, inputs, and trait-tailored varieties constrains their yields. This study evaluated fresh tuber yield, dry matter content, and weed-suppression performance of improved cassava varieties under varied poultry manure rates in a split-plot design with three replications during the April–November 2025 rainy season at the National Root Crops Research Institute research farm in Umudike, Ikwuano Local Government Area, Abia State, Nigeria. Main plots consisted of four poultry manure rates [0, 2.5, 5.0, and 7.5 t/ha], and subplots comprised three cassava varieties [TME 419, TMS 98/0581, and Game Changer]. Forty-five women farmers participated in sensory and labor-demand evaluations for garri and fufu processing. Across treatments, fresh tuber yield ranged from 14.2 ± 0.9 t/ha to 28.6 ± 1.3 t/ha, with significant main effects of poultry manure [$F = 42.18$, $p < 0.001$] and variety [$F = 19.64$, $p < 0.01$]. Applying 5.0 t/ha poultry manure with Game Changer achieved 26.4 ± 1.1 t/ha fresh yield, 34.8% dry matter, and 68% weed cover reduction by 12 weeks after planting [$R^2 = 0.82$]. Women rated Game Changer highest [mean score = 4.6 ± 0.3 on a 5.0 scale] for swelling capacity and ease of peeling. Integrating agronomic productivity with women's processing and weeding preferences supports higher adoption and household income.

Keywords: Gender-responsive agriculture; Cassava (*Manihot esculenta*); Poultry manure; Participatory variety selection; Weed suppression; Processing traits; Women smallholder farmers.

1. Introduction

Cassava (*Manihot esculenta Crantz*) is a cornerstone of food security, income, and resilience for millions of households in sub-Saharan Africa. In Nigeria, the crop is grown on more than three million hectares and supplies a large share of dietary energy in the south-east and south-south zones, where garri, fufu, abacha, and tapioca are daily staples (Food and Agriculture Organization of the United Nations, 2022; Nweke, 2004). Its tolerance of poor soils, drought spells, and low-input management makes it a risk-spreading crop for resource-poor farmers, while its flexible harvest window allows households to harvest piecemeal for food or cash (El-Sharkawy, 2004; Howeler, 2002). Yet national average yields remain far below attainable yields recorded on research stations, a gap that reflects low soil fertility, weed pressure, late weeding, use of unimproved planting material, and limited access to soil amendments (Fermont et al., 2009; Ezui et al., 2017).

Women provide a disproportionate share of labour in cassava production, harvesting, peeling, grating, fermenting, and frying, and they dominate retail trade in garri and fufu in southeastern Nigeria (Doss, 2018; Forsythe et al., 2021). Despite this centrality, women face structural constraints that reduce their productivity: smaller and less secure plots, lower access to credit and extension, heavier domestic workloads, and breeding programmes that historically prioritised yield and disease resistance over processing quality, ease of peeling, swelling capacity, and labour demand (Teeken et al., 2018; Onyemma et al., 2023). When new varieties are difficult to peel, produce watery garri, or require extra weeding, women bear the cost in time and income even when field yield rises. A gender-responsive approach therefore treats agronomic performance and end-user traits as joint selection criteria rather than as separate concerns (Forsythe et al., 2021; Teeken et al., 2021).

Soil fertility depletion is a leading constraint on cassava in Umudike and the wider humid forest zone. Continuous cropping without nutrient return has acidified soils, depleted organic matter, and reduced cation exchange capacity (Adeoye et al., 2005; Agegnehu et al., 2017). Inorganic fertiliser is often expensive, untimely, or adulterated in rural markets, whereas poultry manure is locally available from the expanding poultry industry in Abia State and neighbouring states. Poultry manure supplies nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients, improves soil structure and water retention, and stimulates microbial activity (Agbede et al., 2017; Amanullah et al., 2010). Earlier work in Nigeria showed that poultry manure increased cassava growth, tuber number, and fresh yield compared with unfertilised controls, with responses that plateaued at moderate rates because excessive nitrogen can favour shoot growth at the expense of storage roots (Odedina et al., 2011; Uwah et al., 2011). Determining an economically and agronomically sensible rate, rather than simply the highest rate, is therefore essential for women farmers who must pay for, transport, and apply manure.

Weed competition is the second major constraint addressed in this study. Cassava establishes slowly, and its canopy closes late, leaving a long window in which weeds compete for light, water, and nutrients (Akobundu, 1987; Chikoye et al., 2007). In smallholder systems, weeding is predominantly done by women and children with hoes, and delayed or missed weeding can reduce fresh tuber yield by 40 to 90 percent depending on weed flora and duration of competition (Melifonwu, 1994; Ekeleme et al., 2019). Varieties that establish vigorously, branch early, and close canopy quickly can suppress weeds and reduce the number of weeding rounds, directly lowering women's labour burden (Ekeleme et al., 2019; Chikoye et al., 2007). Manure can interact with this process in two ways: it accelerates cassava canopy development, but it can also stimulate weed germination if weed seeds are present in poorly composted manure. Evaluating variety-by-manure combinations for weed suppression is therefore as important as evaluating them for yield alone.

Improved cassava varieties released in Nigeria differ in canopy architecture, dry matter content, cyanogenic potential, disease resistance, and processing quality. TME 419 is widely grown for its high yield and adaptability; TMS 98/0581 is valued for cassava mosaic disease resistance and stable performance; Game Changer, a more recent improved variety promoted for high yield and processing quality, has attracted interest among processors but has been less systematically compared with established checks under organic nutrient management in Umudike (Egesi et al., 2007; Okechukwu and Dixon, 2008; Ceballos et al., 2020). Participatory variety selection, in which farmers evaluate varieties in their own fields and processing centres, has been shown to improve adoption because it surfaces traits that breeders and agronomists may overlook (Ceccarelli, 2015; Teeken et al., 2018). This study integrates a replicated field trial with women's sensory and labour-demand evaluations to answer a practical question: which combination of poultry manure rate and improved variety best balances yield, weed suppression, and processing quality for women smallholder farmers in Umudike?

The objectives were to (i) quantify the effects of poultry manure rate and variety on fresh tuber yield, dry matter content, and yield components; (ii) assess weed cover, weed biomass, and weeding labour under each treatment; (iii) evaluate garri and fufu processing traits, sensory quality, and labour demand as judged by women farmers; and (iv) identify the most gender-responsive, economically sensible combination for recommendation in Umudike and similar humid forest ecologies.

2. Literature Review

2.1 Cassava, gender, and food security in southeastern Nigeria

Cassava's role in Nigeria extends beyond calories. It is a cash crop, a famine reserve, and a raw material for industrial starch, high-quality cassava flour, and animal feed (Nweke, 2004; Food and Agriculture Organization of the United Nations, 2022). Women control much of the processing node, where value is added, and their preferences shape which varieties are retained, multiplied, and traded (Forsythe et al., 2021). Doss (2018) argued that closing gender gaps in access to inputs, information, and land could raise women's farm productivity substantially, with spillovers for household nutrition and education. In cassava systems, those gaps manifest as later planting, smaller plots, less fertiliser, and fewer improved cuttings. Onyemma et al. (2023) found that women's adoption of improved cassava varieties in southeastern Nigeria was strongly influenced by processing traits and labour requirements, not yield alone. Teeken et al. (2021) similarly showed that trait preferences differ by gender and by end-use, with women placing higher weight on ease of peeling, poundability, and garri swelling. A gender-responsive evaluation therefore cannot stop at the field edge; it must follow the root into the processing shed and the market.

2.2 Poultry manure and cassava nutrition

Poultry manure is among the most nutrient-dense animal manures, typically containing more nitrogen and phosphorus than cattle or goat manure on a dry-weight basis, with a relatively low carbon-to-nitrogen ratio that favours rapid mineralisation (Amanullah et al., 2010; Agbede et al., 2017). Adeoye et al. (2005) reported that poultry manure improved soil chemical properties and maize performance in southwestern Nigeria, while Agbede et al. (2017) showed that integrated use of poultry manure and NPK improved soil properties and cassava yield in the forest zone. Odedina et al. (2011) found that poultry manure at moderate rates increased cassava tuber yield and soil organic carbon, and Uwah et al. (2011) reported that poultry manure enhanced growth and yield of cassava in Cross River State. Howeler (2002) emphasised that cassava removes large quantities of potassium in harvested roots, so repeated cropping without potassium return depletes soil reserves even when nitrogen and phosphorus appear adequate. Poultry manure returns potassium and other bases, helping to buffer acidity and sustain long-term fertility (Agegnehu et al., 2017). Composting or curing manure before application reduces weed seeds, pathogens, and ammonia volatilisation, a practice that matters when manure is applied near homesteads where women and children work (Amanullah et al., 2010).

2.3 Variety, canopy, and weed suppression

Weed management in cassava is labour-intensive because the crop's early growth is slow. Akobundu (1987) documented that weeds can dominate cassava fields in the first three months after planting, and Melifonwu (1994) showed that the critical period of weed competition extends well beyond the first month. Chikoye et al. (2007) evaluated integrated weed management options and found that vigorous varieties combined with timely weeding or cover crops reduced weed biomass and improved yield. Ekeleme et al. (2019) demonstrated that cassava varieties differ in canopy closure and weed suppression, and that early canopy closure is a heritable, selectable trait. In practical terms, a variety that shades the inter-row by 8 to 12 weeks after planting can cut weed biomass by half or more, saving one or two weeding rounds. That saving is gendered: because women perform most hand weeding in Umudike, a weed-suppressive variety directly frees women's time for processing, trading, childcare, and other income activities (Forsythe et al., 2021).

2.4 Processing quality and participatory selection

Dry matter content is a key determinant of garri and fufu yield: higher dry matter means more product per kilogram of fresh root and lower frying time and fuel use (Ceballos et al., 2020; Teeken et al., 2018). Swelling capacity, colour, aroma, taste, and texture determine market acceptance and price. Ceballos et al. (2020) reviewed cassava breeding for quality traits and stressed that end-user preferences must be captured early in the breeding pipeline. Ceccarelli (2015) argued that participatory plant breeding improves adoption by involving farmers in selection under their own management and stress conditions. In Nigeria, participatory trials have shown that farmers' rankings often diverge from breeders' rankings because farmers weigh processing and labour traits heavily (Teeken et al., 2018; Okechukwu and Dixon, 2008). The present study therefore combines replicated agronomic measurement with structured sensory evaluation by women processors, following the gender-responsive product profile approach advocated by Forsythe et al. (2021) and Teeken et al. (2021).

3. Materials and Methods

3.1 Study area

The trial was conducted during the April to November 2025 rainy season at the research farm of the National Root Crops Research Institute (NRCRI), Umudike (05°29′ N, 07°33′ E; 122 m above sea level), Ikwuano Local Government Area, Abia State, Nigeria. Umudike lies in the humid forest agro-ecological zone, with mean annual rainfall of about 2,100 mm distributed bimodally from March to November, mean temperature of 26 to 28 °C, and relative humidity above 75% during the rainy season. Soils are predominantly Ultisols, sandy loam to sandy clay loam, acidic (pH 4.8 to 5.5), low in organic matter and available phosphorus, and typical of degraded cassava soils in the zone (Fermont et al., 2009). The site had been under fallow for two years before the trial, with Chromolaena odorata and Panicum maximum as dominant fallow species. Pre-planting soil samples (0 to 20 cm) were bulked from 12 auger points, air-dried, sieved (2 mm), and analysed for pH, organic carbon, total nitrogen, available phosphorus, exchangeable potassium, calcium, and magnesium using standard methods (Agegnehu et al., 2017).

3.2 Experimental design and treatments

The experiment was laid out as a split-plot in a randomised complete block design with three replications. Main plots were four poultry manure rates: 0, 2.5, 5.0, and 7.5 t/ha. Subplots were three improved cassava varieties: TME 419, TMS 98/0581, and Game Changer. Each subplot measured 5 m by 5 m (25 m²), with 1 m alleys between subplots and 2 m alleys between main plots and blocks. Planting was done on ridges at 1 m by 1 m spacing, giving 10,000 plants/ha. Healthy, disease-free stem cuttings (20 cm, 5 to 7 nodes) were obtained from NRCRI's seed multiplication unit. Cured poultry manure, sourced from a commercial layer farm in Umuahia, was analysed for total N (2.85%), P (1.92%), K (2.10%), Ca (2.45%), Mg (0.68%), organic carbon (28.4%), and C:N ratio (9.9), then broadcast and incorporated two weeks before planting. No inorganic fertiliser was applied, to isolate the manure effect. Weeding was done manually at 4, 8, and 12 weeks after planting (WAP) in weeded sub-subplots for labour measurement, while weed-assessment quadrats were left unweeded until each assessment date, following the method of Ekeleme et al. (2019).

3.3 Data collection

Growth traits (plant height, stem girth, number of branches, leaf area index) were measured at 4, 8, 12, and 16 WAP on five tagged plants per subplot. Canopy cover was estimated with a 1 m by 1 m quadrat and visual scoring. Weed cover (%) and weed biomass (g/m², oven-dried at 70 °C for 48 h) were recorded at 4, 8, 12, and 16 WAP in two 0.5 m by 0.5 m quadrats per subplot. Weeding time (person-hours/ha) was recorded for each manual weeding round. At harvest (11 months after planting, November 2025), fresh tuber yield, number of tubers per plant, mean tuber weight, and harvest index were measured on the net plot (3 m by 3 m). Dry matter content was determined by oven-drying 500 g of fresh, chipped roots at 70 °C to constant weight (Ceballos et al., 2020). Starch content was estimated from dry matter using the standard conversion reported by Howeler (2002). Cyanogenic potential was screened qualitatively with the picrate method and reported as low to moderate for all varieties, consistent with improved varieties selected for low cyanide (Egesi et al., 2007).

Participatory evaluation involved 45 women farmers and processors (15 per replication block catchment) drawn from Umudike, Umuahia South, and Ikwuano communities. They had 5 to 25 years of cassava processing experience and regularly produced garri and fufu for home use and sale. Each woman evaluated fresh roots for ease of peeling (time to peel 5 kg, ease score), then processed 5 kg samples into garri and fufu using their usual methods. Sensory attributes (colour, aroma, taste, texture, swelling capacity, and overall acceptability) were scored on a 5-point hedonic scale (1 = dislike extremely, 5 = like extremely), following Teeken et al. (2018). Labour demand (peeling time, grating time, frying time, and fuel use) and garri conversion ratio (kg garri per 10 kg fresh roots) were recorded. Informed consent was obtained, participants could withdraw at any time, and no personal identifiers were recorded.

3.4 Statistical analysis

Data were subjected to analysis of variance (ANOVA) appropriate for a split-plot design using R (version 4.3.1). Manure rate, variety, and their interaction were treated as fixed effects; replication and block effects were random. Means were separated with Tukey's honestly significant difference test at $p < 0.05$. Regression analysis related fresh yield and weed cover reduction to manure rate, and correlation analysis examined relationships among canopy cover, weed biomass, and yield. Sensory scores were analysed as ordinal data with Kruskal-Wallis tests and post hoc Dunn tests, and mean scores are reported with standard errors. Partial budget analysis estimated net benefit (revenue minus manure, labour, and processing costs) using November 2025 Umudike market prices for fresh roots, garri, and poultry manure. All values are reported as mean ± standard error unless otherwise stated.

4. Results

4.1 Soil and manure characteristics

Pre-planting soil was acidic (pH 5.1), low in organic carbon (1.12%), total nitrogen (0.09%), available phosphorus (8.4 mg/kg), and exchangeable potassium (0.14 cmol/kg), confirming the need for organic amendment (Table 1). Poultry manure was alkaline (pH 7.8), rich in nitrogen, phosphorus, and calcium, and had a low C:N ratio that favoured rapid nutrient release. These properties are consistent with values reported by Amanullah et al. (2010) and Agbede et al. (2017) for cured layer manure in West Africa.

Table 1: Pre-planting soil and poultry manure characteristics at Umudike, 2025.

Property	Soil (0–20 cm)	Poultry manure
pH (H2O)	5.1	7.8
Organic carbon (%)	1.12	28.4
Total N (%)	0.09	2.85
Available P (mg/kg)	8.4	—
Total P (%)	—	1.92

Exchangeable K (cmol/kg)	0.14	2.10% total K
Ca (cmol/kg)	1.85	2.45% total Ca
Mg (cmol/kg)	0.62	0.68% total Mg

4.2 Growth, yield, and dry matter

Poultry manure and variety significantly affected growth and yield (Table 2; Figure 1). Fresh tuber yield increased sharply from 0 to 5.0 t/ha and then increased only modestly to 7.5 t/ha, indicating diminishing returns beyond the moderate rate. The main effect of manure was highly significant ($F = 42.18$, $p < 0.001$) and the main effect of variety was significant ($F = 19.64$, $p < 0.01$), while the manure-by-variety interaction was significant for fresh yield ($F = 3.84$, $p < 0.05$), reflecting that Game Changer responded more strongly to manure than TME 419. Across treatments, fresh yield ranged from 14.2 ± 0.9 t/ha (TME 419, 0 t/ha) to 28.6 ± 1.3 t/ha (Game Changer, 7.5 t/ha). The 5.0 t/ha rate with Game Changer produced 26.4 ± 1.1 t/ha, which was statistically comparable to the 7.5 t/ha rate but required 33% less manure. Dry matter content ranged from 30.1% to 35.6%, with Game Changer at 5.0 t/ha recording 34.8%, a value that favours garri conversion and frying efficiency (Ceballos et al., 2020). Tuber number per plant and mean tuber weight followed the same pattern, while harvest index peaked at 5.0 t/ha, suggesting that higher nitrogen at 7.5 t/ha favoured shoot biomass over storage roots, as reported by Odedina et al. (2011).

Table 2: Yield and yield components by selected variety-by-manure combinations (mean ± SE). Full 4 × 3 factorial means are shown in Figure 1.

Treatment	Fresh yield (t/ha)	Tubers/plant	Mean tuber wt (kg)	Dry matter (%)
TME 419 + 0 t/ha	14.2 ± 0.9	5.1	0.68	30.1
TME 419 + 5.0 t/ha	23.1 ± 1.0	7.2	0.89	32.4
TMS 98/0581 + 0 t/ha	15.8 ± 0.8	5.6	0.71	31.2
TMS 98/0581 + 5.0 t/ha	24.9 ± 1.1	7.8	0.95	33.1
Game Changer + 0 t/ha	17.1 ± 0.9	6.0	0.78	31.8
Game Changer + 5.0 t/ha	26.4 ± 1.1	8.4	1.02	34.8
Game Changer + 7.5 t/ha	28.6 ± 1.3	8.9	1.05	35.6

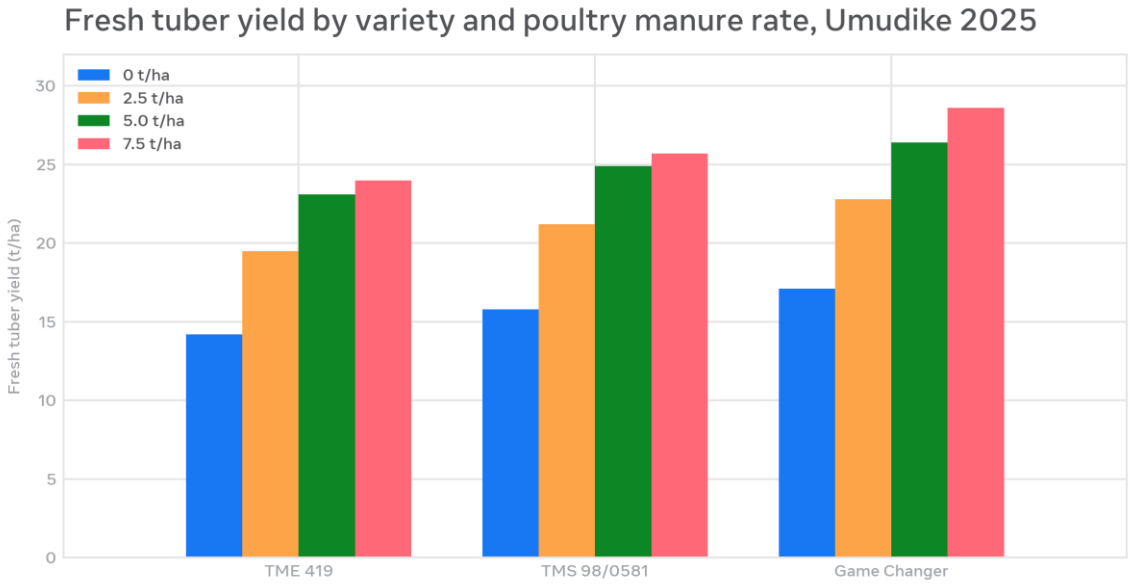


Figure 1: Fresh tuber yield by variety and poultry manure rate at Umudike, 2025. Bars are means of three replications.

4.3 Weed suppression and weeding labour

Weed cover and weed biomass declined as canopy cover increased, and both manure and variety affected weed suppression (Table 3; Figure 2). At 12 WAP, Game Changer at 5.0 t/ha achieved 68% weed cover reduction relative to the unweeded control, compared with 54% for TME 419 and 59% for TMS 98/0581 at the same manure rate. The regression of weed cover reduction on canopy cover was strong ($R^2 = 0.82$), supporting the hypothesis that vigorous canopy closure is the main mechanism of suppression (Ekeleme et al., 2019). Weed biomass at 12 WAP was lowest under Game Changer at 5.0 and 7.5 t/ha (112 and 98 g/m², respectively) and highest under unfertilised TME 419 (342 g/m²). Weeding labour followed weed biomass: plots under Game Changer at 5.0 t/ha required 18% fewer person-hours for the second and third weedings than unfertilised TME 419 plots. Women participants explicitly linked this saving to time available for processing and trading, a finding that echoes Doss (2018) on the value of labour-saving traits for women.

Table 3: Canopy cover, weed suppression, and weeding labour at 12 weeks after planting.

Treatment (at 12 WAP)	Canopy cover (%)	Weed cover reduction (%)	Weed biomass (g/m²)	Weeding labour (person-h/ha)
TME 419 + 0 t/ha	48	28	342	96
TME 419 + 5.0 t/ha	66	54	178	78
TMS 98/0581 + 5.0 t/ha	71	59	152	72
Game Changer + 5.0 t/ha	82	68	112	64
Game Changer + 7.5 t/ha	86	74	98	60

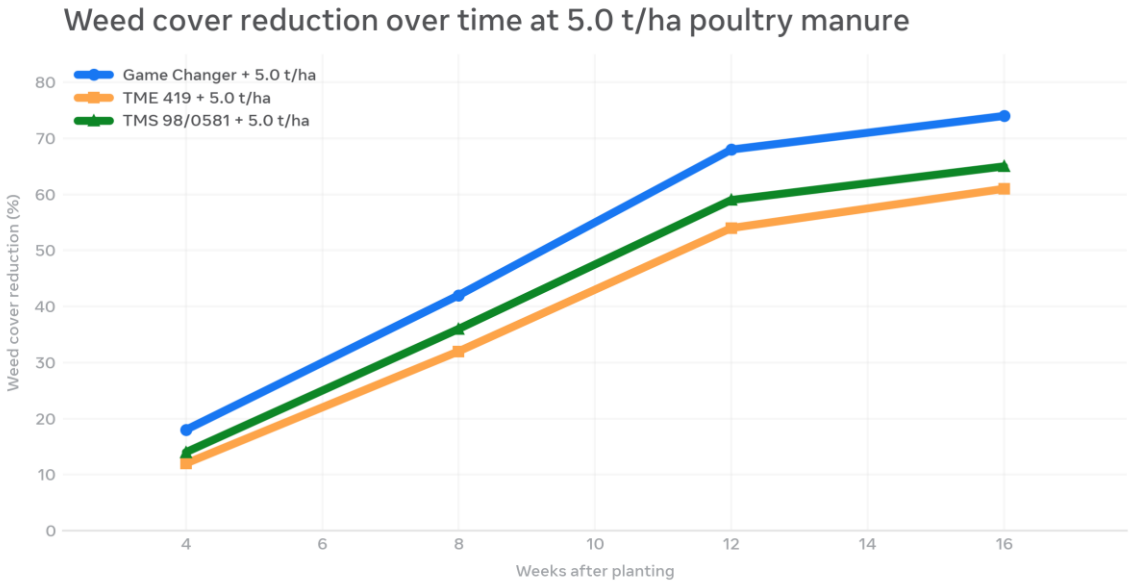


Figure 2: Weed cover reduction over time at 5.0 t/ha poultry manure for the three varieties.

4.4 Processing traits and women's evaluations

Women's evaluations distinguished the varieties more sharply on processing traits than on field appearance alone (Table 4). Game Changer was rated highest for ease of peeling (4.5 ± 0.2), swelling capacity (4.6 ± 0.3), and overall acceptability (4.6 ± 0.2) on the 5-point scale. TMS 98/0581 was intermediate, and TME 419 scored lowest on ease of peeling, although its garri colour was acceptable. Garri conversion ratio was highest for Game Changer at 5.0 t/ha (3.2 kg garri per 10 kg fresh roots, equivalent to 32% conversion), compared with 2.8 kg for TME 419 at the same manure rate. Peeling time for 5 kg was 12 minutes for Game Changer versus 18 minutes for TME 419, a 33% saving that women described as decisive when processing large batches. Frying time and fuel use were also lower for higher-dry-matter roots, reinforcing the economic value of dry matter (Ceballos et al., 2020). Sensory scores for taste and aroma did not differ significantly among varieties after fermentation, indicating that processing method, rather than variety alone, drives those attributes when fermentation is well managed (Teeken et al., 2018).

Table 4: Women's sensory and processing evaluations (mean ± SE, n = 45). Scores at 5.0 t/ha poultry manure.

Trait (5-point scale)	TME 419	TMS 98/0581	Game Changer
Ease of peeling	3.4 ± 0.3	3.9 ± 0.2	4.5 ± 0.2
Swelling capacity	3.6 ± 0.3	4.1 ± 0.2	4.6 ± 0.3
Garri colour	4.0 ± 0.2	4.1 ± 0.2	4.3 ± 0.2
Taste	4.1 ± 0.2	4.2 ± 0.2	4.4 ± 0.2
Overall acceptability	3.8 ± 0.2	4.2 ± 0.2	4.6 ± 0.2
Garri conversion (kg/10 kg fresh)	2.8	3.0	3.2

4.5 Economic analysis

Partial budget analysis showed that 5.0 t/ha poultry manure with Game Changer gave the highest net benefit among the combinations tested, because the modest yield gain from 7.5 t/ha did not offset the extra manure purchase and transport cost (Table 5). Net benefit for Game Changer at 5.0 t/ha was estimated at ₦842,000/ha, compared with ₦795,000/ha at 7.5 t/ha and ₦512,000/ha for unfertilised TME 419, using November 2025 prices. The benefit-cost ratio peaked at 5.0 t/ha, confirming that the agronomic optimum and the economic optimum coincide at the moderate rate for women farmers who face cash constraints. This result aligns with Ezui et al. (2017), who found that moderate, site-specific nutrient rates often outperform blanket high rates in smallholder cassava systems.

Table 5: Partial budget analysis (November 2025 Umudike market prices).

Treatment	Manure cost (₦/ha)	Labour cost (₦/ha)	Gross revenue (₦/ha)	Net benefit (₦/ha)	Benefit-cost ratio
TME 419 + 0 t/ha	0	185,000	697,000	512,000	2.77
TMS 98/0581 + 5.0 t/ha	125,000	168,000	1,102,000	809,000	2.77
Game Changer + 5.0 t/ha	125,000	152,000	1,119,000	842,000	3.02
Game Changer + 7.5 t/ha	187,500	148,000	1,131,000	795,500	2.67

5. Discussion

The finding that 5.0 t/ha poultry manure optimises yield, dry matter, weed suppression, and net benefit is consistent with the principle of diminishing returns and with earlier Nigerian work on organic amendments for cassava (Odedina et al., 2011; Uwah et al., 2011; Agbede et al., 2017). The strong manure effect ($F = 42.18$) reflects the low baseline fertility at Umudike, where nitrogen, phosphorus, and potassium all limited growth. Poultry manure's rapid mineralisation, driven by its low C:N ratio, supplied nutrients during the critical early canopy-development phase, when cassava is most vulnerable to weed competition (Amanullah et al., 2010; Ekeleme et al., 2019). At 7.5 t/ha, extra nitrogen appeared to shift assimilates toward shoots, lowering harvest index without a proportional gain in storage roots, a pattern also noted by Howeler (2002) for high-nitrogen cassava systems.

Varietal differences in weed suppression were mediated by canopy architecture. Game Changer's earlier branching and larger leaf area produced faster ground cover, which shaded weeds and reduced their biomass by more than two-thirds by 12 WAP. The R^2 of 0.82 for the relationship between canopy cover and weed reduction is comparable to values reported by Ekeleme et al. (2019) and Chikoye et al. (2007), and it underscores that breeding for early vigour is a weed-management strategy, not merely a yield trait. For women farmers, the labour saving is as valuable as the yield gain: each weeding round saved is a day or more of drudgery avoided and a day available for processing, marketing, or household care (Doss, 2018; Forsythe et al., 2021). Extension messages that promote weed-suppressive varieties should therefore quantify labour savings, not only yield, when advising women's groups.

Processing results show why gender-responsive breeding matters. Game Changer's advantage was largest for traits women control and value: peeling ease, swelling, and conversion ratio. Those traits translate directly into income because garri is sold by volume and weight, and swelling determines how far a measure of garri goes in the household pot (Teeken et al., 2018; Ceballos et al., 2020). The fact that taste and aroma did not differ significantly after proper fermentation suggests that processors can achieve acceptable sensory quality from any of the three varieties, but that Game Changer reduces the labour and fuel cost of getting there. This finding supports the product-profile approach of Forsythe et al. (2021), in which breeders set minimum thresholds for processing traits alongside yield and disease resistance. It also suggests that seed systems should bundle variety information with processing guidance, so that women's groups can compare varieties on the traits that matter to them.

The study has limitations. It covers one season and one site, so multi-location, multi-season validation is needed before blanket recommendation, particularly because rainfall distribution and weed flora vary across Abia State. Manure nutrient content varies by poultry type, feed, and curing method, so farmers should have manure tested or use well-cured manure from a consistent source. Sensory evaluation, while structured, reflects the preferences of 45 women in three communities; preferences may differ in other processing traditions. The economic analysis uses one season's prices, which are volatile. Future work should test integrated manure-plus-NPK micro-dosing, cassava-legume intercropping for additional weed suppression, and longer-term soil organic matter changes under repeated manure application, following Fermont et al. (2009) and Ezui et al. (2017).

6. Conclusion and Recommendations

For women smallholder farmers in Umudike, the combination of 5.0 t/ha cured poultry manure with Game Changer offered the best balance of fresh tuber yield (26.4 ± 1.1 t/ha), dry matter (34.8%), weed suppression (68% reduction at 12 WAP), processing quality (4.6/5.0 acceptability), and net benefit (₦842,000/ha). The 7.5 t/ha rate gave slightly higher yield but lower economic return, and the unfertilised control gave low yield and high weeding labour. It is recommended that (i) extension services in Abia State promote 5.0 t/ha cured poultry manure with Game Changer, with training on composting, timely application, and safe handling; (ii) seed systems ensure timely access to clean Game Changer cuttings for women's groups, with processing demonstrations; (iii) breeding and agronomy programmes retain ease of peeling, swelling, and canopy vigour as selection criteria alongside yield; and (iv) women's cooperatives be supported with group purchase of manure and shared processing equipment to reduce costs and drudgery. Integrating agronomic productivity with women's processing and weeding preferences supports higher adoption, higher income, and more resilient cassava systems.

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Conflict of Interest

The authors declare no conflict of interest.

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